A Beginning Look at the Effect of Age on Dyspnea, Physical Functioning and Self-Efficacy for Home Walking and Managing Shortness of Breath in Adults with Chronic Obstructive Pulmonary Disease (COPD)

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ABSTRACT

A BEGINNING LOOK AT THE EFFECT OF AGE ON DYSPNEA, PHYSICAL FUNCTIONING AND SELF-EFFICACY FOR HOME WALKING AND MANAGING SHORTNESS OF BREATH IN ADULTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

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Chronic illness is common in older adults and is associated with functional impairments. Older adults with chronic obstructive pulmonary disease (COPD) face both age-related and disease-related decline in pulmonary function. Dyspnea, also referred to as shortness of breath, is a major symptom in COPD and progressive dyspnea is associated with decline in physical function. Aging, chronic illness and a decline in physical function can compromise the individual's confidence, also known as self-efficacy, for performing physical activities. Chronic disease self-management programs for COPD that include an exercise program have been reported to improve functional status, decrease dyspnea and improve self-efficacy for specific tasks. It is not known if advancing age moderates the effect of a dyspnea self-management program (DSMP) on functional performance, dyspnea and self-efficacy outcomes.

Purposes: 1) Determine if advancing age is a moderator of functional performance, dyspnea, or self-efficacy outcomes following three different DSMP interventions; 2) Determine if predictors of self-efficacy for home walking and self-efficacy for managing shortness of breath are similar; and 3) Determine if self-efficacy for home walking and self-efficacy for managing shortness of breath change following three different DSMP interventions.

Methods: This is a secondary analysis of a longitudinal, randomized-controlled DSMP trial. One hundred and three (103) participants with COPD (57 women; mean age 66 ± 8; mean FEV-1% predicted: 44.8 ± 14%) were randomized to: 1) a dyspnea self-management program (DM group); 2) a DSMP and four supervised treadmill exercise session (DM-Exposure group) or 3) DM plus 24 supervised treadmill exercise sessions (DM-Training) group. Functional performance outcomes, including self-reported measures and exercise tests, dyspnea intensity measures and self-efficacy for home walking and self-efficacy for managing shortness of breath ratings were measured at specific intervals over the 12 month study period.

Results: Age was found to be a significant moderator of self-reported physical function, exercise test performance, and dyspnea intensity both during and after exercise. Additionally, self-efficacy for home walking and self-efficacy for managing shortness of breath improved in all groups following the DSMP intervention. Age was not a significant moderator of self-efficacy outcomes. The predictors of baseline self-efficacy domains evaluated in this study were not similar.

Conclusions: Advancing age moderates the effect of three different DSMP interventions on self-reported and exercise test functional performance measures, and dyspnea intensity

ratings during and after exercise. Self-efficacy for home walking and self-efficacy for managing shortness of breath ratings improved after the DSMP interventions. While not a completely consistent pattern, it does appear that a more intense exercise intervention may be favorable for the older adult.

Advisor and Chair of Dissertation Committee:

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CHAPTER ONE: PROBLEM AND SIGNIFICANCE

Introduction

A joint position statement issued by the American Thoracic Society (ATS) and the European Respiratory Society (ERS), defines chronic obstructive pulmonary disease (COPD) as a "preventable and treatable disease state characterized by airflow limitation that is not fully reversible" (ATS/ERS, 2005). The term COPD encompasses chronic obstructive bronchitis, which is clinically characterized by obstruction of small airways, and emphysema, which is hallmarked by enlargement of airspaces, destruction of lung tissue, reduced lung elasticity and closure of small airways (Barnes, 2000). Also included under the category of COPD is chronic bronchitis. Chronic bronchitis is clinically defined as the presence of a cough and sputum daily for at least three months for two consecutive years, and requires that other causes for cough have been excluded (ATS, 1995; Barnes, 2000). A major feature of this form of COPD is mucus hypersecretion, which may or may not be accompanied by airway obstruction (Barnes, 2000; Vestbo, Prescott, & Lange, 1996). Most cases of COPD can be attributed to smoking and the diagnosis is often made in the fifth decade or later (ATS/ERS, 2005)

The most common symptom reported by COPD patients is dyspnea, also commonly termed "breathlessness" or "shortness of breath" (Mahler & Baird, 2005). Dyspnea is a subjective term that describes a sensation of uncomfortable breathing that varies in intensity (ATS, 1999). The mechanisms of dyspnea are complex and incorporates physiological, psychological, psychosocial and environmental factors that may be manifested by the individual as secondary behavioral and physical responses (ATS, 1999).

Advancing age is associated with declining physical activity. In the case of the adults and older adults (generally age 65 or older) with COPD, the individual gradually reduces physical activity in an effort to reduce dyspnea associated with activity (Mahler, 1993) (Sassi-Dambron, Eakin, Ries, & Kaplan, 1995). The fall in physical activity contributes to an overall reduction in physical functioning in COPD patients (Reardon, Lareau, & Zuwallack, 2006) and setting into motion a downward cycle of disability, declining function and worsening dyspnea (Carrieri-Kohlman, 2003).

It is also recognized that as one ages, their confidence for remaining physically active can gradually decline (Bandura, 1997). This type of confidence is called "self-efficacy" and reflects the individuals' self-assurance in being able to complete or accomplish a specific task (Bandura, 1997). Aging is associated with some gradual decline in physical activity and this decline can negatively impact one's self-efficacy or confidence that they can carry out a specific physical activity task (Bandura, 1997).

When evaluating the older adult with COPD, it is important to recognize that the pathophysiological changes associated with COPD are superimposed on expected age-related changes in the pulmonary system. There is ample evidence that the lung undergoes numerous changes as part of the normal aging process, which results in a gradual decline in respiratory function. The three most important age-related changes in the respiratory system are 1) decreased compliance (increased stiffness) of the chest wall; 2) a loss of respiratory muscle strength; and 3) increased compliance of lung tissues (Zeleznik, 2003). These age-related changes in the lung influence airway function, lung volumes, flows and gas exchange. Expected age-related decline in pulmonary function, coupled with pathophysiological

changes associated with COPD, results in a "double- edged sword" for the older adult with COPD.

In summary, the age-related physiological decline in lung function, superimposed with pathophysiological changes associated with COPD are considerable. It is well recognized that declining physical activity leads to disability and morbidity and that aging and chronic illness can gradually erode self-efficacy for subsequent physical activity and subsequent physical activity. Therefore therapeutic interventions that are designed to increase physical activity, instill confidence in being able to be physically active, are particularly important for the older adult with COPD.

Statement of the Problem

Dyspnea is known to negatively impact functional status (Reardon et al., 2006). Dyspnea and declining physical activity pose significant problems for the adult and older adult with COPD. Given that older adults are particularly vulnerable to the adverse effects of declining functional status, that functional losses are associated with a decline in self-efficacy for physical activity, and that dyspnea is linked to a decline in functional status, it is critical that interventions designed to support or improve physical function and reduce dyspnea be evaluated for their effect on functional status and symptoms. Due to age-related physiological changes, coupled with the pathophysiological changes associated with COPD, it is quite possible that a specific intervention, such as a symptom self-management program, may be less efficacious in an older adult COPD patient in effecting improvements in symptoms, quality of life or exercise performance. The older adult faces an uphill battle in maintaining or restoring physical function, therefore the intensity and/or length of the intervention may moderate the effectiveness of an intervention in this subpopulation.

Additionally, because functional status is clearly linked to self-efficacy for physical activity in older adults, the key to an effective intervention may lie in the positive impact the intervention has on self-efficacy for physical activity, particularly in the older adult with COPD experiencing dyspnea.

Purpose of the Study

The overall aim of this secondary analysis is to: 1) describe the influence of age on functional status (both functional performance and functional capacity) and dyspnea outcomes in COPD patients participating in a trial that tested three versions of a dyspnea self-management program (DSMP) ; 2) compare predictors of self-efficacy for home walking and managing shortness of breath in a sample of adults and older adults with COPD participating in a trial of three different versions of a DSMP; 3) evaluate changes in self-efficacy ratings for home walking and managing shortness of breath (SOB) after three different DSMP interventions and 4) determine if age moderates changes in self-efficacy for home walking and managing shortness of breath ratings over time in a trial that tested three different versions of a DSMP.

Significance

Prevalence, Morbidity and Mortality of Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease is a highly prevalent chronic illness in adults. According to World Health Organization (WHO) estimates, 80 million people worldwide have moderate to severe COPD (WHO, 2007). United States (U.S.) Centers for Disease Control (CDC) data collected through 2000 estimates that between 10 and 24 million

Americans have COPD (CDC, 2007). Current data indicates that moderate COPD is found in 6.9% of the general U. S. population aged 25-75 years (ATS/ERS, 2005).

Chronic obstructive pulmonary disease is quite prevalent in the U.S. older adult population. Data from the 2003 National Health Interview Survey revealed that 928,000 adults aged 65-74 reported they had emphysema, and 1,131,000 in the same age group reported they had chronic bronchitis. In the 75 years and older age group, the numbers remain substantial: 771,000 reported a diagnosis of emphysema and 865,000 reported chronic bronchitis. Due to inconsistencies in disease reporting, authorities caution that the older adult disease prevalence estimates may be inaccurately low (NHLBI/WHO, 2001). With the number of older adults (aged 65 years and older) in the U.S. predicted to double over the next 25 years (CDC, 2006), it can be expected that the prevalence of COPD in the older adults will increase.

Chronic obstructive pulmonary disease is associated with considerable mortality, morbidity and expense. In the U.S., COPD is the fourth leading cause of death among individuals aged 65 or older; only cardiovascular disease, cancer and stroke rank higher (CDC, 2006; Hurd, 2000). Male gender and advancing age are associated with increased morbidity in COPD (NHLBI/WHO, 2001). In 1996, more than 16 million physician office visits were attributed to a primary diagnosis of COPD. In 2002 alone, U. S. healthcare expenditures associated with COPD costs totaled $32.1 billion, with $18.1 billion attributed to medical services and $14.4 billion associated with the indirect costs of morbidity and premature mortality (NHLBI, 2002). Medicare expenditures for beneficiaries with COPD were 2.5 times higher than expenditures for all other patients (NHLBI, 2002). The predicted

25% increase in the American older adult population in the coming decades is projected to boost medical expenditures by 25% as well (CDC, 2006).

Functional Tasks and Functional Status

Functional tasks are the very basic physical activities that are required for independent daily living (Reuben, 2003). Supporting or restoring independence in performing functional tasks is the primary focus of geriatric care. Functional tasks are hierarchically organized into three levels: the basic ability to perform activities of daily living (ADLs), such as bathing, eating, and transferring; instrumental activities of daily living (IADLs), such as handling finances, using the telephone and managing medications; and advanced activities of daily living (AADLs) which includes fulfilling social roles, family roles and work activities (Reuben, 2003).

The terms "functional status," "functional capacity" and "functional performance" are often used interchangeably, but actually are not synonymous. Klein-Leidy has proposed a logical and succinct framework for delineating the different components of the larger concept of functional status (Leidy, 1994). The term functional status refers to the entire domain of functioning. Subsumed under the domain of functional status are four distinctly different, but interrelated elements that must be considered: functional capacity, functional reserve, functional performance and functional capacity utilization. These will de addressed in more detail in Chapter Two.

Impact of Chronic Illness on Functional Status

Chronic illness can result in a decline in functional status at one level or several levels. Centers for Disease Control data indicates that 80% of people age 65 or older report

one chronic illness, and 50% have at least two chronic illnesses (CDC, 2006). Collectively, these chronic illnesses lead to disability, pain, and most importantly, a decline in physical functioning. When a functional loss occurs, the help of another person to accomplish a task becomes necessary. When the functional status loss or losses are at the basic ADL level, he/she may have to hire personal care help or move out of their home to a community facility where assistance with ADLs is readily available. Clearly such changes are life changing and expensive.

The importance that geriatric care assigns to maintaining and supporting functional status is well placed. Functional status impairments are clearly associated with chronic illnesses, are quite prevalent in the older adult population, and are associated with substantial expense. Data from the 2003 Medicare Current Beneficiary Survey (MCBS) (which reflects a cohort of individuals age 65 and older or permanently disabled) revealed that 37% of the community dwelling respondents reported a physical limitation, 14% reported an IADL impairment, 19% reported 1-2 ADL impairments and 9% reported impairment of 3-6 ADLs (CDC, 2003). Only 21% of survey respondents denied any physical limitations or ADL/ IADL impairment.

Impact of Dyspnea on Functional Status

Dyspnea is widely recognized to be the driving force behind the gradual reduction in physical activity commonly observed in COPD patients (Graydon, Ross, Webster, Goldstein, & Avendano, 1995; Peruzza et al., 2003; Reardon et al., 2006; Weaver, Richmond, & Narsavage, 1997). Controlling for age and oxygen use, dyspnea has been reported to be a significant predictor changes in functional performance (Reishtein, 2005). When compared to healthy older adult controls, older COPD patients report a greater number of impairments

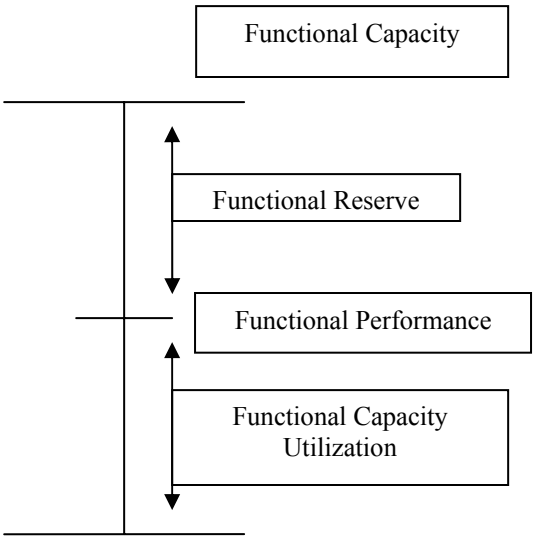
in performing ADLs, have a higher incidence of depression, perform poorer on walking tests, report higher dyspnea intensity, and report a poorer health-related quality of life (Peruzza et al., 2003). Psychological symptoms in older adults with COPD also adversely impact functional status (Lee, Le, & Mackenzie, 2006). When compared to age matched controls, older adults with COPD are significantly less physically active (Pitta et al., 2005). Older adult women with COPD suffer greater losses in household management functionality than their male COPD patient counterparts (Skumlien, Haave, Morland, Bjortuft, & Ryg, 2006).

CHAPTER TWO: REVIEW OF RELEVANT LITERATURE

Definition of Functional Status

To provide a clear context for this review, the concept of functional status will be presented first. The nursing and medical literature are fraught with inconsistent use of terms to describe functional status. Klein-Leidy (Leidy, 1994) proposed a framework for differentiating the different components under the domain of functional status. The elements are represented in Figure 2.1.

Figure 2.1: Klein-Leidy Functional Status Conceptual Framework



Klein-Leidy acknowledges that functional status is multi-dimensional and quite broad, as it spans the spectrum of function, ranging from basic ADLs to the psychological, spiritual and social aspects of an individual's life (Leidy, 1994). The psychosocial, spiritual and social aspects of function come into play when an individual may choose (or not chose) to perform a task or physical activity up to their personal capacity (Leidy, 1994). Functional status refers to the entire domain of functioning, and under this broad concept, there are four inter-

related, but distinctly different elements: functional capacity, functional reserve, functional performance and functional capacity utilization (Leidy, 1994).

According to Klein-Leidy's framework, functional capacity, which is positioned at the top of the spectrum, represents an individual's maximal potential to perform daily activities. This can be measured by means of cycle ergometry performance, ventilatory capacity during treadmill testing or grip strength and reflects the individual's muscle strength, coordination, and balance. The individual may never tap into this maximal capacity for a variety of reasons, including lack of volition. Functional performance, which is positioned on the lower portion of the spectrum, represents ADLs and IADLs that are performed to meet the individual's daily needs, to maintain personal health, and to fulfill roles, such as caring for a family member. The level of exertion needed to perform tasks at this level is lower than what is required when functional capacity is being utilized. Functional reserve, on the other hand, spans the difference between functional performance and functional capacity. It is not required to complete daily activities, but is available if circumstances warrant. The "size" of functional reserve varies considerably across individuals and involves a level of exertion that is beyond usual levels needed to function. Finally, the dynamic element of functional capacity utilization is the inverse of functional reserve and represents the individual's maximum potential to achieve a desired level of performance. As functional capacity utilization increases, the amount of available reserve decreases. Kline-Leidy's framework nicely represents the important inter-play between these four components of functional status. In this study, functional performance and functional capacity are key outcome measures.

Review of Relevant Literature

COPD Self-Management Programs

Recognizing that COPD patients could benefit from disease education and supervised exercise training in a supportive social environment, pulmonary rehabilitation programs were developed (ATS/ERS, 2006). The most commonly cited reasons for referral to pulmonary rehabilitation are to reduce dyspnea and fatigue, to improve ability to perform ADLs, and to improve overall quality of life (ATS/ERS, 2006). Pulmonary rehabilitation programs typically offer education about the disease process and medications, promote self-management of the disease, supervised and progressive exercise and social interaction.

Pulmonary rehabilitation programs are considered to be more effective in improving dyspnea, exercise endurance, functional capacity and quality of life than nearly any other currently available treatment for COPD (ATS/ERS, 2006; Lacasse et al., 2001). Unfortunately, the typical 12-week time commitment, cost/reimbursement issues and travel/transportation hassles often precludes COPD patients from being able to participate in pulmonary rehabilitation programs. It is estimated that only 0.1% of eligible COPD patients in the U. S. actually participate in pulmonary rehabilitation programs (Bickford, Hodgkin, & McInturff, 1995).

An alternative to a formal pulmonary rehabilitation program is a self-management program. The concept of self-management can be broadly defined as the individual's skill in responding to symptoms, treatments and the psychosocial and physical manifestations of a chronic illness (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002). This involves continuously and effectively managing one's condition through self-monitoring of

symptoms, cognitive, emotional and behavioral manifestations of the condition and taking appropriate action to maintain an acceptable level of health (Barlow et al., 2002).

Chronic illnesses self-management programs are recognized by the CDC as an essential component of a larger plan to promote functionality, reduce symptoms and improve quality of life particularly in older adults (CDC, 2006). Given COPD is a chronic illness with persistent symptoms, self-management programs would be expected to be of benefit to the patient. Self-management programs are recognized to be an important aspect of providing effective chronic illness care. The Chronic Care Model (CCM) (Wagner et al., 2001) inspired by the Institute on Medicine (IOM) report on quality gaps in healthcare (IOM, 2001), provides a clear place for self-management in chronic illness care The six components of the CCM are as follows: organizational design of health care delivery; patient-oriented community resources and policies; delivery system design; decision support; clinical information systems; and patient self-management programs (IOM, 2001).

Self-management programs for COPD have been developed to support people after they completed acute treatment or a rehabilitation program, particularly when dyspnea remains a distressing symptom. Compared to formal pulmonary rehabilitation programs, self-management programs for COPD typically are offered within a more flexible framework, can be performed at home, place a great deal of emphasis on symptom management, and may or may not include an exercise component. The overall goals of self-management programs are to decrease dyspnea, increase self-management skills and, in some cases, improve self-efficacy for specific functions or activities.

Since 1986, 12 COPD self-management program studies have been described in the nursing and medical literature (J. Bourbeau et al., 2003; Carrieri-Kohlman et al., 2005;

Gallefoss, Bakke, & Kjaersgaard, 1999; Howland et al., 1986; Littlejohns, Baveystock, Parnell, & Jones, 1991; Monninkhof, van der Valk, van der Palen, van Herwaarden, & Zielhuis, 2003; Sassi-Dambron et al., 1995; Stulbarg et al., 2002; Watson et al., 1997; Zimmerman, Brown, & Bowman, 1996). In addition, a recent Cochrane review was conducted to evaluate self-management education programs for COPD (Monninkhof et al., 2002).

Unfortunately, COPD self-management programs do not consistently yield improvement in symptom or physical function outcomes. Monnikhof and colleagues' Cochrane review (Monninkhof et al., 2002) concluded that COPD self-management studies failed to demonstrate any reduction in hospital admission rates, emergency department visits, lung function or days of work lost. The review did note that self-management education was associated with a reduction in rescue medication use, antibiotic use and oral steroids.

Monninkhof's Cochrane review noted that comparison of studies is difficult mainly because numerous outcome measures are used (Monninkhof et al., 2002). While the components of the programs and outcome measures vary, the major difference across studies is whether or not exercise is included and emphasized. Please see Table 1 for an overview of COPD self-management studies.

Among the six studies that offered only an educational component (ranging from two individualized sessions to multiple session over an eight week period) (Gallefoss et al., 1999; Howland et al., 1986; Littlejohns et al., 1991; Sassi-Dambron et al., 1995; Watson et al., 1997; Zimmerman et al., 1996), none yielded a significant improvement in symptoms. Only the Zimmerman study (Zimmerman et al., 1996) yielded an improvement on a measure of self-efficacy for managing symptoms of COPD, but the sample was very small. Two studies

have evaluated the effect of self-management education, prescriptions for antibiotics and steroids, and an action plan (J. Bourbeau et al., 2003; Gallefoss et al., 1999). The 12-month Bourbeau study (J. Bourbeau et al., 2003), which included self-management education, home visits and an optional exercise component, reported a decrease in hospital services utilization and unscheduled medical office visits, but no improvement on walking tests or symptoms. Similarly, the Gallefoss study (Gallefoss et al., 1999) did not yield health-related quality of life improvements. Among the three other studies (described in five papers) that also included an exercise component (Carrieri-Kohlman et al., 2005; Gadoury et al., 2005; Monninkhof et al., 2004; Monninkhof et al., 2003; Stulbarg et al., 2002), only two studies (reported in three paper) demonstrated improvement in physical functioning outcomes (J. Bourbeau et al., 2003; Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002).

As noted above, a collective evaluation of this body of literature in this area is difficult due to inconsistencies in design and/or measurement. Design problems include small sample size (Zimmerman et al., 1996), the use of only one curriculum to teach self-management to both COPD and asthma patients (Gallefoss & Bakke, 1999) or an optional exercise component that was apparently not monitored (J. Bourbeau et al., 2003). Other studies used either non-validated tools (Howland et al., 1986) or completely missed opportunities to collect important data such as changes in dyspnea (Watson et al., 1997) or performance based measures of function (Howland et al., 1986; Monninkhof et al., 2003). One study sought to measure the effect of self-management, but may have actually tested the effect of a case manager/liaison (Littlejohns et al., 1991). A very important economic impact study demonstrated the expense of dyspnea self-management program (Monninkhof et al., 2004) that, unfortunately, did not result in favorable outcomes (Monninkhof et al., 2003).

Two reports (from one study) provide some evidence of reduced hospital service utilization (J. Bourbeau et al., 2003; Gadoury et al., 2005), but did not account for the costs of the program itself, raising important questions about cost effectiveness.

On the other hand, several interventions contained within the self-management studies and three exercise only studies are instructive. The use of individualized treatment plans (J. Bourbeau et al., 2003; Watson et al., 1997), education tailored to disease severity (Howland et al., 1986), the use of a case manager (Littlejohns et al., 1991), or emphasizing and strengthening self-management strategies (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002) may be of particular benefit to some groups. Additionally, three studies reported favorable outcomes from home-based exercise programs (Hernandez et al., 2000; Larson et al., 1999; Puente-Maestu et al., 2000). While these three studies were not intended to be self-management programs, they do reinforce the notion that exercise is a critical component in reducing symptoms. It appears the optimal self-management program must include both education and exercise components (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002).

The COPD self-management studies reported in the literature describe a wide spectrum of educational and exercise interventions, but determining what are the critical elements or combination of elements, other than the clear need for an exercise, remains elusive. Unfortunately, the majority of these programs have fallen short of demonstrating significant improvements, including functional status/performance, if measured. It is also not known if advancing age is a factor in whether or not the interventions are effective or not. None of the studies reviewed here have addressed age as a variable.

The ideal self-management program would be time, resource and cost-efficient, and would reliably yield significant improvements in functional status, reduce symptoms through

effective application of self-management skills, and enhance quality of life. In the case of the older adult COPD participant, it is important to determine if the physiological "double-edged sword" of age-related respiratory systems changes and COPD pathophysiology diminish the desirable effects of the treatment.

Self-Efficacy for Physical Activity and Symptom Management in Older Adults

The older adult with COPD faces many factors that are potentially detrimental to their functional status. An important aspect in maintaining or improving functional status is linked to an individual's confidence, or "self-efficacy," for being able to accomplish a given task. Bandura, known for his widely applied Social Cognitive Theory, defines self-efficacy as the individual's perception that they will be capable of performing a specific behavior that leads to achieving a desired outcome (Bandura, 1997).

While the concept of self-efficacy has application across the life-span, Bandura devotes considerable attention to self-efficacy in the older adult. Bandura acknowledges that the functional status decline in older adults is frequently attributed to physiological aging, evidenced by statements such as "Oh, I'm just getting old." This sentiment is linked with decline in self-efficacy for physical activity (Bandura, 1997). Some older adults who experience a decline in functional status over time eventually may give up trying to care for themselves, resulting in lower self-efficacy (Zautra, Reich, & Newson, 1995). Bandura asserts that while illness in later life can damage self-efficacy, favorable self-efficacy has a protective effect (Bandura, 1997), so interventions designed to support or improve functional status should incorporate strategies that target self-efficacy for physical activity specifically.

In the past decade, studies involving older adults have increasingly evaluated self-efficacy influencing exercise behaviors and/or physical functioning. Self-efficacy for

exercise and self-management has been studied in a general sample of community-dwelling older adults (Resnick, 2000, 2001, 2004; Resnick & Nigg, 2003; Resnick, Palmer, Jenkins, & Spellbring, 2000), in older adults with heart disease (Gray, 2006), and in hypertensives (Lee & Laffrey, 2006). Additionally, the effect of demographic characteristics has been related to self-efficacy for health behaviors and exercise (Clark, Patrick, Grembowski, & Durham, 1995; Grembowski et al., 1993).

Lee and Laffrey (Lee & Laffrey, 2006) measured self-efficacy for physical activity in a trial involving older adults with hypertension. They found that self-efficacy for physical activity both directly and indirectly influenced exercise behaviors in their sample, confirming that the intervention had a positive effect on exercise behaviors.

Resnick and colleagues (Resnick et al., 2000) found that in their older adult sample, self-efficacy for exercise was directly related to exercise behaviors and also indirectly related to exercise behaviors through outcome expectations (Resnick, 2000). Path analysis demonstrated that age and gender indirectly influenced exercise behaviors through self-efficacy for exercise and outcome expectations. Correlational analysis revealed that physical and mental health were found to be correlated with self-efficacy for exercise expectations. A later path analysis reported by the same researcher (Resnick & Nigg, 2003) confirmed the mediating effect of self-efficacy for exercise, and that both self-efficacy for exercise and outcome expectations influence exercise behaviors in older adults (Resnick & Nigg, 2003). This analysis also confirmed that age and self-efficacy for physical activity were significantly correlated (Resnick & Nigg, 2003).

One longitudinal study of self-efficacy for exercise behaviors with older adults has been reported (Resnick, 2004). This study evaluated self-efficacy for exercise behaviors in a

cohort of older adults living in a continuing care retirement community. Self-efficacy for exercise expectations (whether or not the respondent thought they could continue to exercise even if barriers were present) and outcome expectations (a belief that exercise will result in a certain consequence) did not change significantly over the four year study period, but actual exercise activity decreased over time. Path analysis indicated that age, gender and mental health had an inconsistent influence on exercise activity and that self-efficacy for exercise expectancies and outcome expectancies both directly and indirectly influenced actual exercise activity.

Important covariates of self-efficacy in older adults have been identified. Several studies have focused specifically on older adult women. Using a cross-sectional design, Conn determined that self-efficacy for exercise expectations, along with perceived exercise barriers and age, influenced exercise behaviors in older adult women (Conn, 1998). McAuley and colleagues (McAuley et al., 2006) also studied older adult women and found that functional limitations were influenced by physical activity level, functional status and self-efficacy ratings for exercise, gait and balance and physical function. The authors of this cross-sectional study call attention to the fact that that both physical function and self-efficacy are modifiable, and are therefore amendable to specifically-directed interventions. A recent controlled study of older woman with diastolic heart failure evaluated the effect of a home walking and educational intervention on walking performance, depression, physical function and self-efficacy ratings for exercise adherence(Gray, 2006). Following the 12-week trial period, walking performance, depression, physical function and self-efficacy for exercise adherence all improved significantly in the intervention group, but not in the control group.

Researchers have reported that self-efficacy for health-related or exercise behaviors in older adults are linked to socioeconomic status. Grembowski and colleagues (Grembowski et al., 1993) studied self-efficacy for a variety of domains (exercise, dietary fat, weight control, alcohol intake, and smoking) in an older adult sample and found that a higher socioeconomic status was associated with better functional status. Furthermore, they were able to determine that the association between socioeconomic status and functional status was mediated by self-efficacy for health promoting behaviors (Grembowski et al., 1993). Clark, Patrick, Grembowski and Durham (Clark et al., 1995) explored the effect of socioeconomic status on self-efficacy for exercise behaviors in older adults and found that age and educational level were directly associated with exercise behaviors. Clark and Nothwehr (Clark & Nothwehr, 1999) studied a large sample of socioeconomically disadvantaged adults aged 55 and up and found that sociodemographic factors/characteristics, environmental factors and interpersonal factors collectively accounted for 31% of variance in their regression model. Additionally, they reported that exercise self-efficacy scores were higher among individuals who denied fear of pain or shortness of breath, had experience with exercise and rated their own health as good.

Self-Efficacy in COPD Patients

A study by Scherer and colleagues examined changes in self-efficacy for managing shortness of breath by comparing pre and post pulmonary rehabilitation program self-efficacy ratings (Scherer & Schmieder, 1996). The researchers reported improved self-efficacy for managing shortness of breath in the program participants and the positive effect on self-efficacy was sustained six months after the program ended. The researchers concluded that the "active ingredient" in this intervention, namely the pulmonary

rehabilitation program, demonstrated the value of the program and exercise had on positively influencing change in self-efficacy. A later published report by the same researchers found that the COPD Self-Efficacy Scale (CSES) (Wigal, Creer, & Kotses, 1991), the Dyspnea Scale (Fix & Daughton, 1988) and 12 minute walk tests all improved following the pulmonary rehabilitation intervention (Scherer & Schmeider, 1997). These findings are important as they associate changes in self-efficacy with improvements in both physical functioning and dyspnea and demonstrate sustainability over time.

A recent study compared ratings of competence for managing personal health and controlling symptoms in adults and older adults with either COPD or chronic heart failure (Arnold et al., 2005). A between group comparison revealed that COPD patients rated their health and self-efficacy for managing their health significantly lower than the heart failure patients (Arnold et al., 2005)

Carrieri-Kohlman and colleagues studied self-efficacy for treadmill walking and treadmill performance in a sample of older adults with COPD (Gormley, Carrieri-Kohlman, Douglas, & Stulbarg, 1993). Bandura's concept of self-efficacy served as the rational for the intervention. Bandura asserts that self-efficacy is derived from four sources: enactive mastery experiences, vicarious experience, verbal persuasion and physiological and affective states (Bandura, 1997). The intervention for this study specifically targeted enactive mastery and verbal persuasion. Using guided mastery techniques, participants in the intervention group received coaching during treadmill exercise session, where as the control group did not. The authors proposed that nurse coaching and verbal persuasion would result in improved ratings of self-efficacy for treadmill walking and treadmill performance. Self-efficacy for treadmill walking and treadmill performance increased significantly for both

experimental groups, and the rate of improvement in treadmill walking self-efficacy ratings out-paced the actual treadmill performance measure.

Another study by the same research team evaluated self-efficacy for managing shortness of breath and symptoms associated with COPD following an intervention that included three different versions of a DSMP intervention (Davis, Carrieri-Kohlman, Janson, Gold, & Stulbarg, 2006). The authors questioned whether a change in self-efficacy for managing shortness of breath would correspond in improved dyspnea. Self-efficacy was measured by the CSES and the Self-Efficacy for Managing Shortness of Breath Scale [SEMSOB] (Lorig et al., 1996). This secondary analysis, which compared data collected at baseline with data collected immediately after the exercise intervention was completed (two months), related changes on The Self-Efficacy for Walking Questionnaire (Carrieri-Kohlman, Gormley, Douglas, Paul, & Stulbarg, 1996; Dishman, 1994) with walking performance as measured by the Six Minute Walk (6MW) (ATS, 2002), dyspnea at the beginning of each 6MW test session and a clinical dyspnea measure (Dyspnea sub-scale of the Chronic Dyspnea Questionnaire (CRQ-D)(Guyatt, Berman, Townsend, Pugsley, & Chambers, 1987).

The variables were analyzed by means of correlations and repeated measures analysis of variance. All three groups (which received three different versions of a dyspnea self-management intervention) increased their self-efficacy for walking ($p < .0005$), with no significant differences between the groups (Davis et al., 2006). Scores on the Self-Efficacy for Managing Shortness of Breath scale improved significantly for the entire sample but CSES score did not.

Changes in self-efficacy for walking were also reported to be significantly related to improvement in walking performance for the entire sample. Self-efficacy for walking was significantly correlated with 6MW distance at baseline ($r = .57$, $p < .0005$) and at two months ($r = .74$, $p < .0005$). The CSES and dyspnea ratings at the beginning of the 6MW did not correlate at baseline or after the intervention. Significant but relatively weak correlations between CSES and the CRQ-D at two months was observed ($r = .22$, $p = .02$). The Self-Efficacy for Managing Shortness of Breath Questionnaire was moderately correlated with the CRQ-D at baseline ($r = .34$, $p = .001$) and two months ($r = .39$, $p < .005$), and weakly correlated with dyspnea before baseline 6MW (r -.30, $p = .01$) and at two months ($r = -.30$, $p = .002$). These findings indicate that all three versions of the dyspnea self-management intervention were effective in improving self-efficacy for managing COPD and this improvement correlated with a decline in dyspnea. This analysis also confirms the importance of domain specific self-efficacy for walking and managing symptoms on performance and symptoms. Further analysis is needed to determine if the changes and improvements in these measures of self-efficacy can be sustain over a longer period of time, if the changes correlate to improved dyspnea and if age moderates the changes.

The significance of these studies as a whole lies in recognizing that interventions designed to elevate self-efficacy for exercise, walking or managing symptoms can have a positive effect on physical functioning, symptoms, and exercise outcomes. Given COPD is so prevalent in the older adult population, and that older adults are particularly vulnerable to negative consequences of functional losses and subsequent decline in self-efficacy for physical activity, it is clear that interventions designed to promote self-efficacy for physical activity are crucial in preserving physical functioning. With the few exceptions, only a

handful of studies evaluated self-efficacy longitudinally (Davis et al., 2006; Gormley et al., 1993; Resnick, 2004).

Summary of Parent Study

This secondary analysis will extend the findings from the parent study by Carrieri-Kohlman and colleagues (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002). A brief overview of the study hypotheses, design and outcomes will be provided next. Specific details of the interventions and measures used can be found in the Chapter Three of this paper.

The parent study, titled "Treatments for Dyspnea: Education, Exposure or Training" (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002) tested three different versions of a DSMP intervention. This was a randomized-controlled longitudinal study; the intervention lasted 12 months. The main difference between the three versions of the DSMP interventions was the number of supervised exercise session attended. The Dyspnea Self-Management Group (DM) received the dyspnea self- management educational intervention and were given a home walking prescription. Participants in the Dyspnea Self-Management–Exposure Group (DM-Exposure) also received the dyspnea self-management educational intervention, were given a home walking prescription and attended four supervised treadmill exercise sessions. The participants in the Dyspnea Self-Management-Training Group (DM-Training) received the same dyspnea self-management educational intervention, were also given a home walking prescription and attended 24 supervised treadmill exercise sessions. The researchers hypothesized that the DM-Training group would demonstrate the greatest improvement on the primary outcome measures, which were dyspnea and physical functioning.

The study sample was composed of 103 adults and older adults (mean age 66 ± 8 years, 57 females) with moderate to severe COPD (mean FEV-1 % predicted 44.8 ± 14). After initial screening and baseline testing, participants were randomized into one of the three groups described above. The supervised exercise sessions all took place during the first two months of the 12-month study. All participants also received bi-weekly telephone calls designed to offer encouragement for home walking, a pedometer and a diary to track home walking activity.

As was hypothesized, by the two-month time point, the DM-Training group had significantly greater improvement compared to the two other groups. Improvements were seen in dyspnea intensity during the incremental treadmill test (ITT) ($p = .006$), ITT duration ($p = .005$), endurance treadmill duration (ETT) ($p = .003$), 6MW ($p = .01$), Medical Outcomes Study (MOS) Short Form-36 (SF-36) vitality scale (Ware, Snow, Kosinski, & Gandek, 1997) ($p = .031$) and on the Mastery Subscale of the CRQ ($p = .007$). A dose dependent improvement for dyspnea with ADLs (as measured by the CRQ-Dyspnea subscale) was seen ($p < .05$), with only the DM-Exposure and DM-Training groups showing improvement. It was determined that at this time point, the DM-Training program yielded significant changes that were not seen in the other groups.

At 12 months, the improvements continued to be primarily in the DM-Training group. Significant improvements on the ITT, ETT and dyspnea during the ITT were sustained at the six and 12 month measurement points and were significantly different than those observed in the other two groups ($p < .05$). Interestingly, dyspnea with ADLs and self-reported physical functioning improved in all groups. Additionally, depression decreased in all groups over the course of the study. The dose-response difference observed between the DM-Training group

and the other groups was not evident at study conclusion. There was also no significant difference in outcomes between the DM group and the DM-Exposure group (who attended the four supervised sessions). The researchers concluded that the number of exercise session contained in the dyspnea self-management study did not impact the long term improvements in dyspnea with ADLs and measures of physical functioning.

CHAPTER THREE: CONCEPTUAL/THEORETICAL FRAMEWORK AND RESEARCH AIMS

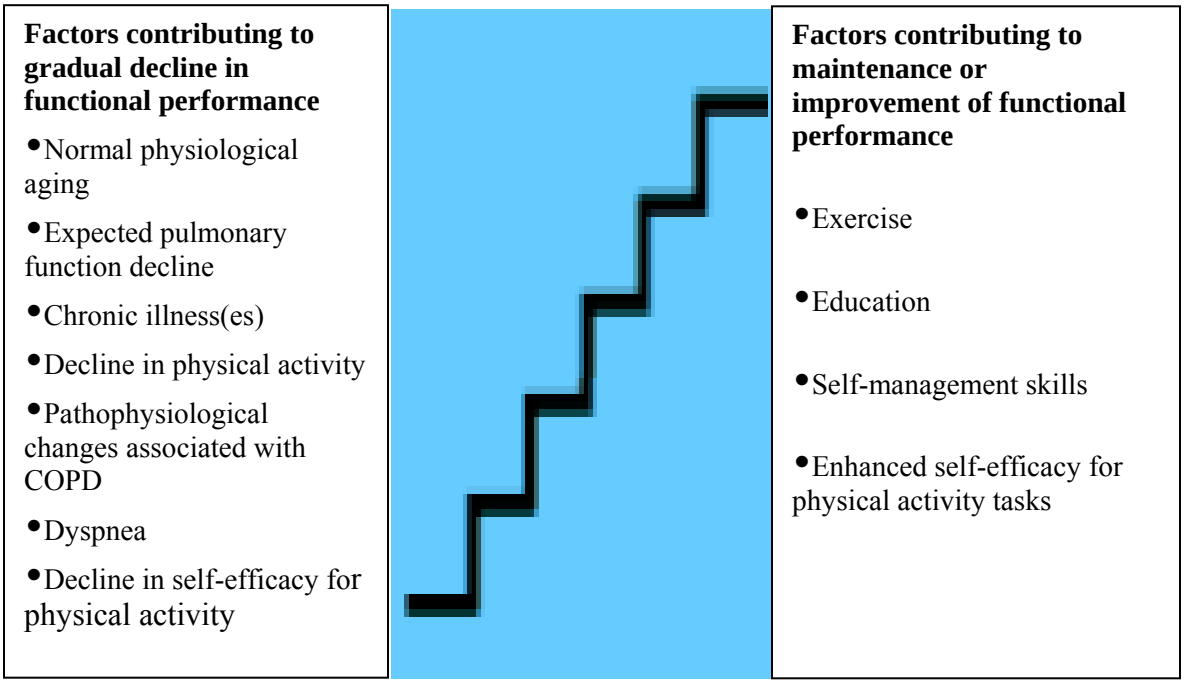
Conceptual Framework for Study

The conceptual framework for this study draws together elements from several theoretical sources, including physiological theory and behavioral theory, represented in Figure 3.1. The figure is a graphic representation of factors that collectively contribute improvement or decline in physical functioning in the older adult with COPD.

Figure 3.1

Factors that contribute to decline or maintenance /improvement of physical functioning in older adults with COPD

The Functional Status Staircase



The "Functional Status Staircase" represents the dynamic nature of older adult physical functionality from two contrasting perspectives. On the left side of the diagram, the older adult with COPD is subject to multiple factors that collectively contribute to declining

function, prompting a gradual "stepping down" the functional status staircase. On the right side of the diagram, the factors that may be effective in supporting or improving functional performance are represented, thus "stepping up" functional performance. It should be noted that the four factors on the right side of the model are typical components of a DSMP.

The major theories and concepts that are represented in the Functional Status Staircase are normal age-related changes, age-related physiological changes in the respiratory system, pathophysiological changes associated with COPD, and Bandura's human behavior concept of self-efficacy, which is part of his larger Social Cognitive Theory (Bandura, 1997).

This conceptual/theoretical framework discussion will begin with a brief over view of overview of age-related changes in the respiratory system and pathophysiological changes associated with COPD. The neurophysiology of dyspnea will be briefly described and linked with physiological changes associated with aging and COPD. The theoretical discussion will conclude with a review of the concept of self-efficacy and, specifically, self-efficacy in the context of self-management program interventions and in older adults.

Age-Related and COPD-Related Changes of the Respiratory System

The age-related structural changes that occur in the respiratory system can be organized into five categories: reduced compliance of the chest wall, increased compliance of the lung tissue, a relative weakening of the muscles of respiration, airway changes, air space changes, and lung parenchyma changes (Zeleznik, 2003). The net result of these changes are changes in flow rates, lung volumes, gas diffusion, physiologic responsiveness to changes in gas conditions or respiratory load and altered immune function. The major age-related changes in the respiratory tract are summarized in Table 2.

It is interesting to note that many of the pathophysiological changes that occur in COPD are similar to age-related changes in the lung. Major pathophysiological changes that occur in COPD include impaired expiratory air flow, lung tissue, airway and alveolar changes, changes in lung volumes, changes in gas exchange, immune dysfunction, and greater ventilation-perfusion mismatch (ATS, 1995; Barnes, 2000; Mahler, 1993). The major pathophysiological changes associated with COPD are presented in Table 2.

A side-by-side comparison of age-related changes in the lung and COPD pathology presented in Table 1 provides evidence that the older adult with COPD faces considerable physiological challenges. How this may influence the effectiveness of treatments designed to reduce the negative physiological effects of the disease is not clear.

The impetus for this study is to evaluate whether or not advancing age, coupled with COPD, moderates the outcomes of interest. In other words, if a variable is determined to operate as a moderator, the level of the moderating variable (in this case advancing age) influences the outcome variables. Age-related and COPD-related changes in the respiratory system may moderate (either positively or negatively influence) the effectiveness of the interventions tested in this analysis.

Neurophysiology of Dyspnea

Dyspnea is recognized to be the most common symptom in COPD (ATS, 1999; Mahler & Baird, 2005). Dyspnea is also common in older adults, with an estimated prevalence of up to 31% in the general older adult population (Waterer et al., 2001).

The sensation of dyspnea is thought to originate in the respiratory sensory system (ATS, 1999). The respiratory center in the brain receives afferent signals from numerous sources: chest wall receptors, airway receptors, lung tissue receptors, chemoreceptors,

respiratory muscles and the vagus nerve receptors. Based on feedback from the multiple sources, neurons in the medullary respiratory motor center send out efferent signals to effect respiratory system change as needed (ATS, 1999).

Information from chemoreceptors and mechanoreceptors are also relayed to the higher brain, where it is theorized the sensation of dyspnea is generated (ATS, 1999). Mechanoreceptor feedback provides essential information to the higher brain regarding ventilatory status, including respiratory muscle length and tension (ATS, 1999). This mechanism has been demonstrated in experimental conditions. Research participants subjected to chest wall restraint reported intense air hunger, even when the chemical drive to breathe was held constant (Chonan, Mullholland, Cherniack, & Altose, 1987; Schwartzstein, Simon, Weiss, Fencl, & Weinberger, 1989)

Vagal receptors, which normally regulate tidal volume, also seem to play a role in the generation of dyspnea (ATS, 1999). Interestingly, the vagal receptors appear to function independently of at least the chest wall mechanoreceptors. Studies of individuals with high spinal cord injury or who were subjected to neuromuscular blockade reported dyspnea when tidal volume was experimentally reduced (Banzett, Landsing, & Brown, 1987; Manning et al., 1992). Additionally, interruption of the vagus nerve has been reported to mitigate the sensation of dyspnea (Davies et al., 1987; Guz, Noble, Eisle, & Trenchard, 1970).

The role of chemoreceptor stimulation in generating dyspnea is thought to be related the homeostatic increase in respiratory motor activity (ATS, 1999), but the chemoreceptors may also have a direct influence. The direct influence was demonstrated in a study where individuals, despite being subjected to neuromuscular blockade, still reported dyspnea when given hypercapnic gases to breathe (Banzett et al., 1990).

"Corollary discharges" or "efferent copies" of brainstem respiratory motor signals are also delivered to the higher brain (ATS, 1999). It is these corollary discharges that generate a conscious awareness of respiratory effort (ATS, 1999). The ATS dyspnea statement emphasizes that the sensations from corollary discharges are different from the sensations associated with changes in respiratory muscle length and tension during autonomic breathing. Similarly, the corollary discharge sensations are also distinctly different from messages sent from the cortical motor centers to the sensory cortex during voluntary ventilation. This distinction is important when one considers that respiratory muscle fatigue, weakness, or shortened respiratory muscle length all result in an increased sense of respiratory effort (ATS, 1999). The sensation of increased respiratory effort is proportional to pressure changes generated by respiratory muscles, and persists up to physiological-mechanical limits (Killian, Gandevia, Summers, & Campbell, 1984).

In summary, dyspnea appears to be the result of a dissociation between central respiratory motor control and incoming neural information from the various respiratory system receptors (ATS, 1999; Schwartzstein et al., 1989). The brain sends motor commands to the respiratory muscles that are appropriate to adjust for changing flow and volume needs. If changes in pulmonary pressures, chest wall movement or airflow do not match the motor commands, dyspnea occurs (ATS, 1999). Some sources refer to this phenomenon as neuromechanical dissociation (NMD) (O' Donnell & Webb, 2005). Indeed the concept of NMD ties physiological correlates of dyspnea with the neurosensory component.

Physiological correlates of dyspnea in older adults with COPD

The ATS Dyspnea Statement categorizes dyspnea pathophysiology into five distinct components: heightened ventilatory demand, respiratory muscle abnormalities, abnormal

ventilatory impedance, abnormal breathing pattern, and blood gas abnormalities (ATS, 1999). These categories will be used as a framework for relating physiological correlates of dyspnea in older adults with COPD with neurosensory factors.

Heightened Ventilatory Demands

Physical activity, even at relatively low levels, increases ventilatory demands (Cotes, Chinn, & Miller, 2006). To meet the metabolic needs associated with physical activity, motor output to the lung increases, resulting in a sense of increased effort (ATS, 1999). It is theorized that when the ventilatory response is interpreted in the brain to be excessive or disproportional to the level of activity, the sensation of dyspnea ensues (ATS, 1999; Burns & Howell, 1969). Ventilation of increased dead space (portions of the lung that are ventilated in excess of its perfusion) is also associated with the sensation of dyspnea (ATS, 1999). The proportion of dead space in the lung is known to increase in both normal aging and in COPD (ATS, 1999), suggesting the older adults may experience dyspnea at a lower physiological threshold compared to a younger individual.

Due to age-related and/or COPD-related loss of lung tissue recoil, the lung becomes progressively hyperinflated, which is particularly evident during exercise (O' Donnell & Webb, 2005). This is further compounded when expiratory airflow obstruction is also present, as the tidal breath begins before sufficient lung emptying has occurred (O' Donnell & Webb, 2005). This reduces inspiratory capacity (IC), which reflects the volume of gas that can be inspired from a resting expiratory level (Gold, 2005). Additionally, it places ventilation on the stiffer portion of the flow-volume curve, further increasing the ventilatory load (ATS, 1999). This phenomenon is termed dynamic hyperinflation (DH) and is recognized as an important contributor to the sensation of dyspnea (Bellman, Botnick, &

Shin, 1996; O' Donnell & Webb, 2005). The altered respiratory mechanics described here illustrate the mechanical dysfunction component of NMD.

Respiratory Muscle Abnormalities

When respiratory muscles are weakened, as occurs to some degree in normal aging (Black & Hyatt, 1969; Campbell, Gandevia, Killian, Mahutte, & Riggs, 1990), or the respiratory muscles are mechanically disadvantaged, such as in COPD hyperinflation(Crapo, 1993), respiratory motor command must increase. Increased respiratory motor command is associated with an increased effort to breathe (Campbell et al., 1990; Killian et al., 1984). Increased ventilatory demands during exercise further illustrate mechanical problems that occur in COPD, and to a lesser degree, in normal aging. The ensuing cascade of dysfunction triggered by increased demand superimposed on weak muscles, and resultant dyspnea, is consistent with the theory that NDM is key in generating dyspnea.

Respiratory muscle dysfunction clearly plays a key role in dyspnea. Interestingly, laboratory data provide evidence that older adults are relatively less sensitive to progressive increases in chest wall loading (Tack, Altose, & Cherniack, 1981) and to inspiratory and expiratory loading conditions when compared to younger counterparts (Tack, Altose, & Cherniak, 1982). At least under these circumstances, it appears that the interpretation of respiratory muscle effort in older adults is somewhat altered, and this may relate to the sensation of dyspnea. How this may manifest clinically remains unclear.

Abnormal Ventilatory Impedance

Airflow obstruction (impedance) is also recognized as contributing to the sensation of dyspnea (ATS, 1999). Dyspnea occurs when the level of respiratory effort does not match

the ventilatory effort (ATS, 1999). Recall that both COPD and normal lung aging result in declining expiratory airflow rates, but COPD to a greater degree (ATS, 1995; McClaran, Babcock, Pegelow, Reddan, & Dempsey, 1995). This is one of the mechanisms that contributes to dyspnea in the older adult with COPD (ATS, 1999).

Abnormal Breathing Pattern

Abnormalities involving the lung parenchyma are associated with a more rapid but shallower breathing pattern (ATS, 1995). It is suspected that the abnormal breathing pattern may be the result of a reflexive response associated with pulmonary vagal receptor stimulation, but a direct association between vagal stimulation and dyspnea remains unclear (ATS, 1999). The loss of tethering support that is known to occur in both COPD and normal aging are examples of clinical conditions where functioning lung parenchyma is reduced (ATS, 1995; Janssens, 1999) and may, therefore, be associated with an abnormal breathing pattern and dyspnea.(ATS, 1995).

Blood Gas Abnormalities

The role of blood gas abnormalities in promoting dyspnea is not consistent across individuals, and is even more complex in the older adult with COPD. Blood gas derangements have been reported to poorly correlate with dyspnea, however, both hypoxemia and hypercapnia are thought to be dyspneogenic (ATS, 1999) While hypoxemia and hypercapnia evoke an increase in ventilation in younger adults, this is not true in the healthy older adult (Peterson, Pack, Silage, & Fishman, 1981). Conversely, when compared to younger counterparts, older adults rate the intensity of dyspnea higher relative to different levels of hypercapnia (Akiyama et al., 1993). Supplemental oxygen administration seems to

reduce dyspnea in some individuals, but does not effect a change in ventilation (Chronos, Adams, & Guz, 1988; Lane, Cockcroft, Adams, & Guz, 1987). It appears possible that while older adults with COPD may be less sensitive to blood gas derangements, the dyspnea sensation may be more intense, particularly in hypercapnic conditions. This raises suspicion that the interpretation of chemoreceptor signals in the higher brain may be different in older adults. This clearly has important implications in illness and exercise states.

It has been observed that individuals with reduced diffusing capacity of the lung (DL_{CO}) report more dyspnea and disability when compared to individuals with a preserved DL_{CO} (O' Donnell & Webb, 2005), and is attributed to the reduced surface area available for gas exchange and worsened ventilatory-perfusion mismatch (O' Donnell & Webb, 2005). Given the effective surface area for a gas exchange declines as a function of aging (evidenced by a decline in DL_{CO} with aging (Chan & Welsh, 1998) as well as in emphysema (Gold, 2005), both age-related and pathophysiological factors may contribute to dyspnea in the older adult with COPD.

Summary

Age-related changes in the lung are numerous and have an impact on overall pulmonary function. Pathophysiological processes associated with COPD are detrimental to pulmonary function as well. The combination of age-related lung changes in the face of COPD pathology is quite complex. The common symptom of these derangements is dyspnea. The physiological correlates of dyspnea as they correspond to age-related and COPD-related changes in the lung are represented by the bolded text in Table 2.

The Concept of Self-Efficacy

A key target of many DSMPs and pulmonary rehabilitation programs is to enhance the participants'confidence in being able to perform a task. This is achieved through education, promotion of physical activity, and self-management education (ATS/ERS, 2006). This phenomenon has been conceptualized by Bandura as self–efficacy (Bandura, 1997), which is an element of his larger, and widely known, Social Cognitive Theory (Bandura, 1997). Bandura states that it is the individual's perception that they will be capable of performing a specific behavior that leads to achieving the desired outcome, and specifically emphasizes that self-efficacy is task specific (Bandura, 1997).

Bandura describes two important conditions that influence achieving the desired outcome: efficacy beliefs and outcome expectancies (Bandura, 1997). Perceived self-efficacy is defined by Bandura as the individual's assessment of their ability to organize and achieve a specific performance and these personal assessments can vary in terms of level, strength and generality (Bandura, 1997). Outcome expectations, which is what individual predicts potentially can occur (such as being able to climb a flight of stairs), is a distinctly separate element of self-efficacy (Bandura, 1997). Outcome expectations can be either positive or negative and are either physical, social or self-evaluative in nature. For example, an outcome expectation would be whether or not the individual felt they could complete housework activities (Lorig et al., 1996)

Bandura asserts that self-efficacy beliefs are actually better predictors of behavior than outcome expectations (Bandura, 1997). He also notes that outcomes are often incorrectly thought to be synonymous with performance, and cautions to not confuse the two

(Bandura, 1997). According to Bandura, performance is the actual act to be achieved, whereas the outcome is the consequences of the performance.

Bandura asserts that self-efficacy is derived from four sources: enactive mastery experiences, vicarious experience, verbal persuasion, and physiological and affective states (Bandura, 1997). According to Bandura, enactive mastery experience is the most influential source as it provides validation that one can perform a given task. He specifically notes that even small performance successes can encourage the individual to work to exceed personal expectations and strive to attain higher levels of performance. In the case of vicarious experiences, the individual judges their own ability to perform a task based on observations of others' performance. Self-efficacy beliefs can be either positively or negatively influenced by observation of others' performance. Verbal persuasion provides an expression of faith that the individual can perform the task and can serve to strengthen self-efficacy. Bandura posits that individuals also judge their capabilities through physiological and affective responses, sometimes described as evoking physiological or emotional arousal. In the case of COPD patients, the sensation of dyspnea or fatigue during physical activity may provide negative physiological/sensory feedback signaling to the individual that they are not efficacious in their performance. This can, in turn, prompt the individual to reduce their activity so as to reduce the negative sensation.

Self-Efficacy and Aging

In his analysis of the concept of self-efficacy, Bandura addresses the role of self-efficacy across the life span, including in advanced age. He notes that social and biological views of aging often focus on loss in capacity to perform. Consequently, older adults must re-appraise their self-efficacy or may mis-appraise (underestimate or overestimate) their

performance capabilities. Bandura states that while some loss of energy and physical function can be attributed to the aging process, these losses can also be attributed, at least in part, to reduced self-efficacy (Bandura, 1997). He also asserts that damage to self-efficacy that may occur in the face of mounting physical functioning deficits, and the impact of the damage can be significant (Bandura, 1997). As mentioned briefly earlier, Zautra, Reich and Newson (Zautra et al., 1995) posit that with increasing functional losses over time, older adults who have lowered self-efficacy for functional tasks, may actually give up trying to maintain functionality, resulting in a poorer quality of life. Additionally, Bandura asserts that older adults attend more to somatic sensations, attribute these negative sensations with aging, resulting eventually, in loss of functional capacity (Bandura, 1997).

The question of this secondary analysis is the notion that functional losses associated with chronic illness can be compensated for or restored through acquired knowledge, expertise, or skill enhancement (Bandura, 1997). Indeed, work by Bortz has demonstrated that decline in physical functioning that is frequently attributed to aging alone, can actually be traced back to physical inactivity, rather than expected changes of aging (Bortz, 1982). On a very hopeful note, Bandura notes that self-efficacy has a protective effect on physical functioning (Bandura, 1997) and the impact that self-efficacy has on function does not diminish with age (Bandura, 1997). Similarly, reports dating back more than 20 years indicate that older adults can maintain high levels of self-efficacy well into old age (Baltes & Baltes, 1986; Lachman, 1986) and older adults are no less likely to benefit from improved health behaviors when compared to younger adults (Ferrini, Edelstein, & Barrett-Connor, 1994).

Self-Efficacy in the Context of a Self-Management Program Intervention

The concept of self-management can be broadly defined as the person's ability to appropriately respond to symptoms, treatments and psychosocial and physical manifestations of a chronic illness (Barlow et al., 2002). In order to achieve successful self-management, the individual must exhibit constant vigilance in managing one's condition through self-monitoring of symptoms, cognitive, emotional and behavioral manifestations of the condition, and taking proper action to maintain an acceptable level of health (Barlow et al., 2002). As mentioned earlier, self-management is recognized as an essential component the Chronic Care Model (Wagner et al., 2001) and has been identified as a very important factor in maintaining the health of older adults (CDC, 2006).

The enhancement of self–efficacy is recognized to be an important factor in self-management programs (ATS/ERS, 2006; J. Bourbeau, Nault, & Dang-Tan, 2004). Bourbeau proposes four specific strategies that can be used to enhance self-efficacy in the context of a self-management educational program: personal experience and practice; feedback and reinforcement; analysis of causes of failure and vicarious experience (J. Bourbeau et al., 2004). Bourbeau asserts self-management educational interventions directly influence self-efficacy by increasing both knowledge and skills, which in turn, enhances self-efficacy. The enhanced self-efficacy subsequently prompts a behavior change and has positive effect on the health of the individual (J. Bourbeau et al., 2004). Simply teaching the skills is not sufficient, but rather, the skills must be incorporated into everyday self-care activities and requires multi-tasking (J. Bourbeau et al., 2004).

Bourbeau specifically points out that advancing age does not diminish the gains associated with improved self-efficacy (J. Bourbeau et al., 2004). Bandura concurs in this

regard (Bandura, 1997). While it is recognized that the functional losses associated with aging and chronic illness can threaten self-efficacy for physical activity and self-care activities, interventions that specifically target boosting self-efficacy can be effective for the older adult (Bandura, 1997).

Self-Management Education and Dyspnea Reduction

In 1999, the ATS published a position statement on dyspnea (ATS, 1999). The expert panel defined clinical dyspnea as follows:

> "…dyspnea is a term used to characterize a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity. The experience derives from interactions among multiple physiological, psychological, social and environmental factors, and may induce secondary physiological and behavioral responses." (ATS, 1999)

The ATS definition of dyspnea fittingly acknowledges the complexity of the symptom and that both physiological and psychological factors contribute to the sensation. It also accurately notes that physiological and behavioral responses to the symptom occur.

In this ATS position statement, the authors propose four physical and/or psychological strategies that can be employed to reduce dyspnea: reduce ventilatory demand, improve muscle function, reduce ventilatory impedance and alter central perception (ATS, 1999; Zuwallack, 2005). Of the four strategies to reduce dyspnea identified, two strategies, reduce metabolic load and alter central perceptions, can be achieved through a COPD self-management program that includes an exercise component. Metabolic load can be reduced through exercise training, which is recognized to be the key factor in achieving a reduction in dyspnea as was seen in studies conducted by Sassi-Dambron et. al, (Sassi-Dambron et al., 1995) and Carrieri-Kohlman et. al (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002). It is also proposed that central perceptions of dyspnea can be altered through education,

cognitive-behavior approaches and desensitization (ATS, 1999; Zuwallack, 2005). Indeed, these activities are pivotal components of self-management programs that seek to reduce dyspnea (Carrieri-Kohlman et al., 2005; Sassi-Dambron et al., 1995; Stulbarg et al., 2002). It is believed that education about self-care strategies helps to increase the COPD patient's confidence in controlling their symptoms (ATS, 1999). In other words, improving self-efficacy for self-management of symptoms such as dyspnea can be an outcome of education.

Research Aims, Hypotheses and Research Questions

The main purpose of this secondary analysis is to determine if advancing age influences, or moderates, the effectiveness of the interventions to promote changes in the outcome variables. In other words, does advancing age influence effect of the three different interventions on the outcomes variables?

Research Aim #1: To investigate if age moderates the effect of the dyspnea self-management program (DSMP) interventions on self-reported functional performance, functional capacity measures, and dyspnea with activities of daily living and exercise.

Hypothesis #1: Age will moderate the effect of the three different dyspnea self-management program (DSMP) interventions on self-reported functional performance over time.

Research Questions:

1a. Does age moderate the effect of the DSMP intervention on overall physical functioning over time?

1b. Does age moderate the effect of the DSMP intervention on ability to perform activities of daily living over time?

1c. Does age moderate the effect of the DSMP intervention on role functioning over time?

Hypothesis #2:

Age will moderate the effect of the three different DSMP interventions on functional capacity over time.

Research Questions:

2a. Does age moderate the effect of the DSMP intervention on walking performance over time?

2b. Does age moderate the effect of the DSMP intervention on symptom-limited exercise test performance over time?

2c. Does age moderate the effect of the DSMP intervention on constant workload exercise performance over time?

Hypothesis #3:

Age will moderate the effect of the three different DSMP interventions on dyspnea outcomes over time.

Research Questions:

3a. Does age moderate the effect of the DSMP intervention on dyspnea with activities of daily living over time?

3b. Does age moderate the effect of the DSMP intervention on dyspnea intensity after walking over time?

3c. Does age moderate the effect of the DSMP intervention on dyspnea intensity during a symptom limited exercise test over time?

Hypothesis #4: Recent dyspnea ratings will change over time following a DSMP intervention.

Research Question:

4a. Do ratings of recent dyspnea change over time or by treatment group following a DSMP intervention?

Hypothesis #5: Age will moderate the effect of the three different DSMP interventions on recent dyspnea ratings over time.

Research Question:

5a. Does age moderate the effect of three different DSMP interventions on recent dyspnea ratings over time?

Hypothesis #6: Recent dyspnea impact on activity of daily living ratings will change over time following a DSMP intervention.

Research Question

6a. Do ratings of recent dyspnea impact on activities of daily living change over time or by treatment group following a DSMP intervention?

Hypothesis # 7: Age will moderate the effect of the three different DSMP interventions on recent dyspnea impact on activities of daily living ratings over time.

Research Question

7a: Does age moderate the effect of three different DSMP interventions on recent dyspnea impact on activities of daily living ratings over time?

Research Aim #2: Compare predictors for self-efficacy for home walking and managing shortness of breath

Hypothesis #8:

Predictors for self-efficacy for home walking and self-efficacy for managing shortness of breath will be the similar.

Research questions:

8a. What are the predictors of baseline self-efficacy for home walking?

8b. What are the predictors of baseline self-efficacy for managing shortness of breath?

Research Aim #3: Investigate changes in self-efficacy for home walking and managing shortness of breath ratings over time following three different DSMP interventions.

Hypothesis #9: Self-efficacy for home walking ratings will improve following a DSMP intervention and the DM-Training group will have the greatest improvement.

Research Question

9a. Do ratings of self-efficacy for home walking change over time following three different DSMP interventions?

9b. Do ratings of self-efficacy for home walking differ among the three different intervention groups over time?

Hypothesis #10: Age will moderate self-efficacy for home walking following three different DSMP interventions.

Research Question

10a. Does age moderate the effect of the DSMP intervention on self-efficacy for home walking ratings over time?

Hypothesis #11: Self–efficacy for managing shortness of breath will improve following a three different DSMP interventions and change will be the largest in the DM-Training group.

Research Questions:

11a. Do ratings of self-efficacy for managing shortness of breath change over time following three different DSMP interventions?

11b. Do ratings for self-efficacy for shortness of breath differ among the three different intervention groups?

Hypothesis #12: Age will moderate self-efficacy for managing shortness of breath ratings over time following three different DSMP interventions.

Research Question:

12a. Does age moderate the effect of the DSMP intervention on self-efficacy for managing shortness of breath ratings over time?

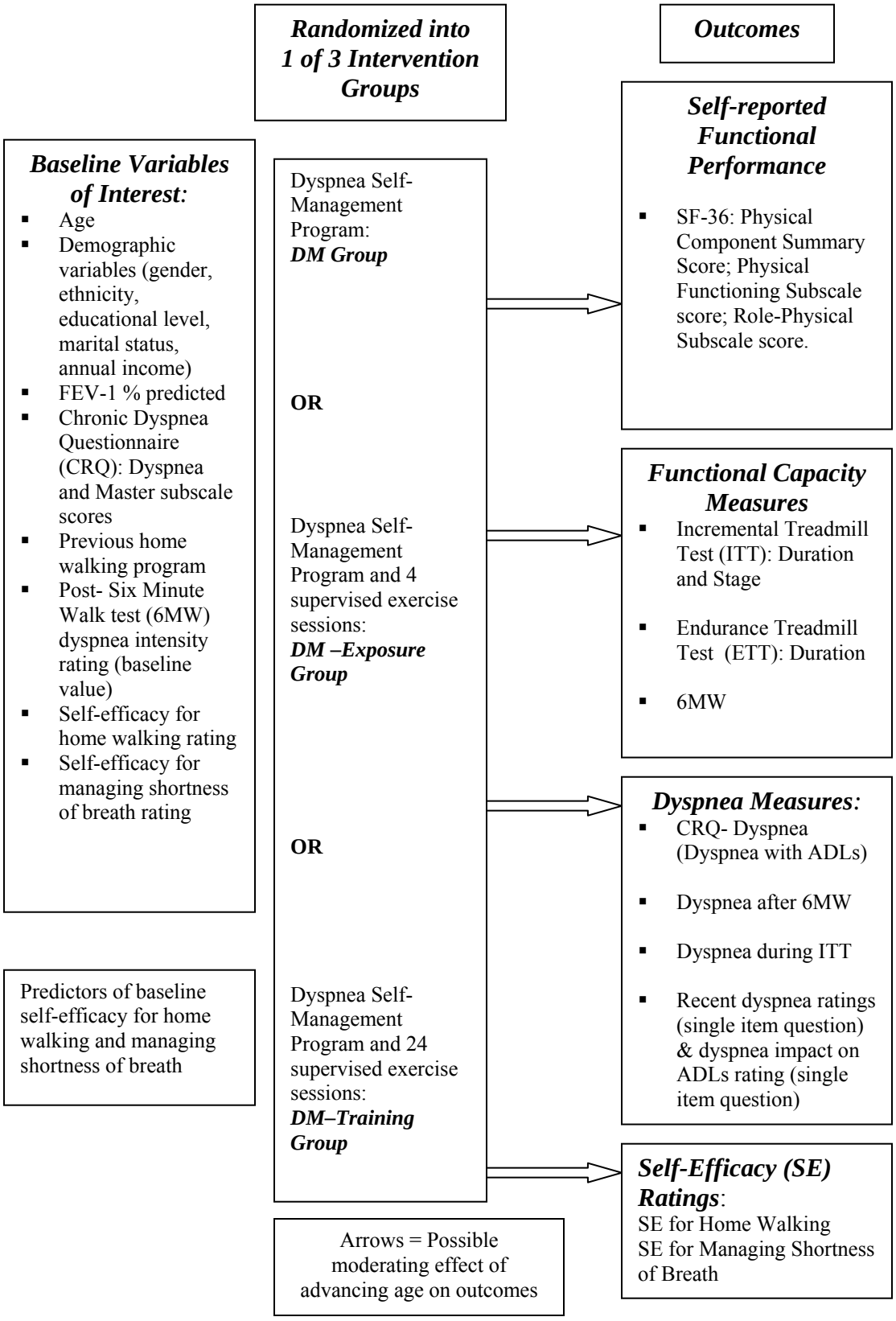
CHAPTER FOUR: METHODS

Design

Data for this secondary analysis were obtained from a larger, randomized, longitudinal study of three versions of a DSMP trial involving a sample of adults and older adults with COPD (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002). The primary research aim of the parent study was to evaluate dyspnea intensity following an intervention that tested three different levels of a DSMP. The secondary aim was to evaluate changes in exercise performance and health related quality of life measures. Prior to randomization, all study participants underwent baseline testing over three testing days. Participants were randomly assigned to one of three levels of a dyspnea self-management program: Dyspnea Self-Management Program (DM); Dyspnea Self-Management Program and four supervised treadmill exercise session (DM-Exposure) or a Dyspnea Self-Management Program and 24 supervised treadmill exercise sessions (DM-Training). All supervised treadmill exercise session occurred over the first two months of the study. Outcome variables were measured at two month intervals over the remaining eight months of the study period. The specific interest of this secondary analysis is to evaluate the moderating effect of age on outcome measures of functional performance, functional capacity, dyspnea, and two domains of self-efficacy: self-efficacy for home walking and self-efficacy for managing shortness of breath. An additional aim of this secondary analysis is to determine predictors of self-efficacy for home walking and self-efficacy for managing shortness of breath.

The framework for the study is presented below in Figure 4.1.

Figure 4.1: Study Design



Please also see Table 3 for outcome measurement schedule.

Setting

Over the course of the study period, participants were evaluated in the University of California, San Francisco (UCSF) Medical Center General Clinical Research Center (GCRC) and the UCSF Adult Pulmonary Function Laboratory (PFL). The interventions took place in the UCSF Chest and Allergy Clinic and the UCSF Department of Physical Therapy. Data for this study was collected between January 1996 and March 2000.

Sample

This study was conducted after approval from the University of California, San Francisco Investigational Review Board (IRB). All participants were consented before participation in the study and all data has been analyzed and protected in accordance with Health Insurance Personal and Accountability Act (HIPAA) regulations and requirements. All identifiers have been removed from the data set and all results will be reported free from any identifying information.

The convenience sample of adults with COPD were recruited from multiple sites and sources throughout the San Francisco Greater Bay Area. Recruitment sources and strategies included healthcare provider referral, neighboring healthcare clinics, senior centers and through print and radio announcements.

Initially participants were screened over the phone. Phone queries included age, medical illnesses/diagnoses, medications used, and any activity limitations. If prior

pulmonary function testing had been performed, a copy of the report was requested and served as a screen for the presence or absence of chronic airway obstruction.

Inclusion criteria

The following inclusion criteria were used in initial screening of interested individuals:

1. Adult age 40 years or older
2. Ability to understand the English language
3. Confirmed diagnosis of moderate to severe chronic bronchitis, emphysema or irreversible airway obstruction with at least one month of clinical stability
4. Persistent, moderate to severe airway obstruction evidenced by forced expiratory volume, one second (FEV-1) percentage predicted less that 60% predicted, or FEV-1/Forced Vital Capacity ratio of less than 60% of predicted value after inhaling two puffs of albuterol (an inhaled bronchodilator)
5. Able to walk on a treadmill
6. No formal pulmonary rehabilitation program or exercise training program participation within the past 12 months
7. No other medical conditions that would interfere with study participation (such as cancer, ischemic heart disease, congestive heart failure, arthritis, psychiatric illness)
8. Willingness to complete an incremental treadmill test while using the modified Borg scale for rating dyspnea intensity during exercise testing

Exclusion criteria

The following exclusion criteria were applied to all potential participants:

1. Diagnosis of angina
2. Diagnosis of aortic stenosis
3. Myocardial infarction (MI) or coronary artery by-pass graft surgery within past six months
4. Hypertension defined as blood pressure greater than 180/100 mmHg
5. Major cardiac arrhythmias
6. Active infectious disease
7. Musculoskeletal limitations for walking

Randomization

To partially control for potential confounding variables, the sample was stratified by oxygen saturation during exercise testing, if aerobic threshold was achieved during exercise testing and by gender. Based on these strata, participants were randomly assigned to one of the three treatment groups through the use of a Statistical Package for Social Sciences (SPSS, Chicago, IL) random number generator.

Intervention

The participants were randomly assigned to one of three groups: a Dyspnea Self-Management Program (DM), a Dyspnea Self-Management program and four supervised treadmill exercise sessions (DM-Exposure) or a Dyspnea Self-Management Program and 24 supervised treadmill exercise sessions (DM-Training). The following is a description of the experimental procedures for each group. The study period was 12 months.

Dyspnea Self-Management Program (DM)

This group was provided dyspnea self-management educational sessions, a home walking prescription and phone calls from study nurses every two weeks, but did not participate in any supervised exercise sessions.

The education program consisted of three hours of individualized dyspnea self-management instruction, in four sessions over an eight-week period. The educational session included specific content and discussion. The content for each educational session and the scheduled occurrence and time for each session is outlined below:

Session #1/Week One: the "seven dimensions" of a symptom; factors related to shortness of breath, major causes of shortness of breath; strategies for managing shortness of breath including pursed-lip breathing, exercise and desensitization procedures, an exercise prescription, instructions on how to check one's pulse and an opportunity to answer the individual's questions about their own dyspnea experience. Session time: 90 minutes.

Session #2/Week Three: Review of individualized exercise prescription; discussion of strategies for managing shortness of breath, specifically body positioning, diaphragm breathing and medications. Session time: 30 minutes.

Session #3/ Week Five: Review of individualized exercise prescription; further content regarding strategies for managing shortness of breath: relaxation techniques, biofeedback methods, music, guided imagery, self talk and social support. Session time: 30 minutes

Session #4/ Week Seven: Review of the individualized exercise prescription and further content regarding strategies for managing shortness of breath, specifically: activity modification and energy conservation. Session time: 30 minutes

The individualized exercise prescription was based on the participant's baseline exercise testing performance on two incremental treadmill tests (ITTs) and one endurance treadmill test (ETT). Participants in this group were asked to walk at home at least three times/week for at least 20 minutes each walking session and to exert themselves to a level equivalent to that achieved during the baseline ETT test. They were also given pedometers to measure their physical activity and daily diaries. They were asked to record their walking distance and their dyspnea intensity in a daily log (using the modified Borg scale) at the end of each walking session. Additionally, the participants received phone calls from the study staff every two weeks. The purpose of the calls was to reinforce the use of the strategies to manage dyspnea, assess adherence to the walking prescription, and to answer questions about the walking prescription.

The Dyspnea Self-Management- Exposure Group (DM-Exposure)

Participants assigned to this group received all of the educational sessions described above, were also given a home walking prescription, pedometer and daily diaries and the bi-weekly phone calls. Additionally, they attended four supervised treadmill exercise sessions, scheduled at the same time as the educational session (weeks one, three, five and seven). The work intensity of each supervised treadmill exercise session was individualized, based on baseline ITT performance. The participants were instructed to work to a level equivalent to the level achieved during their baseline ETT. The goal of each supervised session was to walk on the treadmill for at least 25-30 minutes and to gradually increase their intensity and endurance. The treadmill was started at a rate of 1 MPH for a two minute warm up period; intensity was increased by 1-2 stages every one to three minutes until the participant was exercising at the level of their baseline ETT was achieved or to a level equivalent to the level

reached at their last exercise session. At the conclusion of the supervised exercise session, there was a cool down period of 1 MPH for three minutes. During the supervised session, the nurse coached the participants using guided mastery techniques, modeling of coping strategies, the provision of protective aides, modulating severity of threat, and encouraging a gradual increase in time coping with symptoms.

The Dyspnea Self-Management-Training Group (DM-Training)

Participants assigned to this group received all of the educational sessions described above, and were also given a home walking prescription, pedometer and daily diaries. They attended a total of 24 supervised treadmill exercise session, following the same protocol described in the section above. The participants in this group attended the supervised treadmill exercise session three times per week for eight consecutive weeks. Each participant also received a phone call form study staff every two weeks throughout the study period.

Variables Selected for Secondary Analysis

Demographic Antecedents

Demographic antecedent variables that were included in this analysis were as follows: gender, marital status, annual income, educational level, FEV-1 % predicted (serving as a measure of disease severity), personal history of prior home walking program, and prior attendance at a pulmonary rehabilitation program. The data was collected through a demographic questionnaire each participant completed at the beginning of the study.

Pulmonary Function Testing

On the first baseline testing day (B1) in the GCRC, a physical examination and demographic questionnaire were completed. Participants also underwent spirometry (15-30 minutes after inhalation of two puffs of albuterol via a spacer device [Aerochamber Monaghan, Plattburg, NY]) and arterial blood was collected for blood gas analysis. Spirometry was performed using a 10-ml water seal spirometer (Collins Medical, Braintree, MA) in accordance with ATS specifications (ATS, 1987) and predicted values used were from a widely-recognized reference sources (Crapo, Morris, & Gardner, 1981; Knudson, Slatin, Lebowitz, & Burrows, 1976). For this analysis, the baseline forced expiratory volume, one second (FEV-1) percentage predicted was used.

Self-Reported Functional Performance Measures

The Medical Outcomes Study (MOS) Short Form 36 (SF-36) Questionnaire

Self-reported functional performance was measured with the Medical Outcomes Study (MOS) Short Form 36 (SF-36) Questionnaire (Ware & Sherbourne, 1992). The SF-36 is a widely-used, validated generic physical function and health-related quality of life instrument (Ware & Sherbourne, 1992; Ware et al., 1997).

The scale has two major components: physical functioning and mental functioning plus eight domain scales: physical functioning (measures activities of daily living), role-physical (measures activities necessary to fulfill a role such as care giving, house work or other work), bodily pain, general health, vitality, social functioning, role-emotional and mental health (Ware et al., 1997). Subcategories of each domain scale measure one or more of the following: function, well-being, disability and personal evaluation of health. Each

scale has a separate score that is transformed into a zero-100 score. A score of zero indicates maximal impairment, whereas a score of 100 indicates minimal impairment.

The study participants completed all sections of the instrument, but for this secondary analysis, only the functional performance components were analyzed: Physical Component Summary Score (a composite score for functional performance), the Physical Functioning Subscale (subscale for performance of activities of daily living), and the Role-Physical Subscale (subscale for ability to perform roles such as caregiver, homemaker or worker). The SF-36 was measured at baseline, two months, four months, eight months, and 12 months.

Functional Capacity Measures

The Six Minute Walk Test (6MW).

The Six Minute Walk Test (6MW)(ATS, 2002) was a measure of functional capacity for this study. At baseline, all participants underwent at least two 6MW tests spaced approximately 30 minutes apart and preceded by inhalation of two metered dose inhalation puffs of a bronchodilator medication (albuterol). The 6MW is recognized as a reasonable and reliable measure of functional capacity in cardiopulmonary research studies and as an outcome variable following cardiac or pulmonary rehabilitation programs (Solway, 2001).

For this test, the participant is asked to walk as far as they could, stopping if needed, for a total of six minutes. For this study, the walking was undertaken in a long indoor hallway. The total distance walked during the six minute period was recorded in feet. An increase in distance walked during the six minute testing period reflects an improvement. The minimum clinically important distance for this measure is reportedly 54 meters (95%CI

= 37-71 meters) (Redelmeier, Bayoumi, Goldstein, & Guyatt, 1997). The 6MW was performed at baseline, at two months, at four months, at eight months, and at 12 months.

The Incremental Treadmill Exercise Test (ETT).

On the second day of baseline testing, the participants underwent a symptom-limited incremental treadmill exercise test (ITT). After standardized instructions and a brief demonstration, the participant took two "practice walks" on the treadmill (Quinton 55, Seattle, WA), both with and without the metabolic cart mouthpiece. Additionally two puffs of albuterol were given before the ITT. The treadmill speed and grade (incline percentage) advancement, which occurred every 80 seconds, was according to the following protocol (Carrieri-Kohlman et al., 1996):

Stage 1 = 1.0 miles per hour (MPH) and 0% grade
Stage 2 = 1.4 MPH and 0% grade
Stage 3 = 1.7 MPH and 0% grade
Stage 4 = 2.0 MPH and 0% grade
Stage 5 = 2.5 MPH and 0% grade
Stage 6 = 3.0 MPH and 0% grade
Stage 7 = 3.0 MPH and 2% grade
Stage 8 = 3.0 MPH and 4% grade
Stage 9 = 3.0 MPH and 6% grade
Stage 10 = 3.0 MPH and 8% grade
Stage 11 = 3.0 MPH and 10% grade
Stage 12 = 3.0 MPH and 12% grade
Stage 13 = 3.0 MPH and 14% grade
Stage 14 = 3.0 MPH and 16% grade
Stage 15 = 3.0 MPH and 18% grade
Stage 16 = 3.0 MPH and 20% grade

Stages advance until the participant signals that he/she wishes to stop, followed by a cool down at 1 MPH. The entire test was completed with the participant breathing room air. Physiological measures during the ITT were also follows: a 12-lead continuous electrocardiogram, heart rate and oxygen saturation by pulse oximetry (Sp02) (Nellcor N-10,

Hayward, CA). During the exercise test, the participant breathed room air through a closed circuit mouthpiece attached to a metabolic cart (Sensormedics 2900, Yorba Linda, CA). The following physiological measures were recorded: respiratory rate, minute ventilation (VE), oxygen consumption (VO_2), and carbon dioxide production (VCO_2). All physiological measurements were taken during the last 20 seconds of each stage. All testing equipment was calibrated before each exercise session.

The ITT is recognized to be a reasonable measure of functional capacity, has established norms, occurs in a controlled laboratory environment, and provides physiological data reflecting both cardiac and pulmonary function (Sutherland & Make, 2005). The minutes exercised during the ITT as well as the exercise stage achieved will be the units of analysis for this outcome; an increase in minutes exercised indicated improved endurance. For the analysis presented here, values from the ITTs at baseline, two months, six months and 12 months were be analyzed.

The Endurance Treadmill Test (ETT).

The Endurance Treadmill Test (ETT) was performed on baseline testing day 3 after the ITT. After heart rate and dyspnea ratings had returned to baseline (at least 30 minutes after completing the ITT), a symptom-limited, constant workload endurance treadmill test (ETT) was conducted. The ETT test was run at a difficulty level equal to one exercise stage below what the participant had achieved on the ITT. In other words, if participants achieved stage 5 on the ITT, the participant was exercised at the Stage 4 level. The participants were warmed up at a speed of 1 MPH for 80 seconds and then were taken to the desired stage for the duration of the ETT. The participant breathed room air through the metabolic cart mouthpiece throughout the test. All of the same physiological data collected during the ITT

was also collected during the ETT, but the measurements were recorded during the last 20 seconds at 80 intervals. For this analysis, minutes exercised during the ETT will serve as a measure of physical function. For this secondary analysis, the values from the ETTs at baseline, two months and 12 months were analyzed.

Dyspnea with Activities of Daily Living and Exercise

The Chronic Respiratory Questionnaire (CRQ).

To evaluate dyspnea with ADLs, the participants completed the Chronic Dyspnea Questionnaire (CRQ) (Guyatt et al., 1987). The dyspnea subscale of the CRQ (Guyatt et al., 1987) was used to evaluate dyspnea with ADLs. The 20 item CRQ renders a total score and four sub-scale scores which are designed to reflect the four domains: dyspnea, mastery, fatigue and emotional distress. For this study, the CRQ was administered in the interview format. The first part of the interviewer-lead questionnaire elicits highly-individualized information regarding dyspnea experienced while performing 26 different dyspnea-provoking activities over the past two weeks. The interviewee is asked to respond either "yes" or "no." The participant is asked to select the top five dyspnea-producing activities. The top five are then ranked by the participant in terms of importance in daily living. Next, the top five dyspnea provoking activities are scored on a 1-7 likert scale of severity of shortness of breath by the participant (range 1= "extremely short of breath" to 7="not at all short of breath").

The next section of the instrument is composed of sets of questions pertaining to the mastery, fatigue and emotional distress domains. Again, a likert scale response is elicited for each question. The 15 standard questions address the following: frustration or impatience; fear, upset or panic; restlessness; fatigue; energy; embarrassment; confidence in dealing with

illness; upset, worried or depressed; discouragement; sense of complete control; relaxation; and satisfaction with personal life. For this analysis, only the baseline mastery subscale scores from this portion of the instrument was analyzed.

The dyspnea subscale of the CRQ served as a measure of dyspnea with ADLs. The authors of the parent study reported reasonable reliability for the instrument evidenced by the following measures of internal consistency derived from pre and post-intervention data: dyspnea subscale (alpha = .73-.71), fatigue (alpha .86-.89) emotional function (alpha .86-.92) and mastery (alpha .73-.80) (Stulbarg et al., 2002). The dyspnea subscale scores at baseline, two months, four months, eight months and 12 months were analyzed.

Recent Dyspnea and Dyspnea Impact Ratings

Two additional dyspnea-related questions, patterned after two pain questions in the standard SF-36 (specifically SF-36 questions 7 and 8), were queried. These two questions, which were designed by the parent study investigators, will be referred to as the "recent dyspnea rating" and the "recent dyspnea impact on activates of daily living." The recent dyspnea rating is presented to the respondent as follows: 1) "How much shortness of breath have you had in the past four weeks." The recent impact of dyspnea on activities of daily living question is presented as follows: 2) "During the past four weeks, how much did shortness of breath interfere with your normal work (including both work outside the home or housework)?" Responses for each of the additional questions were rated using the following likert scale: 1 = none, 2 = very mild, 3 = mild 4 = moderate, 5 = severe and 6 = very severe.

The recent dyspnea rating has been validated by means of factor analysis (Nguyen et al., 2003). Using principle component analysis to evaluate different measures of dyspnea,

the recent dyspnea rating question loaded on a "clinical dyspnea" factor. Other variables included in this factor were dyspnea intensity at the end of the 6MW, 6MW dyspnea/distance walked in feet, the Baseline Dyspnea Index (Mahler & Harver, 1992), the University of California, San Diego Shortness of Breath Questionnaire (SOBQ) (Eakin, Resnikoff, Prewitt, Ries, & Kaplan, 1998), the Medical Research Council (MRC) dyspnea scale (Fletcher, Elmes, & Wood, 1959) and the CRQ-Dyspnea subscale. Both the recent dyspnea rating and the recent dyspnea impact on activities of daily living rating were measured at baseline, two months, four months, eight months, and 12 months.

The Modified Borg Dyspnea Intensity Scale.

At the baseline visit, participants were also instructed on how to use the Modified Borg Dyspnea Intensity Scale (Borg scale) (Borg, 1982; Burdon, Juniper, Killian, Hargreave, & Campbell, 1982). At the end of each 6MW, the participants were asked to rate the intensity of their dyspnea using the modified Borg scale, by pointing to a value on the scale held in front of them. The post-6MW dyspnea intensity ratings serve as measure of dyspnea with exercise for this secondary analysis.

The data used for this analysis (Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002) were derived from a slightly different modified Borg Scale (shown below in Figures 4.2 and 4.3).

Figure 4.2:
Modified Borg Scale

0 Nothing at all
0.5 Very, very slight
1 Very slight
2 Slight
3 Moderate
4 Somewhat severe
5 Severe
6
7 Very severe
8
9 Very, very severe (almost maximal)
10 Maximal

(Burdon et al., 1982)

Figure 4.3
Modified Borg Scale used in Dyspnea Self-Management Study

10 Maximal
(worst possible)
9 Very, very severe
8
7 Very severe
6
5 Severe
4 Somewhat severe
3 Moderate
2 Slight
1 Very slight
0.5 Very, very slight (just noticeable)
0 None at all

(Carrieri-Kohlman et al., 2005; Stulbarg et al., 2002)

Two major differences should be noted. For the version used for this analysis, the "maximal" level (10) has the additional descriptor of "worst possible" (Figure 4.3) and there is no descriptor for the "9" level, as there is on the Burdon version (Figure 4.2). Secondly, it is reversed vertically, meaning the maximal level is placed at the top of the scale, just the opposite of other modified Borg scales.

The validity of the Burdon version of the scale (Figure 4.2) has been extensively evaluated (Mador, Rodis, & Magalang, 1995; Mahler et al., 1991; Muza, Silverman, Grover, Hellerstein, & Kelsen 1990; Silverman, Barry, Hellerstein, Janos, & Kelsen, 1988; Wilson & Jones, 1989, 1990, 1991). It has also been specifically correlated with the visual analog scale (Gift, 1989) in a study by Wilson and Jones (Wilson & Jones, 1989). Based on review of several exercise studies involving COPD patients (Clini et al., 2001; Eaton et al., 2002; Foglio et al., 1999; Gigliotti et al., 2003; Martinez et al., 1997; Stulbarg et al., 2002), an increase or decrease of two units on the modified Borg scale is considered a clinically important change (Ries, 2005).

Self-Efficacy Measures

Self-Efficacy for Home Walking Questionnaire.

Self-efficacy for home walking was measured by the Self-efficacy for Home Walking Questionnaire developed by Kaplan and Atkins (Kaplan & Atkins, 1984). This 10-item instrument, based on Bandura's Social Cognitive Theory (Bandura, 1991), asks the respondent to rate their confidence (on a scale ranging from zero = "not confident at all" to 10 = "totally confident") in walking distances both inside and outside their home, ranging from their bed to their bathroom only, around the inside of their house and eight different distance increments ranging from one-half block to two miles. The higher the score, the greater the confidence to complete the task, which in this case, is ability to walk a specific distance. The possible scores range from zero, indicating the respondent did not have any confidence they could walk any distance queried, to 100, which indicates the respondent was totally confident they could walk all of the queried distances. This outcome was measured at five time points: baseline, two months, four months, eight months and 12 months. At each

measurement point, the value recorded reflected the mean score for the ten different questions.

The Self-Efficacy for Managing Shortness of Breath Scale.

The Self-efficacy for Managing Shortness of Breath Scale (Lorig et al., 1996) is a single question scored on a likert scale that queries the respondent's confidence in keeping shortness of breath from interfering with what they want to do. The horizontal scale ranges from one to 10 and is anchored on the left (left of the numeric "1" value) by "not at all confident" to "totally confident on the right side of the scale (right of the numeric "10"). A higher score reflects greater confidence in being able to manage shortness of breath. Prior reliability analyses for the data from another secondary analysis of this same data set reported the two-week test-retest correlation for this instrument was = .77 (Davis et al., 2006).

Baseline depression was evaluated by means of the Centers for Epidemiological Studies Depression (CES-D) Scale (Radloff, 1977). The scale is a brief self-report instrument, and has established validity and reliability for use in the general population (Radloff, 1977).

Data Analysis

The longitudinal, repeated measure data in this study was evaluated by means of linear regression modeling and the mixed-models statistical analysis techniques using SAS Version 9.1 software (PROC MIX). Statistical Package for Social Sciences (SPSS) Version 15 software was used to analyze some demographic data and physiological. The mixed models approach was selected as the primary analysis method as it is designed for use with repeated measures longitudinal data and can accommodate data sets that contain missing data. Additionally, it can provide information regarding individual changes over time as well

as group changes by time. Covariance parameters were estimated using maximum likelihood ratios.

To test for a moderating effect of a variable, models must include an analysis of different interaction terms. For all analyses that examined for a moderating effect of age (Research Hypotheses # 1, #2, #3, #6 and #8), the following strategy was employed. Fixed effects mixed model analysis was initiated with a full model (Model 1) that contained all of the following individual variables and interaction terms: age, treatment group and time (treated as a categorical variable), age by time, age by treatment group, and age by time by treatment group (three-way interaction); Model 2 retained all of the variables and interaction terms contained in Model 1, but removed the three-way interaction term (age by time by treatment group); Model 3 retained age, time and treatment group, but removed the three-way interaction term and the time by treatment group interaction; Model 4 retained age and time, removed the three-way interaction term, and included an interaction term for age by DM group; Model 5 retained age and time, removed the three-way interaction term and included an interaction term for age by time for the DM-Exposure group; Model 6 retained age and time, removed the three-way interaction term, and included an interaction term for age by time for DM-Training group. See Box 1 for a summary of model elements.

The regression model fitting strategy was as follows: all analyses began with the full model (Model 1). If the age by time by treatment group interaction was significant ($p < .05$), then Models 4, 5 and 6 were fit. If the age by time by treatment group interaction in Model 1 was not significant, then variables were fit for Model 2. If the interaction term for time by treatment group was significant, Models 4, 5 and 6 were fit; if the interaction term for time by treatment group was not significant, then the variable were fit for Model 3. To facilitate

interpretation, models were also refit at each time point (visit), providing greater clarity as to the timing of a moderating effect. When appropriate contrast between intervention groups and time points were also conducted.

In cases where age served as significant moderator of the treatment group effect, data was plotted using predicted values for three different prototypical ages, representing younger adults (age 57), middle-aged adults (age 67) and older adults (age 77). The ages selected were approximately the median age for each age sub-group.

For this secondary analysis, self-efficacy for home walking and self-efficacy for managing shortness of breath ratings were each evaluated by means of regression analysis to determine if specific demographic characteristics (age, gender, ethnicity), socioeconomic status (educational level, annual income and marital status), disease severity (FEV-1) and baseline symptom measures (CRQ-dyspnea), a mastery measure (The CRQ-Mastery subscale) and dyspnea intensity after baseline 6MW were significant predictors of self-efficacy for home walking. Secondly, mixed models analyses were run to determine if self-efficacy for home walking and self-efficacy for managing shortness of breath ratings changed over time or differed by treatment group; if a significant change was seen, then age as a moderator was explored.

Means and standard deviations were also employed in this analysis for some demographic and physiological data. The analysis conducted with the assistance of a statistician knowledgeable with mixed-models analysis. The alpha level for statistical significance was pre-set at .05. A type 3 p value is reported for interactions, representing the level of significance of the interaction in the overall model. In cases where multiple

comparisons are made or plots were derived from predicted values, a more stringent alpha level of $p < .01$ was set to indicate statistical significance.

Power Analysis

To assure the parent study was adequately powered, a power analysis was performed a priori based on an estimate sample size of 90 (30 in each treatment group), an effect size of .80 for the major outcomes and an alpha level of .05. The final sample size was 103, indicating the study was adequately powered.

Funding and Data Source

The data for this secondary analysis has been made available to this researcher by permission of Dr. Virginia Carrieri-Kohlman. The study was funded by National Institutes of Health/National Institute of Nursing Research (NIH NINR R01-NR02131-08). Some components of the study occurred in the General Clinical Research Center, Moffitt Hospital, University of California, San Francisco which is partially supported by the National Center for Research Resources (5 M01 RR-00079), United States Public Health Services.

CHAPTER FIVE: RESULTS

Sample

Potential participants were recruited over 36 months. A total of 814 potential participants were screened over the phone, with 183 meeting initial screening criteria. Following spirometry screening, 41 potential participants were excluded, leaving 142 who underwent baseline testing. Through the process of baseline screening, another 27 potential participants were excluded because they did not meet study entry criteria, leaving a sample of 115 participants invited to enter the study. The initial sample of 115 was randomized by strata (according to whether or not they experienced oxygen desaturation during exercise testing, if they did or did not achieve aerobic threshold and gender) into one of three treatment groups: the Dyspnea Self-management Group only (DM), the Dyspnea Self-Management- Exposure group (DM-Exposure) the Dyspnea Self-Management-Training group (DM-Training). Twelve participants dropped out over the course of the 12 month study (four from each group) for the following reasons: non-respiratory medical problems (3); exacerbation of COPD (3); personal reasons (2), death (2); unwilling to use mouthpiece during exercise testing (1); loss of interest in study (1). The final number of participants included in this secondary analysis was 103.

A comparison of demographic and physiological parameters revealed no significant difference in participant characteristics across treatment groups. See Table 4 for a summary of baseline data. The 12 participants that did not complete the study differed from those who completed the study on the following characteristics: they had a higher baseline arterial blood gas partial pressure for carbon dioxide ($PaCO_2$) (43.3 ± 5.0 versus 39.4 ± 4.8 mm Hg, p = .018); and were younger (59 ± 10 years versus 66 ± 8 years, p = .004)

Research Aim #1: To investigate if age moderates the effect of the dyspnea self-management program (DSMP) interventions on self-reported functional performance, functional capacity measures, and dyspnea with activities of daily living and exercise.

Self-Reported Functional Performance Outcomes

Hypothesis #1: Age will moderate the effect of the three different DSMP interventions on self-reported functional performance over time.

Research Question #1a. Does age moderate the effect of the DSMP intervention on overall self-reported physical functioning over time?

The SF-36 Physical Function Component score was the outcome measure. In the original analysis examining for group by time effects, the SF-36 Physical Component Summary scores did improve over time (Likelihood ratio test $p = .02$) (Carrieri-Kohlman et al., 2005). The DM-Training group improved significantly more than the DM-Exposure group at four months and the DM group improved more than the DM-Exposure group at 12 months ($p < .05$) (Carrieri-Kohlman et al., 2005).

The hypothesis that age would moderate the effect of the three different DSMP interventions over time for this self-reported functional performance outcome was not supported. Applying the mixed models analytical strategy outlined above, age was not found to be a significant moderator of treatment effect by time for SF-36 Physical Component Summary scores in Model 1($F = 1.30$, $df = 97$, Type 3 $p = .253$). In addition, there was no significant moderating effect of age by treatment group (Model 2 $F = 1.89$, $df = 97$, Type 3 $p = .157$) or for age by time (Model 2 $F = 1.04$, $df = 97$, Type 3 $p = .390$). Age was not a significant moderator of overall self-reported physical performance over time.

Research Question #1b. Does age moderate the effect of the DSMP intervention on ability to perform activities of daily living over time?

The SF-36 Physical Function subscale served was the outcome measurement of ability to perform activities of daily living. In the original analysis, SF-36 Physical Functioning subscale scores did not change significantly over time (Carrieri-Kohlman et al., 2005). The hypothesis that age would moderate the effect of the three different DSMP interventions over time for this self-reported functional performance outcome was not supported. In this analysis, age was not found to be a significant moderator. The interaction term was not significant between age by treatment group by time (Model 1 F = 1.12, df = 97, Type 3 p = .359), or for the age by treatment group interaction term (Model 2 F = .73, df = 97, Type 3 p = .483) or for age by time interaction term (Model 2 F = .52, df = 97, Type 3 p = .723). Age was not a significant moderator of self-reported ability to perform activities of activities of daily living over time.

Research Question #1c. Does age moderate the effect of the DSMP intervention on role functioning over time?

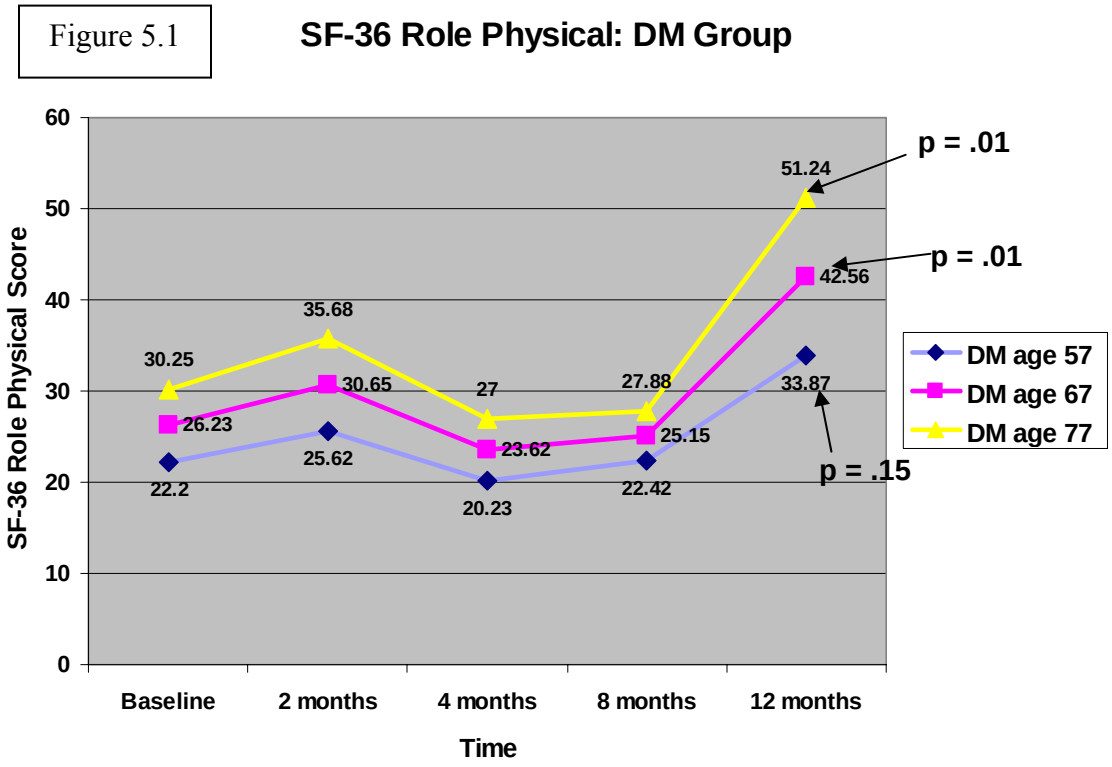
The SF-36 Role Physical subscale served as the measure of role functioning. In the original analysis, the SF-36 Role-Physical subscale score changed significantly by group over time (p = .035) (Carrieri-Kohlman et al., 2005).

The hypothesis that age would moderate the effect of the three different DSMP interventions over time on this self-reported role function performance outcome was supported. The age by treatment group by time interaction was not significant (Model 1, F = .98, df = 97, Type 3 p = .456). However, a significant age by treatment group interaction was present in Model 2 (Model 2 F = 3.19, df = 97, Type 3 p = .035) with a significant

coefficient estimate in Model 2 for the DM-Exposure group (- 2.20, SE .893, 95% CI – 3.98 to - .436, p = .015). This indicates that age was a significant moderator of SF-36 Role Physical subscale scores at baseline.

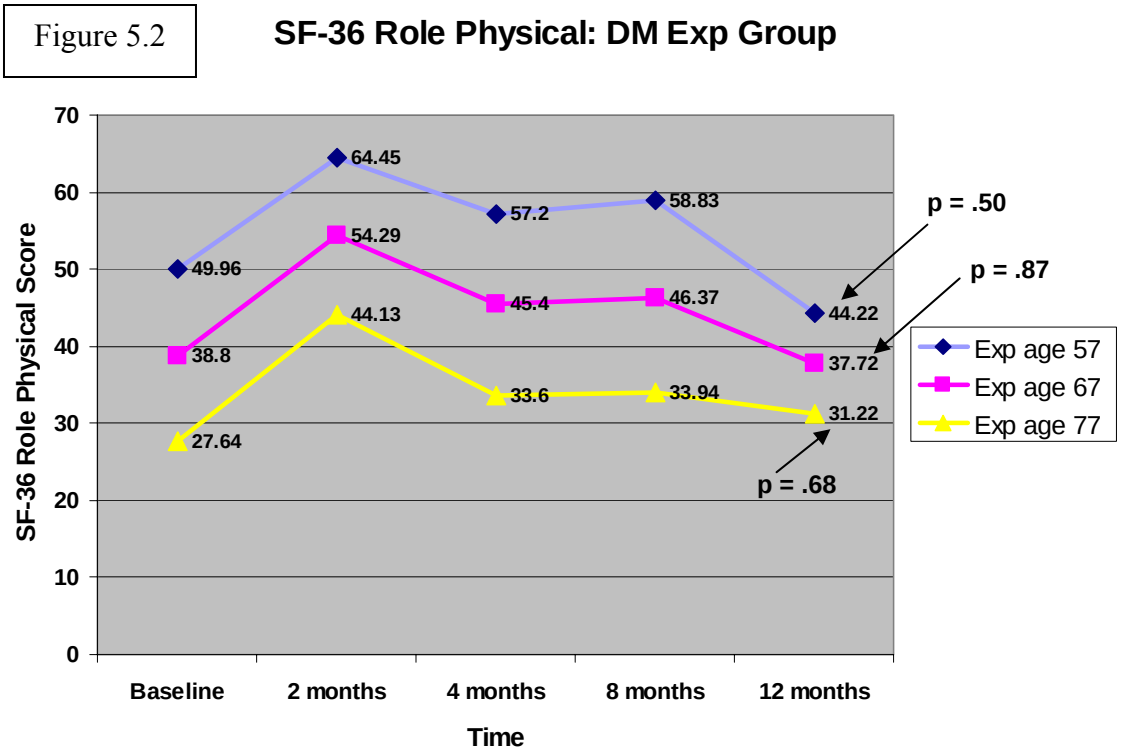
Plots demonstrating predicted values for different treatment groups and predicted values for age prototypes by treatment group are presented in Figures 5.1-5.6 below. (Arrows and p values that point to last data point reflect 12 month change).

Figure 5.1



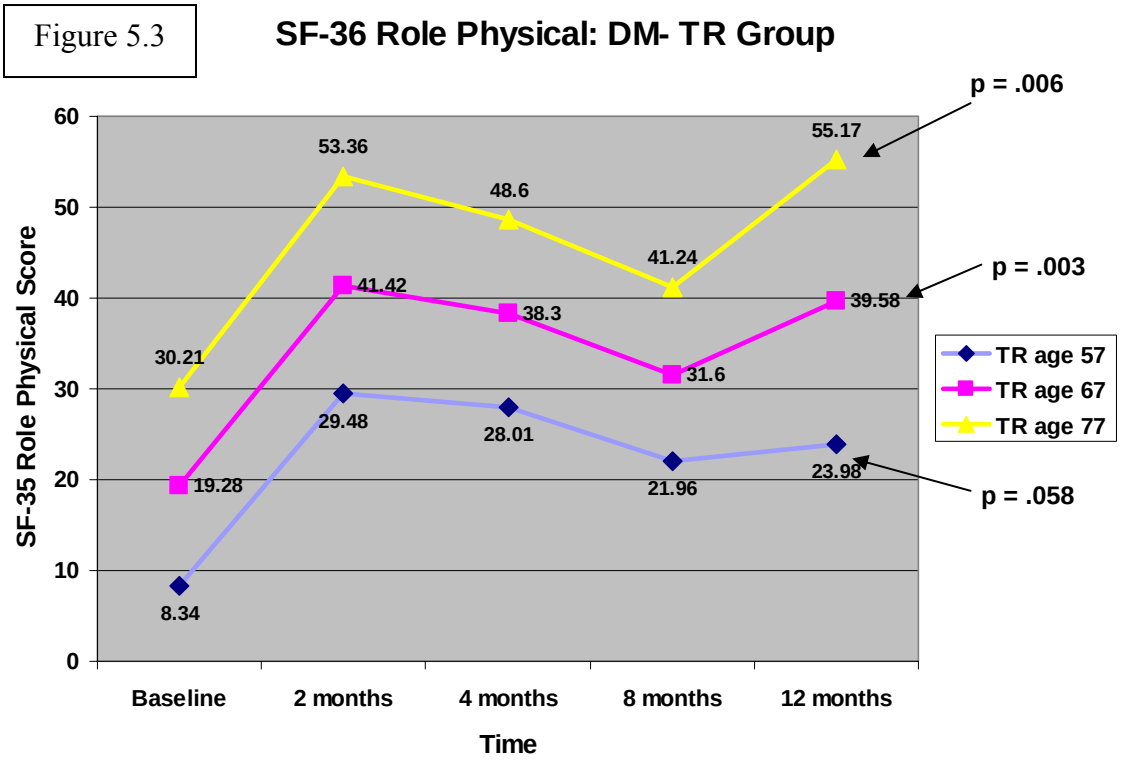
No significant difference in baseline scores
Significant improvements for 67 and 77 y/o

Figure 5.2



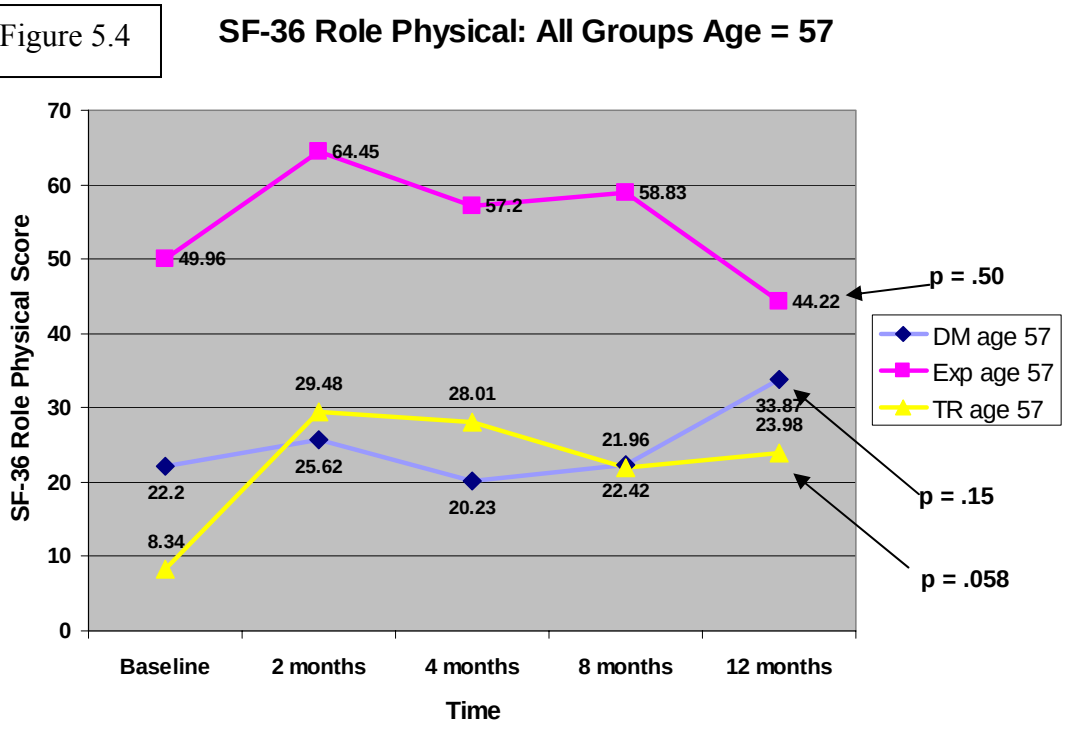
Baseline values not significantly different (age 57 vs. age 67 p = .08; age 57 vs. age 77 p = .08). No significant improvement for any age.

Figure 5.3



Baseline values not significantly different (age 57 vs. age 67 p = .13; age 57 vs. age 77 p = .13). Significant improvement for 67 and 77 y/o at 12 months

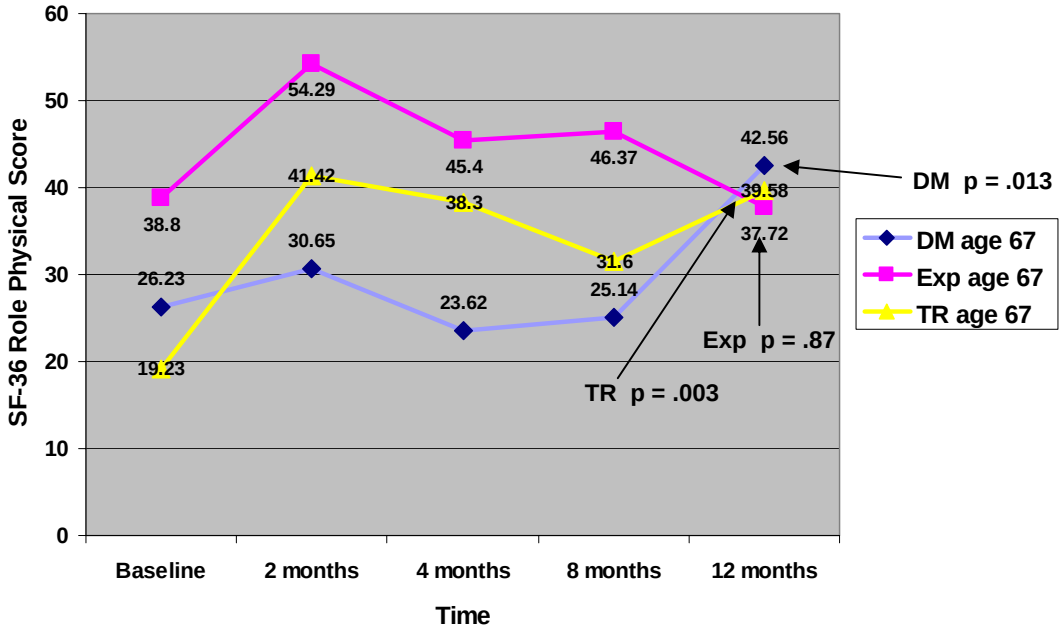
Figure 5.4



Significant difference between DM and DM-Exposure @ BL, 2 mo, 4 mo, 8 mo (all $p < .01$). Significant difference between baseline DM and DM TR Groups ($p < .0006$). No significant changes for any group at 12 months.

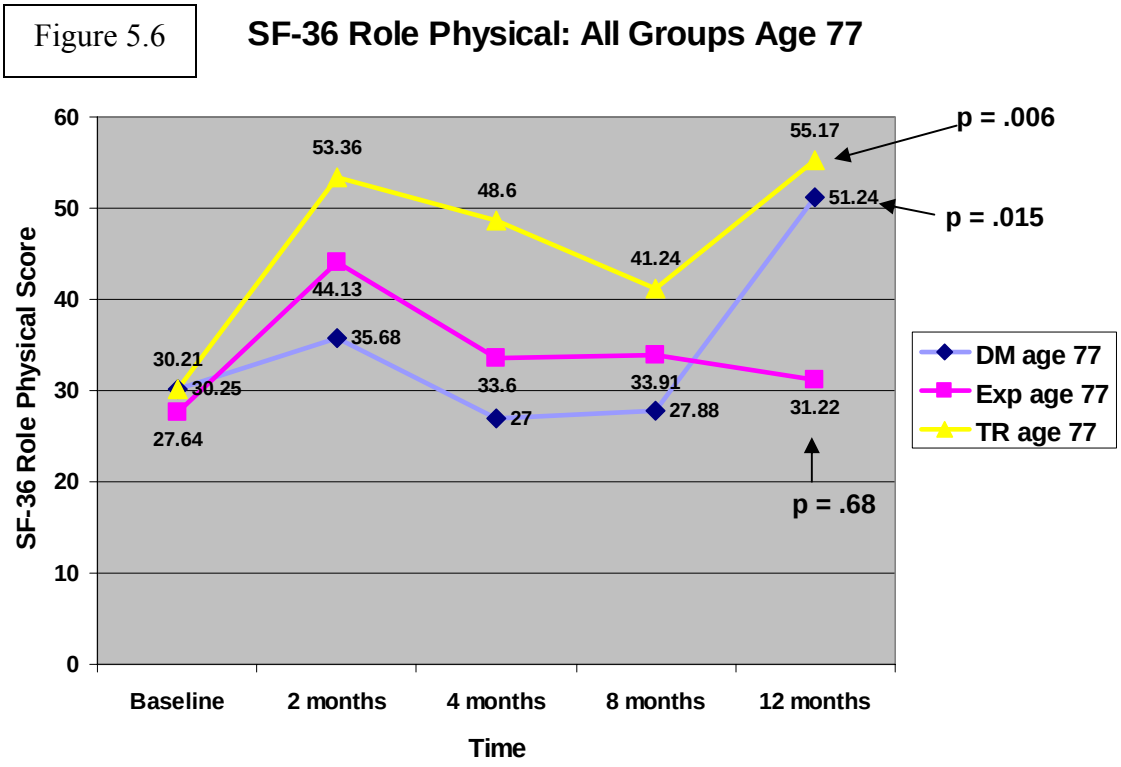
Figure 5.5

SF-36 Role Physical: All Groups Age = 67



Significant difference @ BL between DM Exp and DM-TR (p = .01)
Significant improvements for DM TR group @ 12 months

Figure 5.6



Only significant change in DM-TR Group @ 12 mos.

Using predicted values for the age 67 and 77 year old, significant improvements in the SF-36 Role Physical score were seen on in the DM group (Figure 5.2) (both age p = .01) and in the DM-Training group (Figure 5.3) (p = .003 and .006, respectively). No significant changes were seen in the DM-Exposure group for any age. For this outcome, the older age prototypes faired better and were able to sustain their improvements over time. Additionally, the DM-Exposure intervention did not appear to have any impact on the outcome, but the predicted baseline values were higher than for the other two intervention groups (Figure 5.2).

Functional Capacity Measures

Hypothesis #2: Age will moderate the effects of the three different DSMP interventions on functional capacity over time.

Six Minute Walk.

Research Question 2a. Does age moderate the effect of the DSMP intervention on walking performance over time?

The Six Minute Walk (6MW) distance (measured in feet) served as a performance-based measure of functional capacity for this question. The same sequence of fixed effects mixed models, variables entered and interaction terms were used to analyze the 6MW data collected at four time points: baseline, two months, four months, eight months and 12 months.

In the original analysis, the 6MW distance did not change significantly by treatment group over time for the entire sample (Carrieri-Kohlman et al., 2005). The hypothesis that age would moderate the effect of the three different DSMP interventions over time on this functional capacity outcome was not supported. The age by treatment group by time interaction was not significant (Model 1 $F = .83$, $df = 97$, Type 3 $p = .577$). Similarly, the age by treatment group interaction (Model 2 $F = 2.26$, $df = 97$, Type 3 $p = .110$) or for the age by time interaction (Model 2 $F = .67$, $df = 97$, Type 3 $p = .611$) were not significant. Age did not moderate distance walked during the 6MW test.

Incremental Treadmill (ITT) Duration and Stage.

Research Question # 2b: Does age moderate the effect of the DSMP intervention on symptom-limited exercise performance over time?

The ITT duration (expressed as minutes and decimals of seconds) and stage measured symptom-limited exercise performance, or functional capacity, for this analysis. The ITT duration will be discussed first.

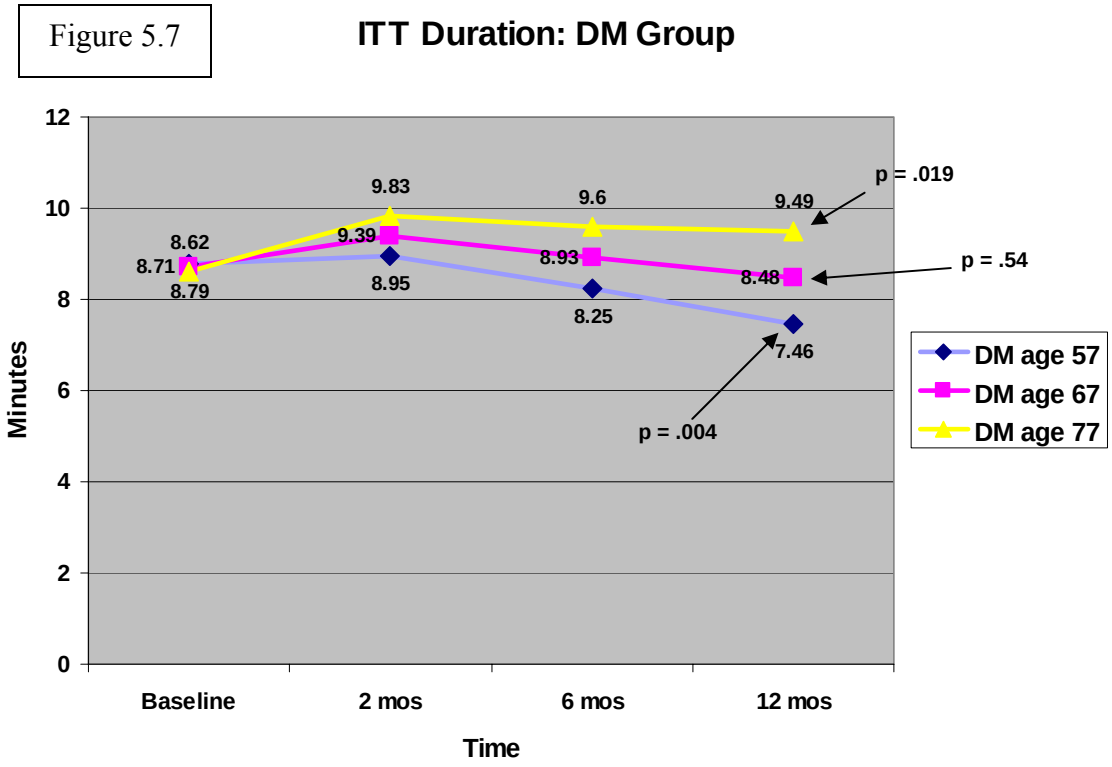
The mean baseline ITT duration for the entire sample was 6.89 minutes (SD 4.75, range .67-32). Values from the original study ITT duration analysis were not available. This

analysis conducted a mixed models analysis for this outcome using the following variables: visit, intervention group and age. This main effects mixed models analysis revealed that the ITT duration changed significantly over time for the entire sample (Type 3 $p < .001$); age was significant predictor (Type 3 p value = .015) and there was also a significant change in duration by treatment group (Type 3 p = .0283).

The hypothesis that age would moderate the effect of the three different DSMP interventions over time on this functional capacity outcome was supported. To test for the presence of a moderating effect of age, additional models were tested following the previously described plan. The interaction term for age by treatment group by time was not significant (Model 1 $F = 1.95$, df = 97, Type 3 p = .079). In Model 2, the interaction term for age by treatment group was significant (Model 2 $F = 3.80$, df = 97, Type 3 p = .016) as was the interaction term for age by visit (Model 2 $F = 4.70$, df =97, Type 3 p = .004).

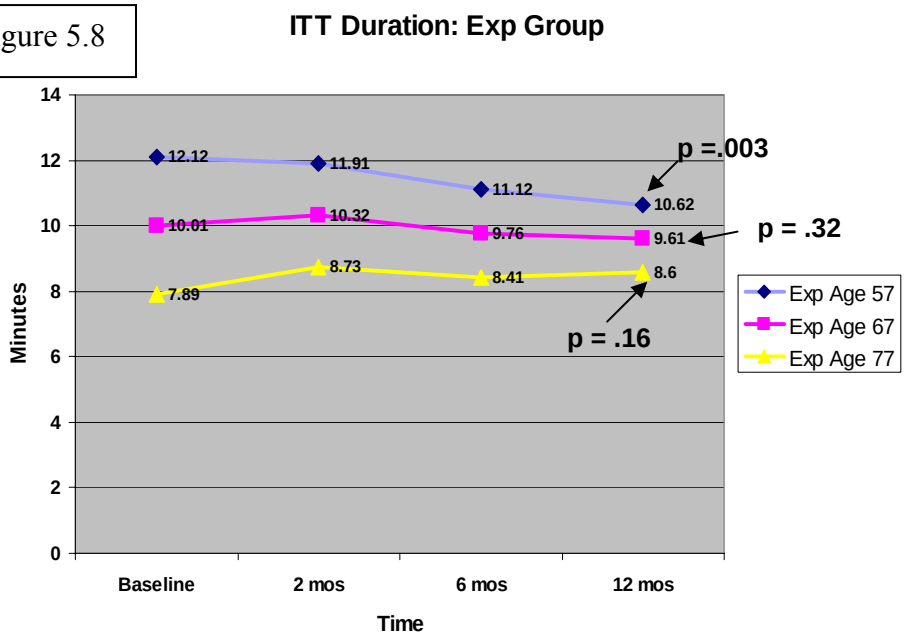
Plots demonstrating predicted values for treatment groups and predicted values for each age by treatment group are presented in Figures 5.7-5.12 below.

Figure 5.7



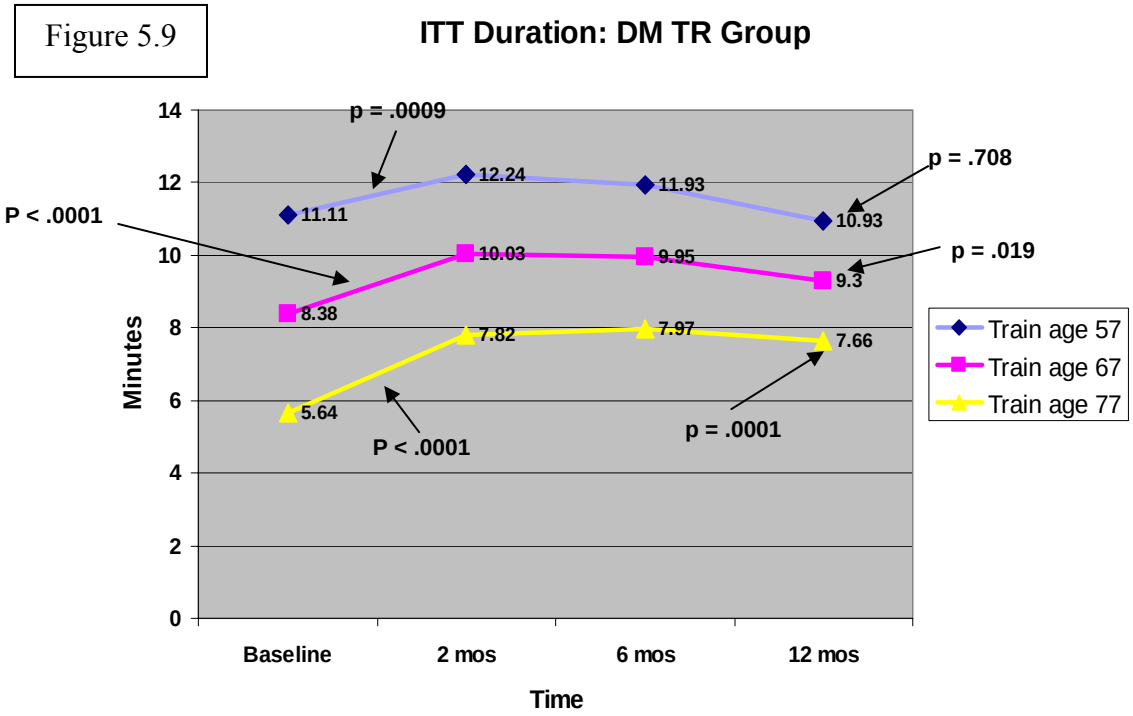
Age 57 had significant decline

Figure 5.8



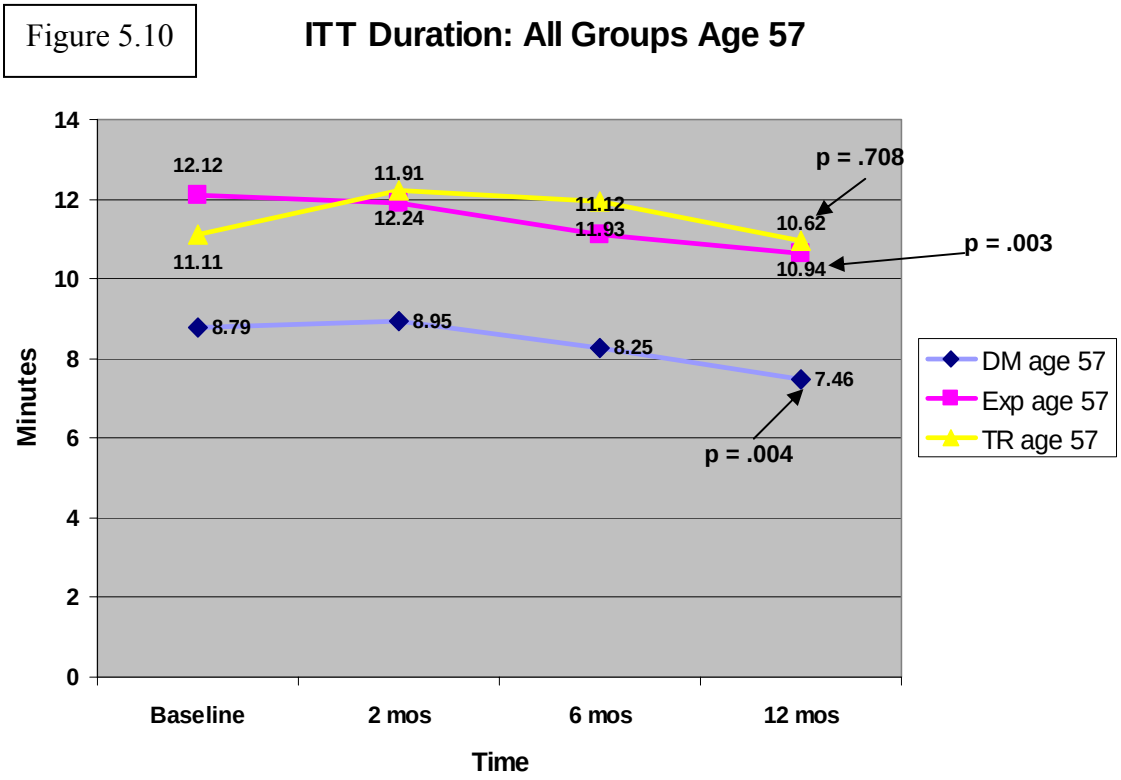
Baseline values significantly different between age 57 and age 67 and age 57 and 77 (both p = .008). Age 57 had significant decline at 12 months.

Figure 5.9



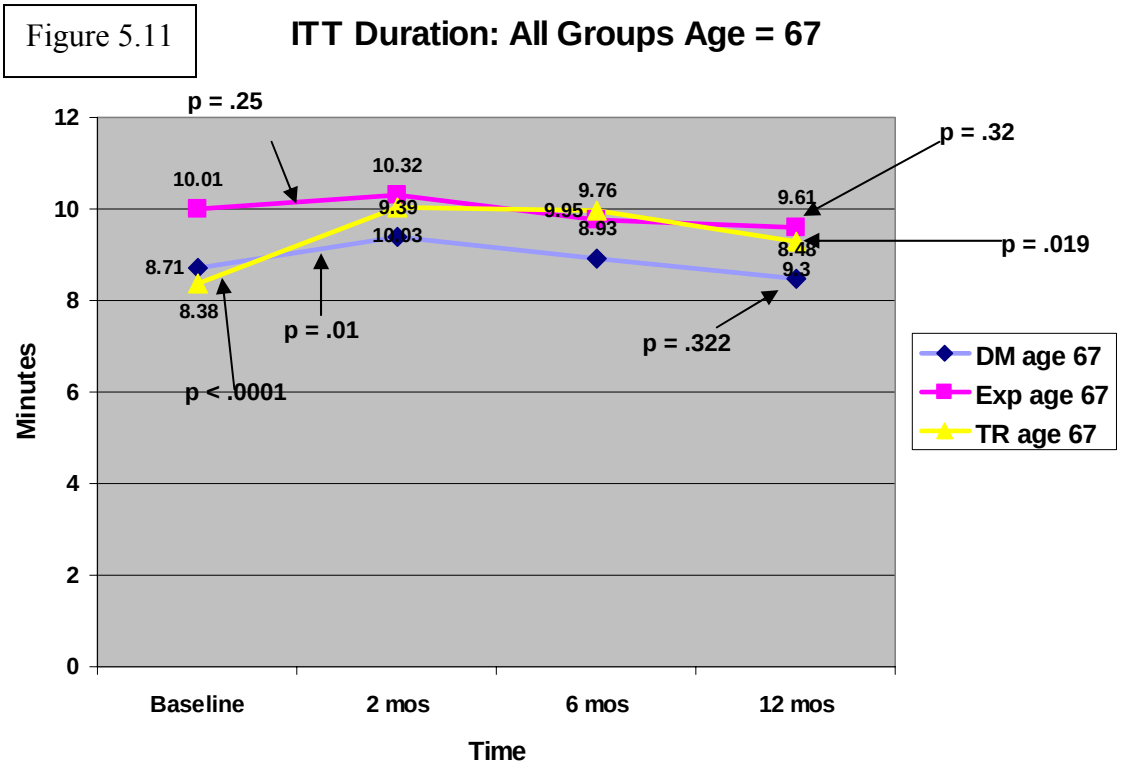
All ages had significant improvement early. Only significant improvement over 12 months seen in 77 y/o.

Figure 5.10



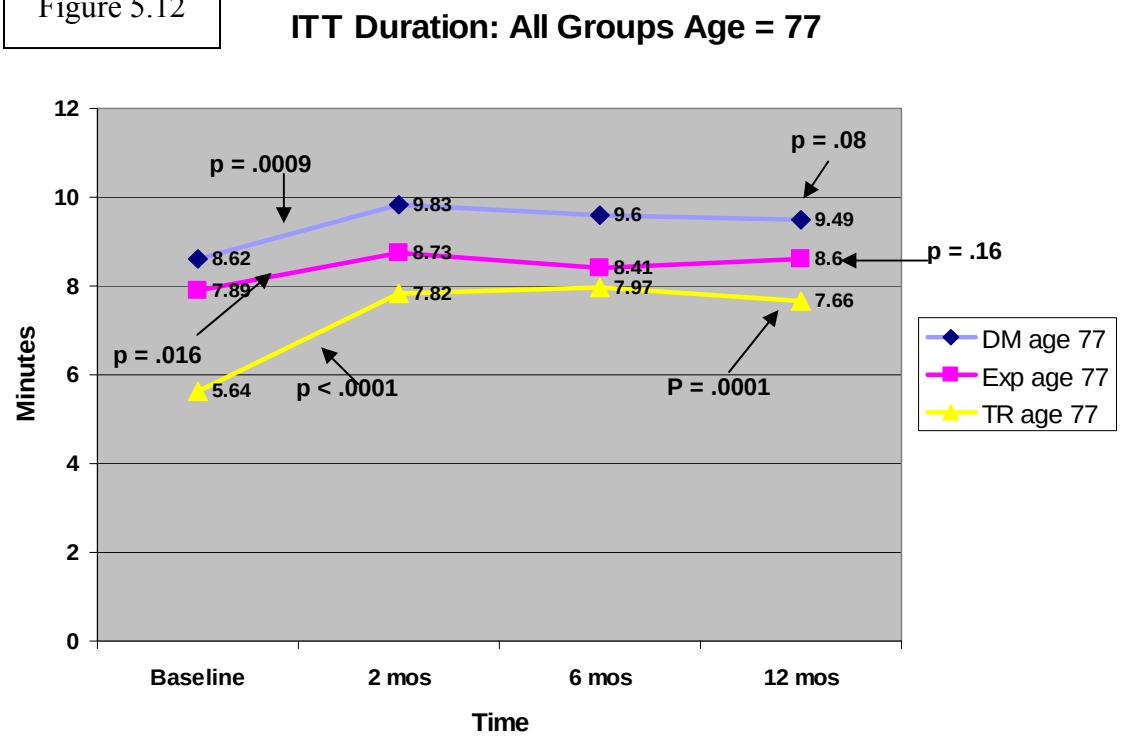
Significant decline in DM and Exp Groups

Figure 5.11



DM-Training Group had significant early improvement.
No significant change for any group @ 12 months.

Figure 5.12



All groups had significant change early. Only the 77 y/o sustained significant improvements @ 12 months.

Using predicted values for age prototypes, there was a significant decline over time for the 57 year old in the DM and DM-Exposure groups (p = .004 and p = .003 respectively) (Figures 5.7 and 5.8). The DM-Training 77 year old (Figure 5.9) was the only prototype case that demonstrated significant improvement at 12 months (p = .0001). For this outcome, the oldest age prototype in the DM-Training group was the only individual that sustained improvements over the course of the entire study period.

Incremental Treadmill Test Stage.

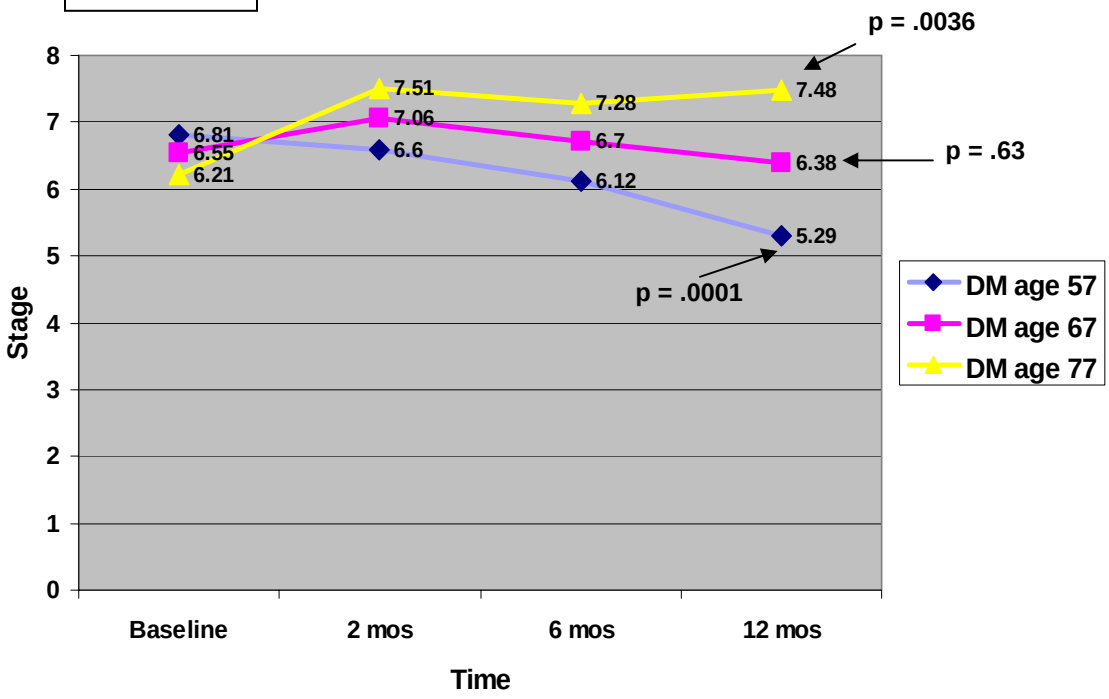
The mean baseline ITT stage achieved was 6.82 (SD 2.84, range 1-13). The ITT stage provides information similar to the ITT duration, but is in a different unit of measure. In the original analysis, there was a significant group by time effect (Likelihood ratio test p = .02). The DM-training group improved over time and the scores were statistically different

across groups: DM-Exposure group as compared to DM-Training group ($p \leq .01$); DM group as compared to DM-Training group ($p \leq .01$) (Carrieri-Kohlman et al., 2005).

The hypothesis that age would moderate the effect of the three different DSMP interventions over time for this functional capacity outcome was not supported. The age by treatment group by time interaction term was significant in the full model (Model 1 $F = 2.06$, $df = 97$, Type 3 $p = .069$), indicating a moderating effect of advancing age.

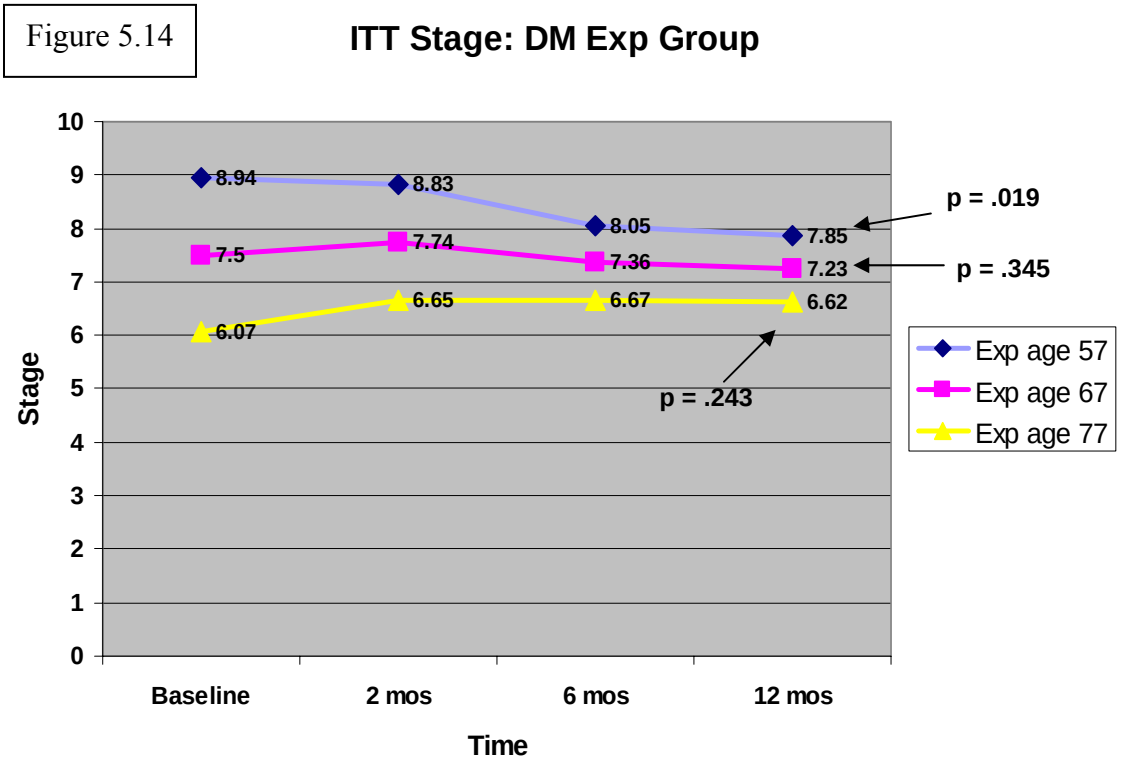
Plots demonstrating predicted values for treatment groups and predicted values for each age by treatment group are presented in Figures 5.13-5.18 below.

Figure 5.13



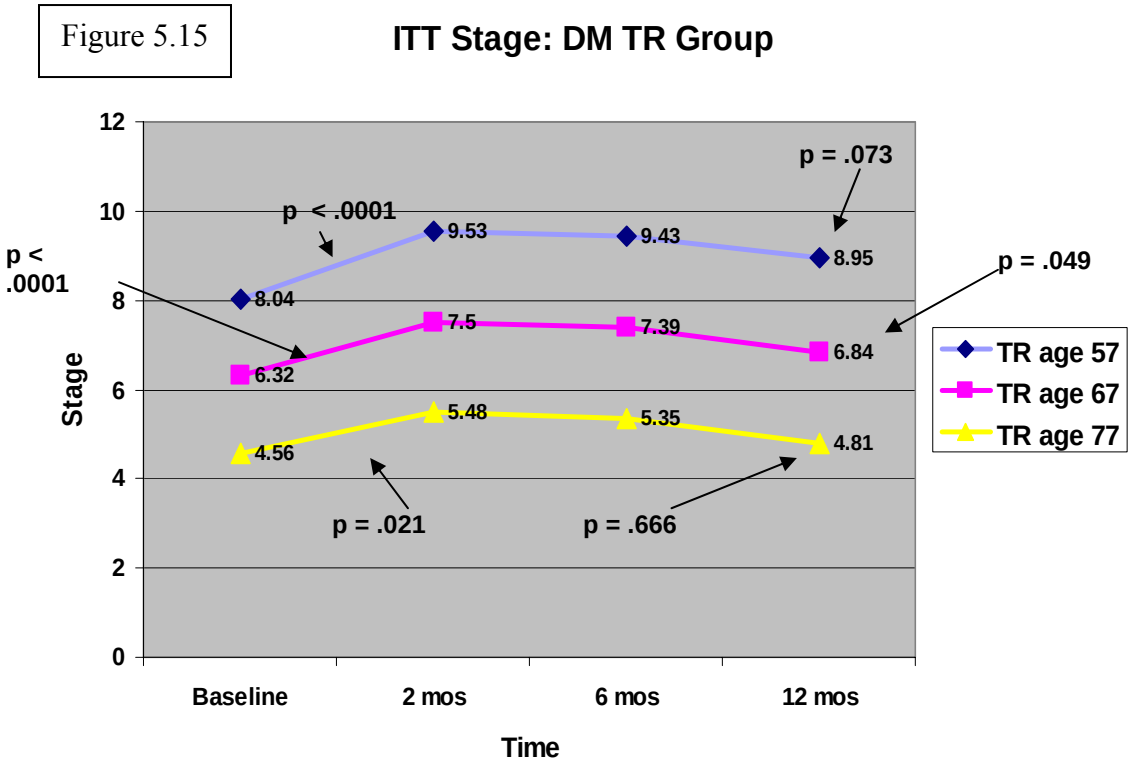
Significant decline for 57 y/o and significant improvement for 77 y/o at 12 months

Figure 5.14



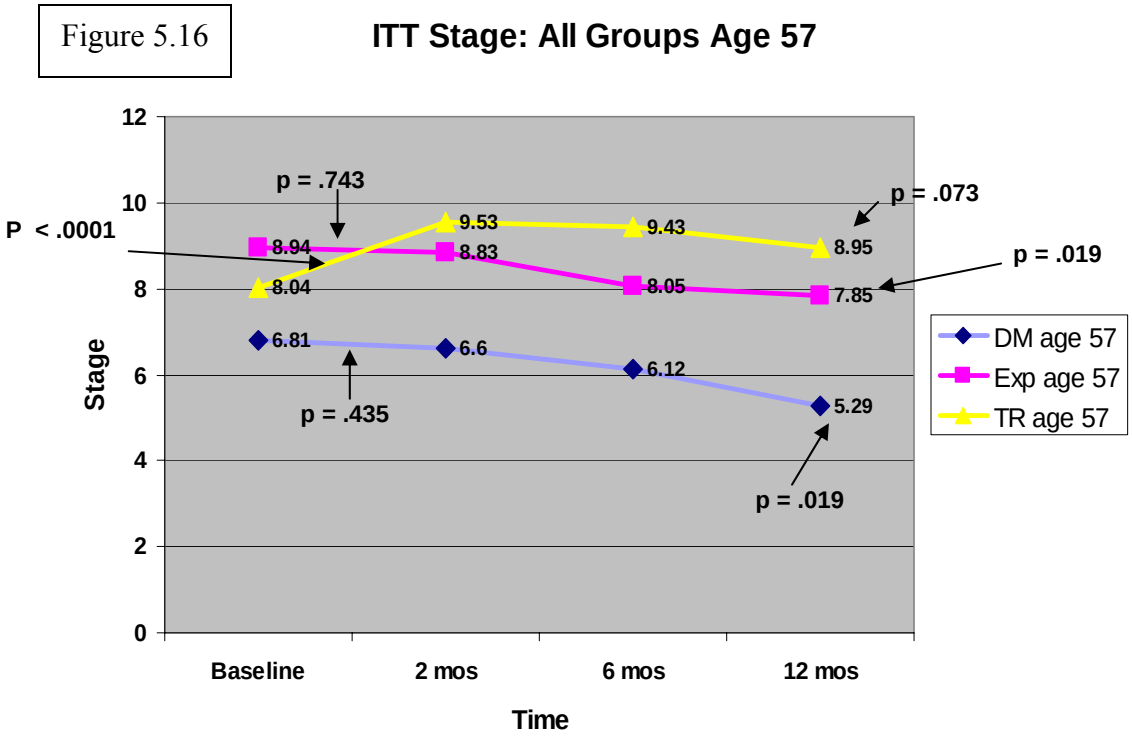
No significant changes for any age at 12 months

Figure 5.15



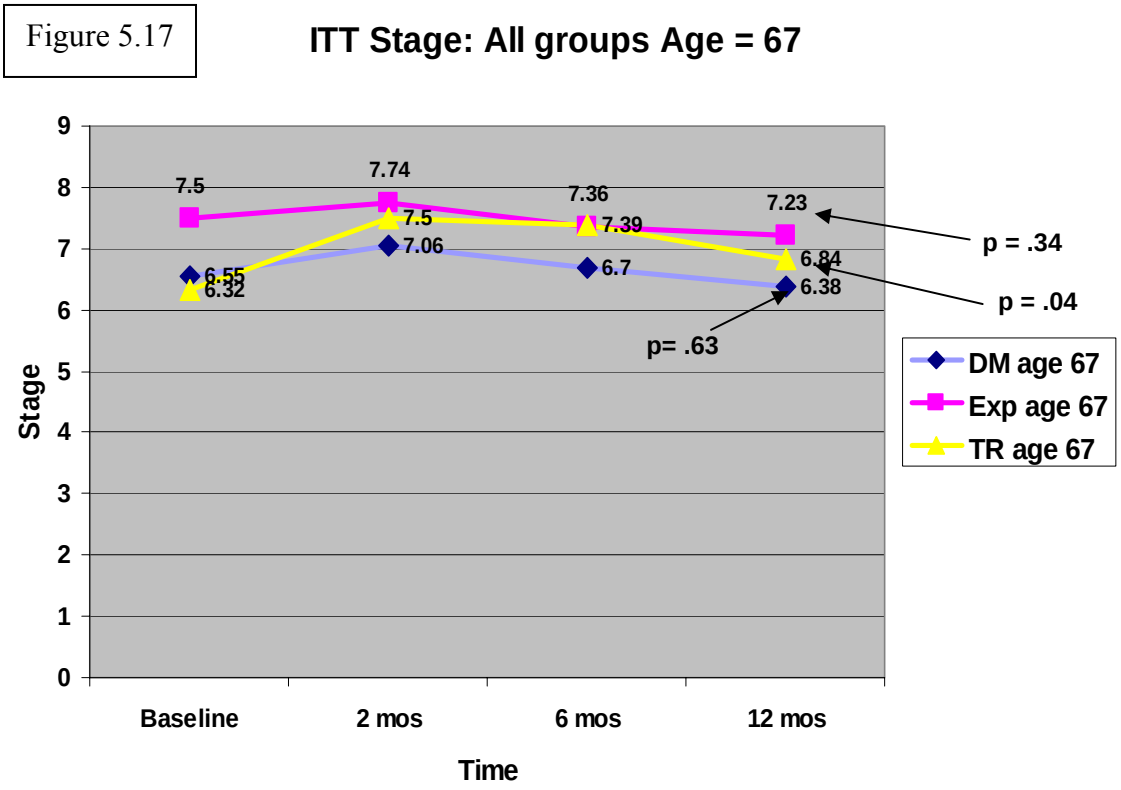
Early improvements for 57 and 67 y/o. No significant change for all ages @ 12 months

Figure 5.16



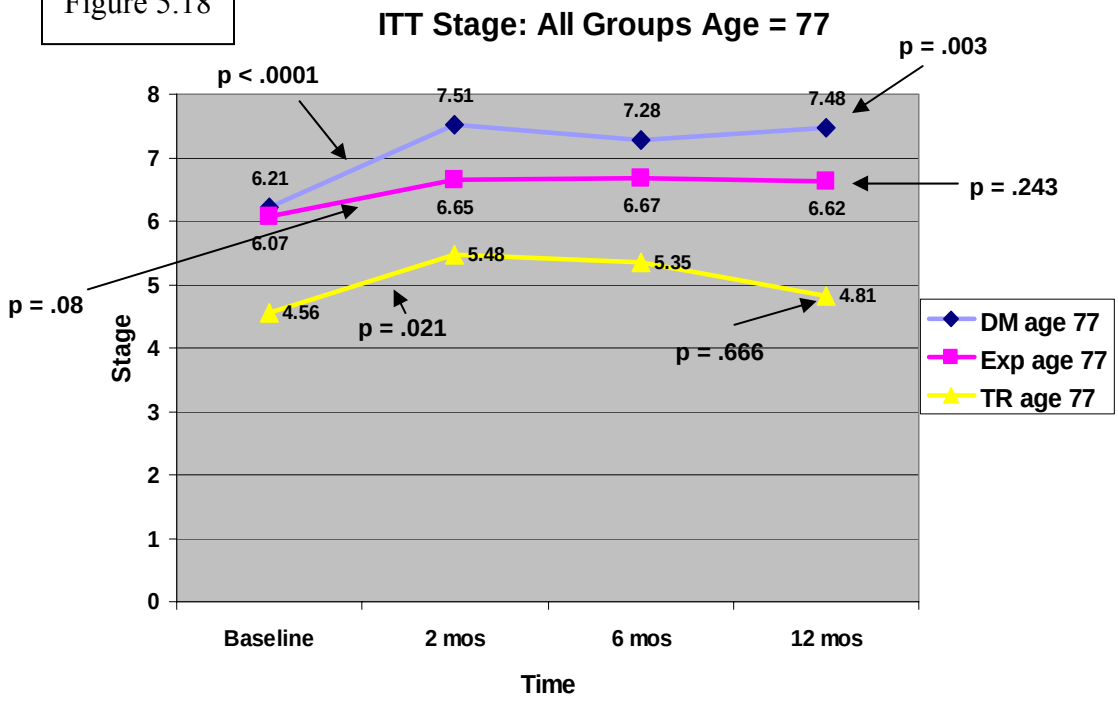
Significant early improvement for TR group. No significant improvement by 12 mos for any group

Figure 5.17



No significant changes @ 12 months

Figure 5.18



Early improvement in DM group that was sustained @ 12 months

In the DM group (Figure 5.13), there was a significant decline for the 57 year old and a significant improvement in the 77 year old over time (p = .0001 and p = .0036, respectively). There were no significant changes in the DM-Exposure group over time (Figure 5.14). While in the DM-Training group there were significant improvements for the 57 year old and the 67 year old between the baseline and two month visit, there were no sustained improvements through the 12 month study period (Figure 5.15). In the all group age 77 plot (Figure 5.18), only the 77 year old demonstrated early improvements that are predicted to be sustained over the 12 month period. For this outcome, the younger and middle aged ages demonstrated early improvements, but only the 77 year old in the DM-Training group demonstrated improvements at 12 months.

Endurance Treadmill Test (ETT) Duration.

Research Question #2c. Does age moderate the effect of the DSMP intervention on constant workload exercise performance over time?

The Endurance Treadmill Test duration (expressed as minutes and decimals of seconds) served as a measure of functional capacity. The same sequence of fixed effects mixed models, variables entered and interaction terms described previously was used to analyze the ETT duration at four time points: baseline, two months, six months and 12 months.

In the parent study, the ETT duration increased significantly across groups over time (Likelihood ratio $p = .02$) (Carrieri-Kohlman et al., 2005). Significant differences in ETT duration were seen between the DM and DM-Training groups at two, six and 12 months (all p values $\leq .05$) and between the DM-Exposure and DM-Training groups at two, six and 12 months (all p values $\leq .01$). The hypothesis that age would moderate the effect of the three different DSMP interventions over time for this functional capacity outcome was not supported. In this analysis, age did not moderate the effect of the treatment group by time on ETT duration (Model 1 $F = .64$, $df = 262$, Type 3 $p = .696$). In Model 2, the interaction term for age by time was not significant (Model 2 $F = 1.53$, $df = 268$, Type 3 $p = .206$) nor was there a significant interaction between age and treatment group (Model 2 $F = .62$, $df = 268$, Type 3 $p = .538$).

Hypothesis #3: Age will moderate the effect of three different DSMP interventions on dyspnea outcomes over time.

Dyspnea with Activities of Daily Living and Exercise

The Chronic Respiratory Questionnaire Dyspnea Subscale (CRQ-D).

Research Question #3a. Does age moderate the effect of the DSMP intervention on dyspnea with activities of daily living over time?

The dyspnea subscale of the Chronic Respiratory Questionnaire (CRQ-D) was used as the measure of dyspnea with activities of daily living. In the original analysis, the CRQ-D scores did improve significantly for the total sample over time (Likelihood ratio p = .02). All three groups improved their CRQ-D scores at the four months, eight months and 12 month time points and the improvements exceeded the minimum clinically important difference of 2.5; there was no significant differences between the groups over the course of the study period (Carrieri-Kohlman et al., 2005).

The sequence of fixed effects mixed models, variables entered and interaction terms described earlier were used to analyze the data collected at five time points: baseline, two months, four months, six months and 12 months.

The hypothesis that age would moderate the effect of the three different DSMP interventions over time on dyspnea with ADLs was not supported. No significant moderating effect of age by treatment group by time was detected by Model 1 (F = 1.23, df =97, Type 3 p = .288). In Model 2, the interaction for age by time was also not significant (F = .17, df = 97, Type 3 p = .953) nor was there a significant interaction for age by treatment group (F = .95, df = 97, Type 3 p = .390).

Dyspnea with Exercise.

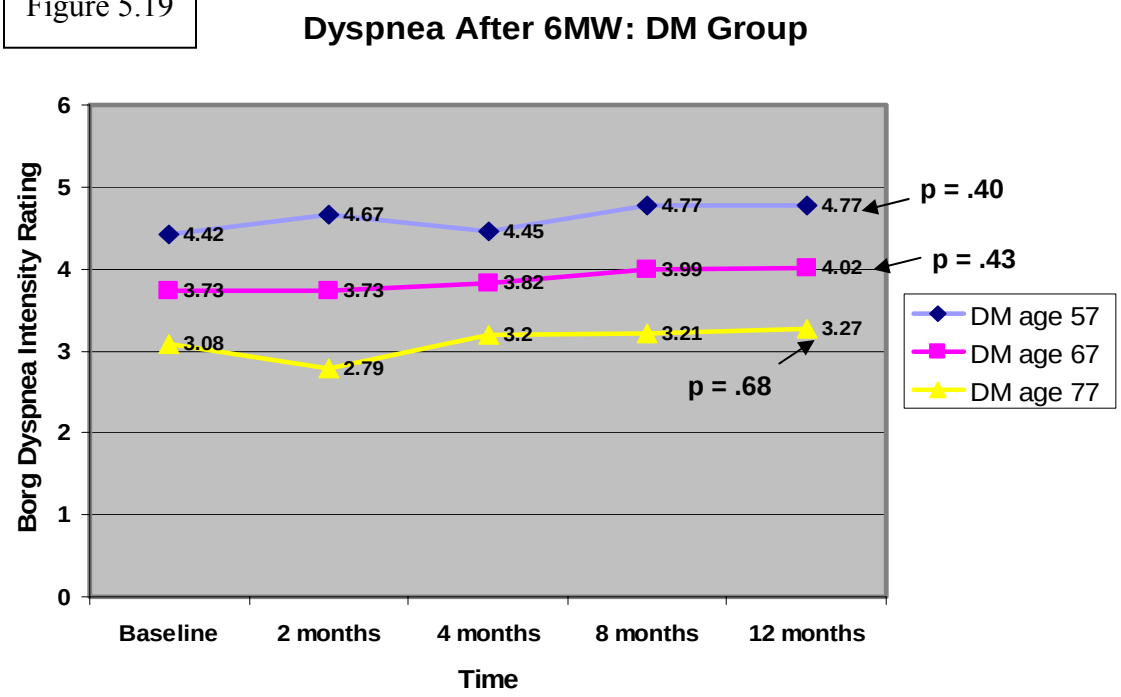
Research Question #3b. Does age moderate the effect of the DSMP intervention on dyspnea intensity after walking over time?

Dyspnea intensity after six minute walk (6MW) was the measure of dyspnea after walking for this question. Dyspnea intensity was rated by the participant using the modified

Borg scale. In the original analysis, dyspnea intensity after the 6MW did not change significantly for the entire sample or between the intervention groups (Carrieri-Kohlman et al., 2005). The sequence of fixed effects mixed models, variables entered and interaction terms described above were used to analyze the data collected at five time points: baseline, two months, four months, six months and 12 months.

The hypothesis that age would moderate the effect of three different DSMP interventions for dyspnea with walking was supported. The interaction between age by treatment group by time was not significant in Model 1 ($F = .51$, $df = 97$, Type 3 $p = .848$). However in Model 2, the interaction between age and treatment group was significant ($F = 4.48$, $df = 97$, Type 3 $p = .013$) indicating that the treatment group effect for dyspnea intensity after walking was moderated by advancing age. Review of data at each visit indicates that at two months, there was a significant interaction term between age and treatment group ($F = 5.20$, $df = 94$, Type 3 $p = .007$) and a significant coefficient estimate for the both the DM-Exposure group (.108, SE .050, 95% CI: .009- .207, $p = .032$) and the DM-Training group (.164, SE .054, 95% CI .056-.272, $p = .003$). The significant estimates indicate that the coefficients for the treatment groups were different from each other at this time point, and that age moderated (reduced) the dyspnea intensity ratings for the DM group. Figures 5.19-5.24 below present the treatment group and age prototype predicted value plots.

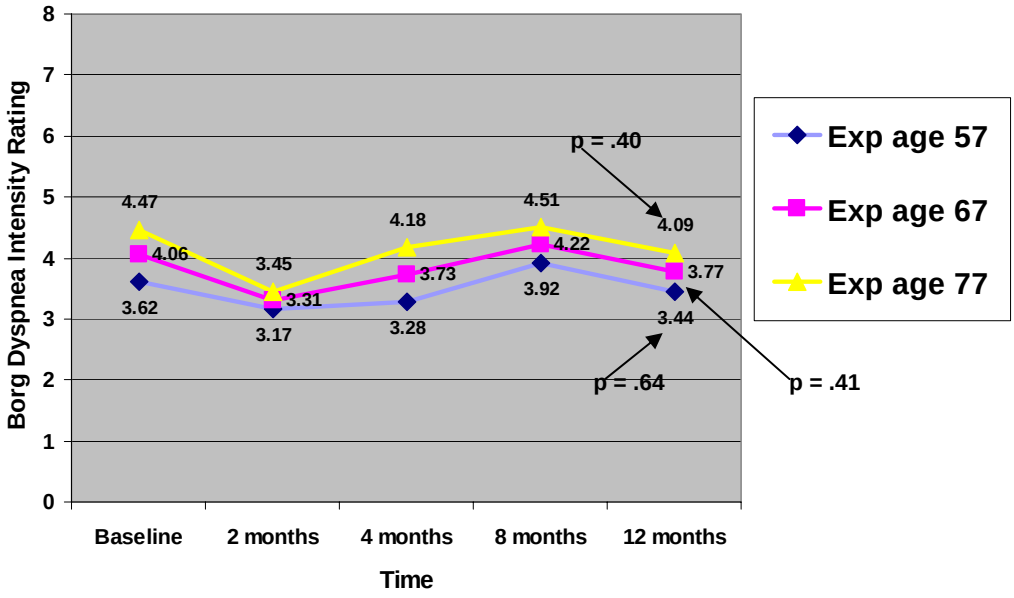
Figure 5.19



No significant differences at 12 months for any age.

Figure 5.20

Dyspnea After 6MW: DM Exp Group

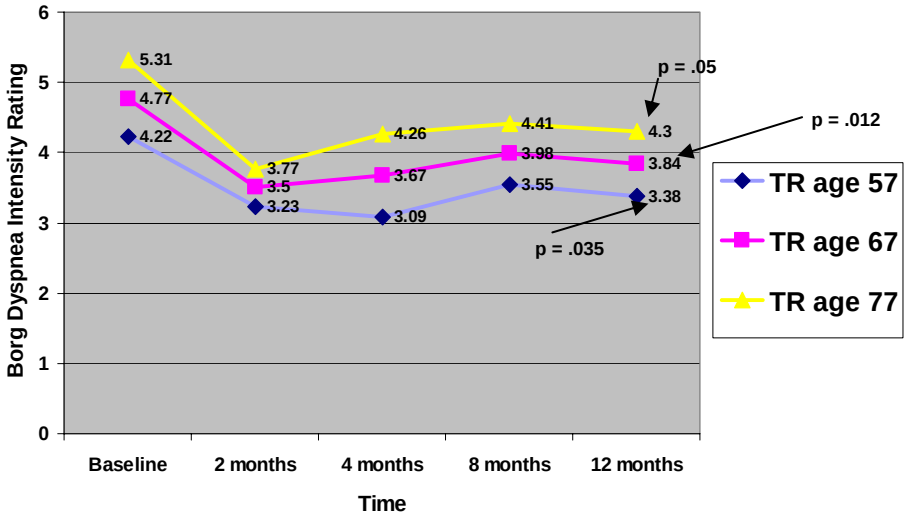


Age 67: BL to 2 mo p = .01
2 mo to 8 mo p = .00

Age 77: BL to 2 mo p = .0077
2 mo to 8 mo p = .01

Figure 5.20

Dyspnea After 6MW: DM - TR Group



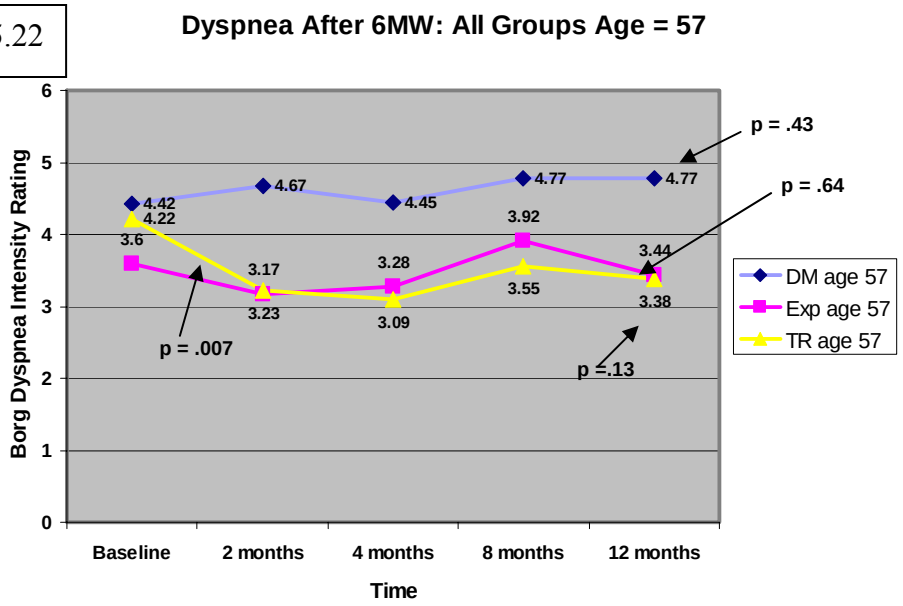
Significant within age groups differences:

Age 57: BL- 4 mo p = .000
2 mo to 4 mo p = .004

Age 67: BL- 2 mo p < .00
BL to 4 mo p = 0008

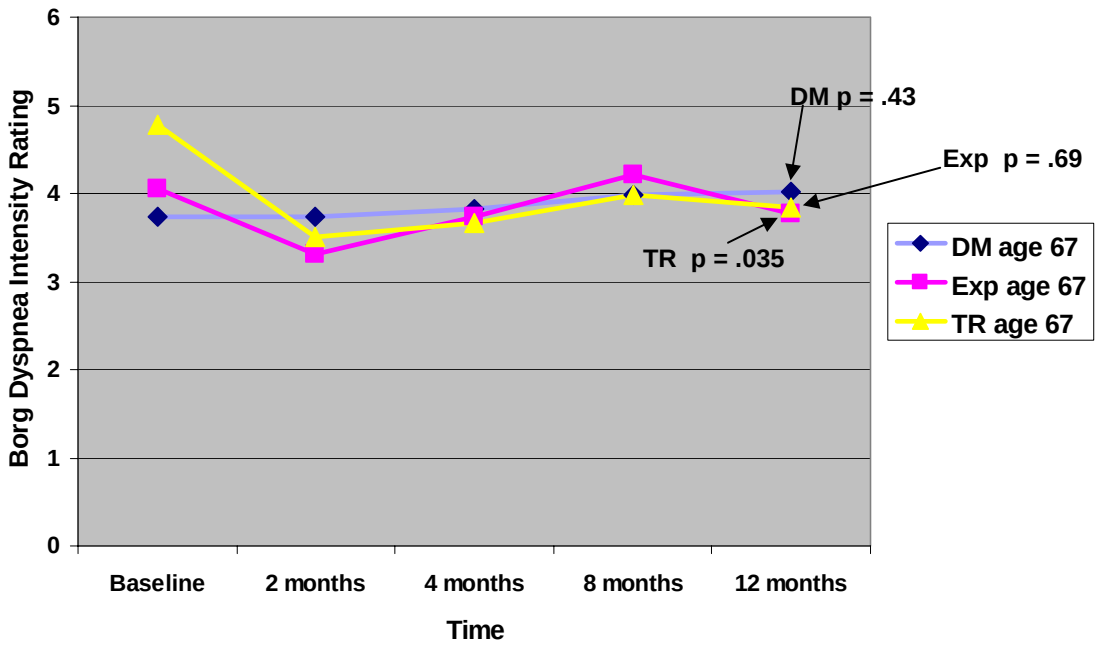
Age 77: BL -2 mo p = .0001

Figure 5.22



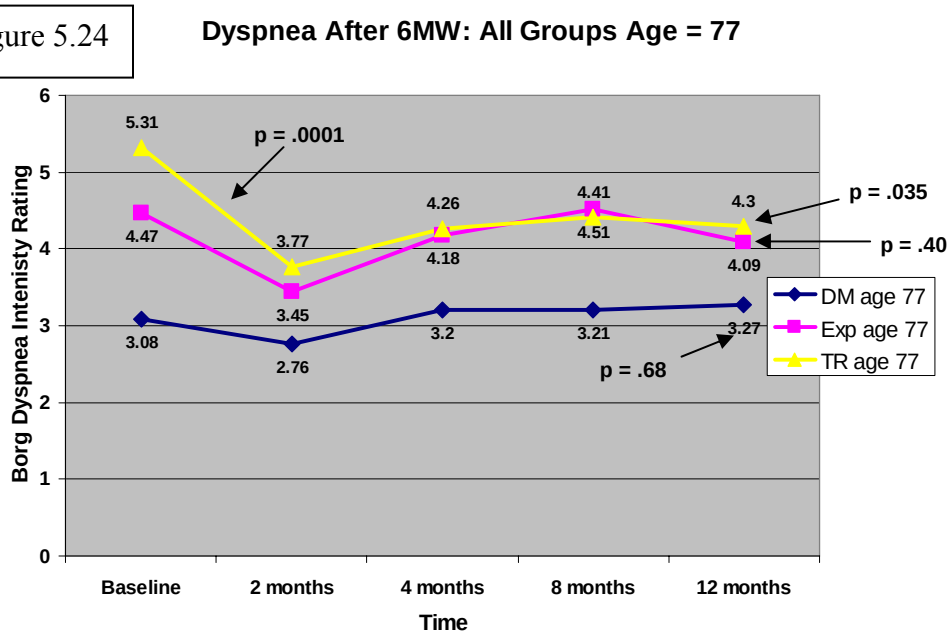
Difference between change seen in DM and DM–Training from baseline to 12 mo. p = .0187. No sig. difference in change between DM and DM Exp (p = .26). No significant change at 12 months for any intervention group.

Figure 5.23



No significant differences for any intervention group at 12 months.

Figure 5.24



Significant difference between DM and DM-Training TR Groups @ baseline (p = .003)

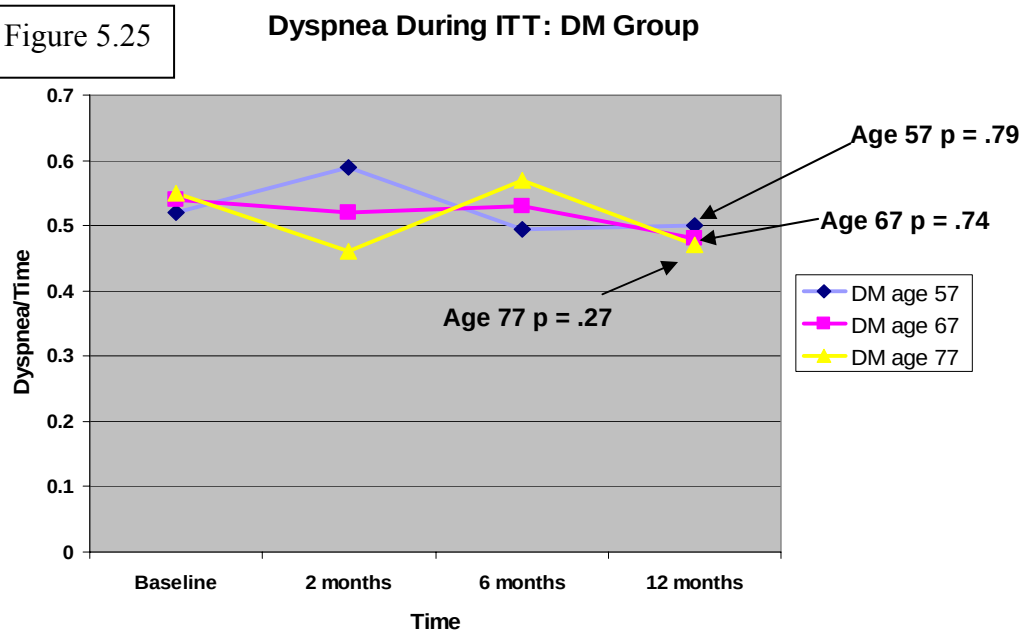
For the DM group, there was no significant difference over the 12 month period for any age prototype (Figure 5.19). In the DM-Exposure group (Figure 5.20), both the 67 and the 77 year old had significant changes from baseline to 2 months (p = .01 and p = .007 respectively) and also when comparing the two month values to the eight month values (for 67 year old p = .00 and for 77 year old p = .010). At 12 months, there were no significant changes in the values. In the DM-Training group (Figure 5.21), all three age prototypes had significant early changes, but no age prototype sustained the changes through 12 months. In the separate age by treatment analysis, there were no significant changes sustained through 12 months. The moderating effect of age for the outcome seemed to be prevalent only early and faded later, with the older ages (67 and 77 year olds) faring better.

Research Question #3c. Does age moderate the effect of the DSMP intervention on dyspnea intensity during a symptom limited exercise test over time?

Dyspnea intensity during the incremental treadmill test (ITT) was measured by the calculated slope of the modified Borg dyspnea intensity rating divided by ITT duration (dyspnea/time). This value was used to evaluate changes in dyspnea over time during the ITT and served as the outcome measure for this question. The sequence of fixed effects mixed models, variables entered and interaction terms described above were used to analyze the data collected at four time points: baseline, two months, six months, and 12 months.

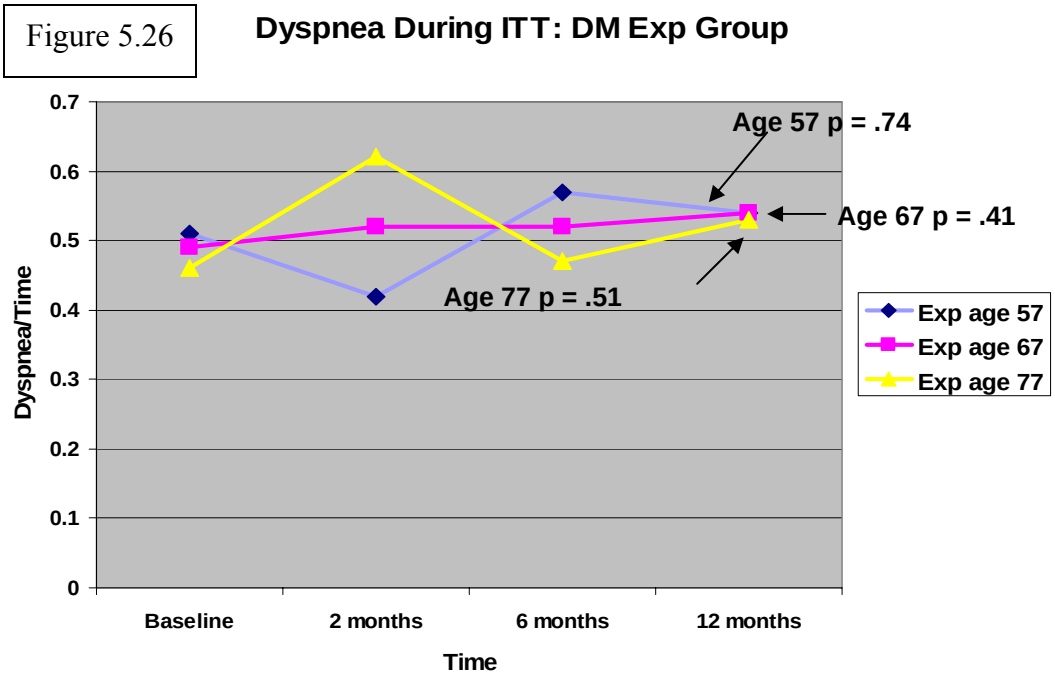
In the original analysis, there was as significant group by time change (Likelihood ratio test .004) (Carrieri-Kohlman et al., 2005). The hypothesis that age would moderate the effect of three different DSMP interventions over time was supported. In Model 1, a significant interaction term was found for age by treatment group by visit ($F = 3.20$, $df = 262$, Type 3 $p = .004$). To assess where the moderating effect is active, individual plots of predicted values for treatment groups and age prototypes were constructed and are presented in Figures 5.25-5.30 below.

Figure 5.25



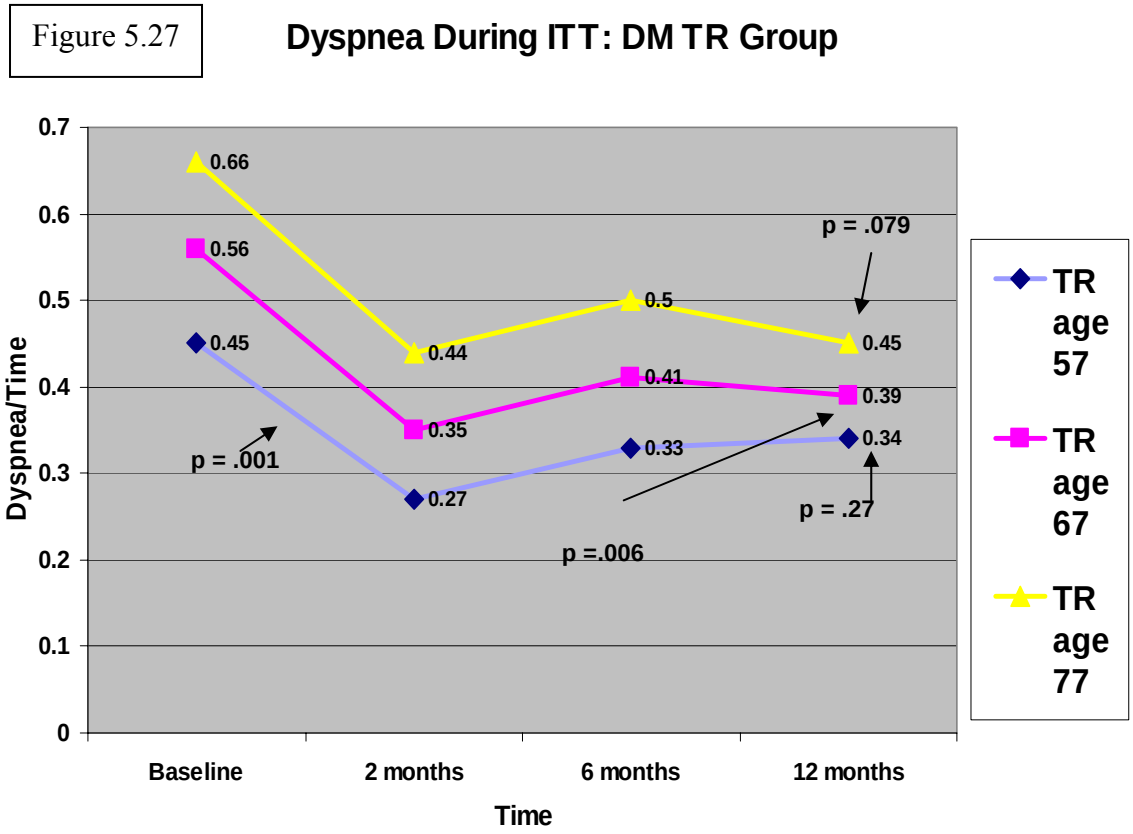
No significant change for any age at 12 months

Figure 5.26



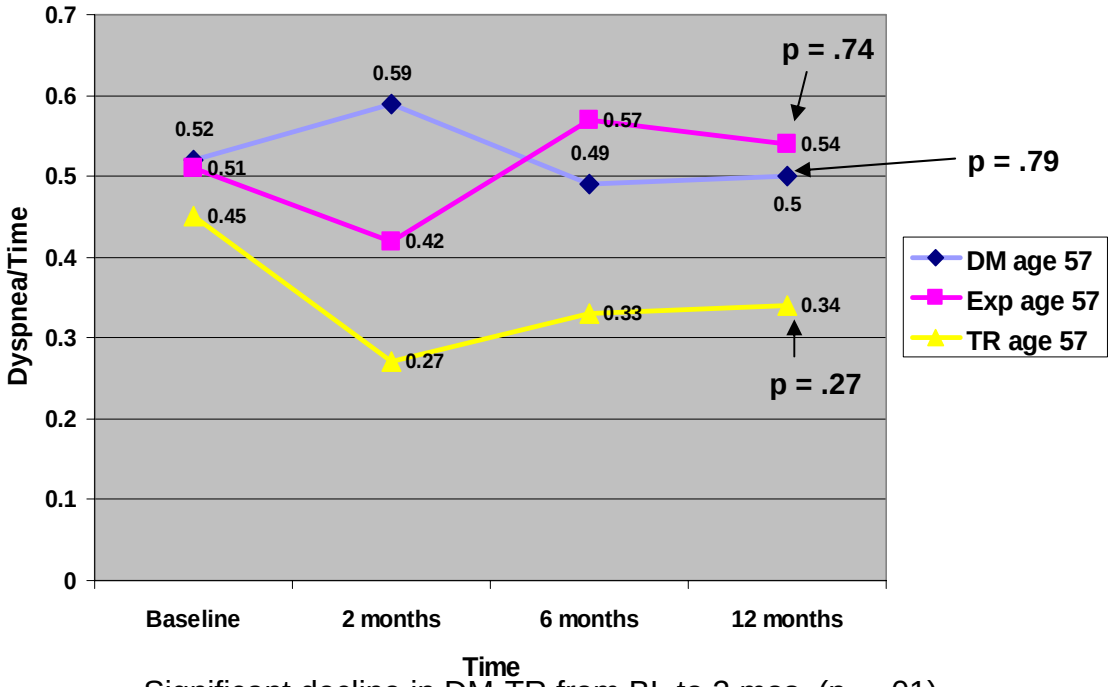
No significant difference for any age at 12 months

Figure 5.27



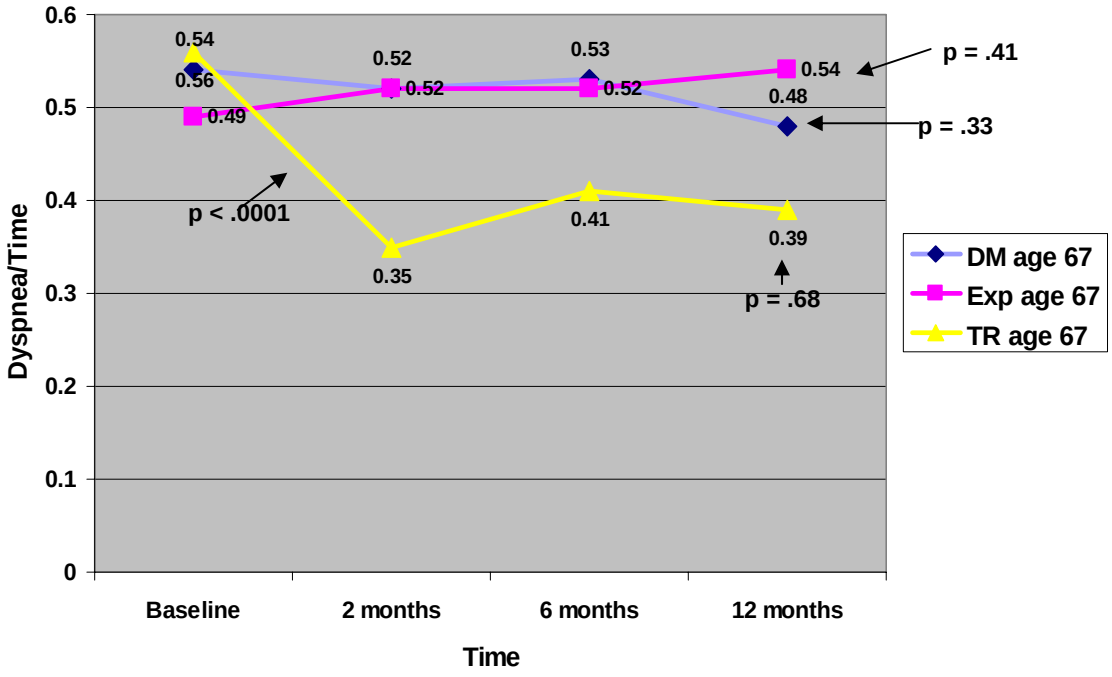
Early significant change for 57 y/o.
Only sustained significant change is for 67 y/o

Figure 5.28 **Dyspnea During ITT: All Groups Age = 57**



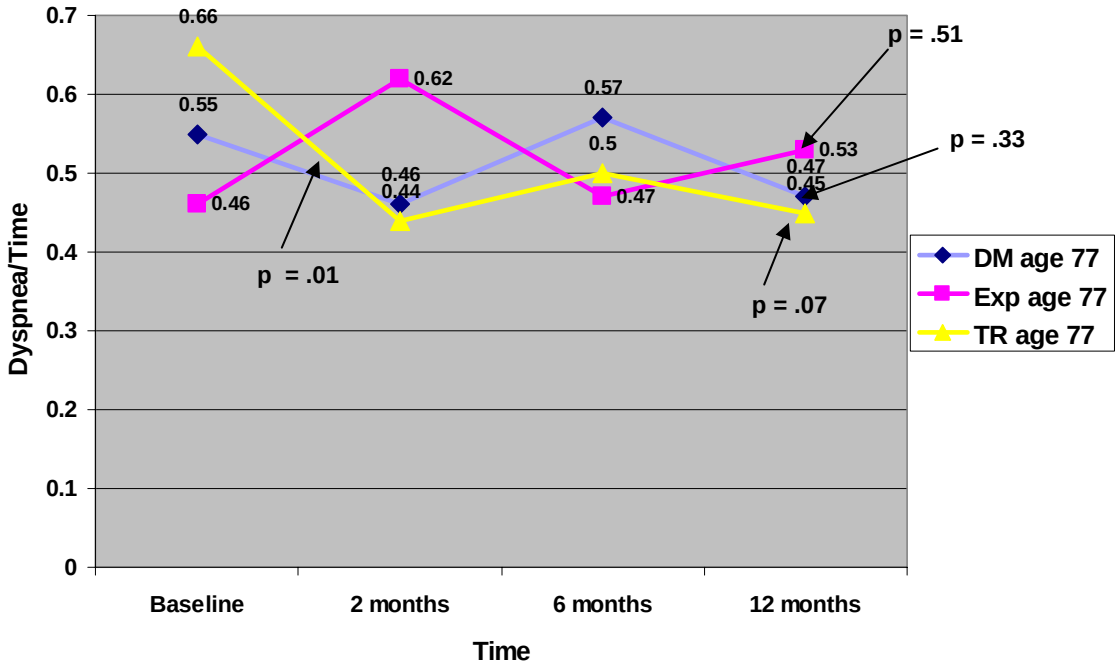
Significant decline in DM-TR from BL to 2 mos. (p = .01).
No significant changes by treatment group @ 12 mos.

Figure 5.29 **Dyspnea During ITT: All Groups Age = 67**



Early decrease in DM-Training group only.

Figure 5.30 **Dyspnea During ITT: All Groups Age = 77**



No significant change for any group over 12 months

There were no significant changes in dyspnea intensity during ITT over time in the DM or DM-Exposure groups (Figures 5.24 and 5.25). The only significant change over time in the DM-Training group was in the 67 year old ($p = .006$) (Figure 5.26). In the age 57 prototype, there was a significant early improvement in the DM-Training group (baseline to two months: $p < .0001$) but this was not sustained through the entire 12 months of the study. There were no significant findings in the age 77 prototype analysis. There was not a strong age moderating effect for dyspnea intensity during ITT.

Recent Dyspnea Ratings.

Hypothesis #4: Recent dyspnea ratings will change over time following a DSMP intervention.

Research Question #4a. Do ratings of recent dyspnea change over time or by treatment group following a DSMP intervention?

The recent dyspnea question queried how much shortness of breath experienced over the past four weeks. A lower value indicates a lower magnitude shortness of breath. This outcome was not included in published reports of the parent study. To determine if the scores for this question changed over time, a simple mixed models analysis was performed. Only treatment group, time, and an interaction term between treatment group by time were included in the model. Data for this outcome was collected at five time points: baseline, two months, four months, six months and 12 months.

The hypothesis that recent dyspnea ratings would change over time was supported. There was a significant difference in scores over time for the entire sample ($F = 13.68$, Type 3 $p < .0001$), across the three treatment groups ($F = 5.60$, Type 3 $p = .0050$), and for the by treatment group over time interaction ($F = 2.16$, Type 3 $p = .0365$). The predicted values for this outcome decreased significantly over time for each treatment group and are presented in Table 5. The predicted DM-Exposure baseline ratings (3.7870) was significantly lower than both the DM group (baseline estimate = 4.4167) and the DM-Training group (baseline estimate 4.4412) ratings. The predicted DM group 12 month value was significantly different from the DM-Exposure group ($p = .018$) but not different from the DM-Training group ($p = .427$). The 12 month values were also significantly different between the DM-Exposure group and the DM-Training group ($p = .001$).

Hypothesis #5: Age will moderate the effect of three different DSMP interventions on recent dyspnea ratings over time.

Research Question #5a. Does age moderate the effect of three different DSMP interventions on dyspnea impact ratings over time?

To evaluate for the possible moderating effect of age on recent dyspnea ratings, additional analyses that included interaction terms were performed. The sequence of fixed effects mixed models, variables entered and interaction terms described above were used to analyze the data. The hypothesis that age would moderate the effect of the three DSMP interventions on recent dyspnea impact ratings over time was not supported. The interaction between age by treatment group by time in Model 1 was not statistically significant ($F = 1.64$, $df = 97$, Type 3 $p = .124$). The age by treatment group interaction in Model 2 was also not statistically significant ($F = .46$, $df = 97$, Type 3 $p = .631$) nor was the age by time interaction (Model 2 $F = .70$, $df = 97$, Type 3 $p = .591$).

Recent Dyspnea Impact on Activities of Daily Living.

Hypothesis #6: Recent dyspnea impact on activities of daily living ratings will change over time following a DSMP intervention.

Research Question #6a. Do ratings of recent dyspnea impact on activities of daily living ratings change over time or by treatment group following a DSMP intervention?

The recent dyspnea impact on activities of daily living (ADLs) rating queried whether how much shortness of breath interfered with the participant's daily work and activities over the prior four weeks. A lower value indicates less impact on ADLs. This outcome was not included in the original published analysis. To determine if the scores for this question changed over time, a simple mixed models analysis was performed. Only treatment group, time, and an interaction term between treatment group by time were included in the model.

Data for this outcome was collected at five time points: baseline, two months, four months, eight months and 12 months.

The hypothesis that recent dyspnea impact ratings will change over time following a DSMP intervention was supported. There was a significant change in scores over time for the entire sample ($F = 8.37$, Type 3 $p < .0001$), and a significant difference in scores between the three treatment groups ($F = 3.38$, Type 3 $p = .0378$). The Type 3 p value for the treatment group by time interaction was not significant, indicating that the pattern of scores over time was not significantly different between the three treatment groups. The ratings improved significantly in the DM and DM-Training groups over 12 months, but not in the DM-Exposure groups. See Table 6 for regression equation estimates.

Hypothesis #7: Age will moderate the effect of the three different DSMP interventions on recent dyspnea impact on activities of daily living ratings.

Research Question #7a. Does age moderate the effect of three different DSMP interventions on dyspnea recent impact on activities of daily living ratings over time?

To evaluate for the possible moderating effect of age on recent dyspnea impact scores, additional analyses were performed. The sequence of fixed effects mixed models, variables entered and interaction terms described above were used to analyze the data from five time points: baseline, 2 months, 4 months, eight months and 12 months.

The hypothesis that age would moderate the effect of three different DSMP interventions on recent dyspnea impact ratings was not supported. The interaction between age by treatment group by visit in Model 1 was not statistically significant ($F = 1.26$, $df= 97$, Type 3 $p = .271$). In Model 2, neither the age by treatment group interaction term ($F = .18$,

df = 97, Type 3 p = .831) nor was the age by visit interaction term significant (F = .73, df = 97, Type 3 p = .570).

Research Aim #2: Compare predictors for self-efficacy for home walking and managing shortness of breath

Self-Efficacy for Home Walking and Managing Shortness of Breath

Self-Efficacy for Home Walking.

Hypothesis #8: Predictors for self–efficacy for home walking and self-efficacy for managing symptoms will be similar.

Research Question #8a. What are the predictors of baseline self-efficacy for home walking?

To address this question, the following variables were regressed on baseline self-efficacy for home walking ratings: baseline FEV-1 % predicted (as a measure of disease severity), gender, age, ethnicity, educational level, marital status, annual income, whether or not they had a regular walking program at study entry, whether they had attended pulmonary rehabilitation in the past, CRQ-Dyspnea, CRQ-Mastery, Centers for Epidemiological Studies- Depression Scale (CES-D) score, and dyspnea intensity at the end of the baseline 6MW.

The mean baseline self-efficacy for home walking score for the entire sample was 7.07 (SD 2.54). The model that included all of the variables listed above was statistically significant (R^2 = .455; F = 4.84, p = <.000). Six of the 13 variables entered into the model had statistically significant coefficients in this model: age (p = .046), FEV-1 % predicted (p = .0017), ethnicity (p = .023), annual income (p = .009), engaged in a walking program for

exercise at study entry ($p < .000$) and dyspnea intensity at end of baseline 6MW ($p = .001$). (See Table 7 for regression coefficients).

Research Question #8b. What are the predictors of baseline self-efficacy for managing shortness of breath?

To address this question, the following variables were regressed on baseline self-efficacy for managing shortness of breath ratings: baseline FEV-1 % predicted (as a measure of disease severity), gender, age, ethnicity, educational level, marital status, annual income, whether or not they had a regular walking program at study entry, whether they had attended pulmonary rehabilitation in the past, CRQ-D, CRQ-Mastery, Centers for Epidemiological Studies Dyspnea Scale (CES-D) score, and dyspnea intensity at the end of the baseline 6MW.

The mean baseline self-efficacy for managing shortness of breath rating for the entire sample was 5.36 (SD 2.65) out of a total possible 10 points. The model that included all of the variables listed above was statistically significant ($R^2 = .342$, $F = 3.45$, $p = <.000$), but the CRQ-mastery subscale score was the only significant predictor in the model ($p = .0014$). (See Table 8 for regression coefficients).

Research Aim #3: Investigate changes in self-efficacy for home walking and managing shortness of breath ratings over time following three different DSMP interventions.

Hypothesis #9: Self-efficacy for home walking ratings will improve following a DSMP intervention and the DM-Training group will have the greatest improvement.

Research Question 9a. Do ratings of self-efficacy for home walking change over time following three different DSMP interventions?

For this analysis, the self-efficacy scale for home walking served as a measure of the respondent's confidence in walking various distances both inside and outside their home. A

higher score on this scale indicates a greater confidence for walking the specified distances. Davis and colleagues have previously reported that self-efficacy for home walking scores increased at two months for the entire sample of the parent study with no significant difference between groups (Davis et al., 2006). The sequence of simple mixed models main effects analysis, variables entered and interaction terms described above were used to analyze the data from five time points: baseline, two months, four months, eight months and 12 months.

The hypothesis that ratings of self-efficacy for home walking would change over time for the entire sample was supported. Using mixed models analysis for fixed main effects, as found previously for two months, self-efficacy for home walking scores did change significantly over the 12 months study period ($F = 8.08$, Type 3 $p < .000$). See Table 9 for least square mean regression coefficients by visit.

Research Question 9b. Do ratings of self-efficacy for home walking differ among the three different intervention groups over time?

Ratings of self-efficacy for home walking did not differ across treatment groups over time ($F = .67$, Type 3 $p = .716$). The hypothesis that changes in ratings of self-efficacy for home walking would improve and would be greatest in the DM-Training group was not supported.

Hypothesis #10: Age will moderate self-efficacy for home walking following three different DSMP interventions.

Research Question #10a. Does age moderate the effect of the DSMP intervention on self-efficacy for home walking ratings over time?

The hypothesis that age would moderate self-efficacy ratings for home walking following three different DSMP interventions was not supported. Age was not found to be a significant moderator of self-efficacy for home walking evidenced by the non-significance for the age by treatment group by time interaction (Model 1 F = 1.28, df = 97, Type 3 p = .264) for the age by visit interaction (Model F = .47, df = 97, Type 3 p = .758), or for the age by treatment group interaction (Model 2 F = 1.66, df = 97, Type 3 p = .196.

Hypothesis #11: Self-efficacy for managing shortness of breath will improve following three different DSMP interventions and the change will be the largest in the DM-Training group.

Research Question 11a. Do ratings of self-efficacy for managing shortness of breath change over time following three different DSMP interventions?

For this question, the Self-Efficacy for Managing Shortness of Breath Scale was the measure of the respondent's confidence in managing shortness of breath. A higher score on this scale indicates greater confidence. Davis and colleagues have previously reported that Self-Efficacy for Managing Shortness of Breath Scale scores in the parent study increased significantly at two months for the entire sample (Davis et al., 2006). This analysis examined for changes over the entire 12 month study period, therefore data from the following time points were included: baseline, two months, four months, six months and 12 months.

The hypothesis that self-efficacy for managing shortness of breath would change following three different DSMP interventions was supported. Using mixed models analysis for fixed main effects, the self efficacy for managing shortness of breath ratings increased significantly for the entire sample over time (F = 7.12, Type 3 p < .000). See Table 10 for least squares regression coefficients).

Research Question #11b: Do ratings of self-efficacy for managing shortness of breath differ among the three different intervention groups?

The hypothesis that ratings of self-efficacy for managing shortness of breath would differ between the different treatment groups and the greatest change would be in the DM-Training group was not supported. The change in ratings of self-efficacy for managing shortness of breath did not vary by treatment group ($F = 1.91$, Type 3 $p = .066$).

Hypothesis #12: Age will moderate self-efficacy for managing shortness of breath ratings over time following three different DSMP interventions.

Research Question #12a. Does age moderate the effect of the DSMP intervention on self-efficacy for managing shortness of breath ratings over time?

The hypothesis that age would moderate self-efficacy for managing shortness of breath ratings was not supported. Age was not a significant moderator of self-efficacy for home walking evidenced by the non-significance for the age by treatment group by time interaction (Model 1 $F = 1.98$, df 97, Type 3 $p = .057$), for the age by treatment group interaction term (Model 1 $F = 1.43$, df 97, Type 3 $p = .244$) or for the age by time interaction term (Model 1 $F = .37$, df = 97, Type 3 $p = .831$).

CHAPTER SIX: DISCUSSION

The major findings of this secondary analysis were that age was found to moderate the effect of the three different DSMP interventions for self-reported role-performance, exercise duration (ITT duration and stage) and dyspnea during exercise (ITT) after exercise (6MW). Ratings for both self-efficacy for home walking and self-efficacy for managing shortness of breath improved over the course of the study. A comparison of selected predictors for these two domains of self-efficacy were found to be quite different and age did not moderate the effect of the three different DSMP interventions for either self-efficacy ratings over time. To this author's knowledge, self-management for COPD trials have not considered the possible moderating effect of age on these outcomes, and there are separate predictors for self-efficacy for home walking and shortness of breath in COPD patients have not been previously explored.

Self-Reported Functional Performance Outcomes

Hypothesis #1: Age will moderate the effect of the three difference DSMP interventions on self-reported functional performance over time.

Three research questions (#1a-1c) examined if age moderated the effect of the three different DSMP interventions on self-reported functional performance outcomes. In the original analysis, a significant group by time change was demonstrated for the SF-36 Physical Component Summary score (Likelihood ratio test $p = .02$), and for the SF-36 Role Physical subscale (Likelihood ratio test $p = .035$) but not for the SF-36 Physical Functioning subscale score (Carrieri-Kohlman et al., 2005).

Hypothesis was partially supported. Age was not found to moderate the effect of the three different DSMP interventions on scores self-reported physical function outcomes (SF-36 Physical Component Summary Score or the SF-36 Physical Functioning score), but age was found to a moderate role-functioning outcome (SF-36 Role Function). Plots by intervention group for three different age prototypes (ages 57, 67 and 77) (Figures 5.4-5.6) revealed significant improvements (increase) in scores for the 67 ($p = .01$) and 77 year old ($p = .01$) in the DM group (Figure 5.1), but not in the 57 year old. Additionally, significant improvements over the 12 month study period were seen in the 67 and 77 year old in the DM-Training group ($p = .003$ and $p = .006$, respectively) (Figure 5.6). For this outcome, the older participant (age 67 or 77 prototypes) is predicted to achieve and sustain greater improvements over time in both the DM group and the DM-Training groups. These findings suggest that supervised exercise sessions are not absolutely necessary to achieve sustained role-function improvements in older adults. Why this improvement was not also seen with the other self-reported functional performance outcomes (SF-36 Physical Component Summary and the SF-36 Physical Functioning subscale) is not clear, but may indicate that the Role-Physical subscale score should be reviewed carefully when evaluating older adults with COPD. Similar to the findings of this study, a recent study by Sewell and colleagues (Sewell, Singh, Willimas, Collioer, & Morgan, 2005) reported that domestic function (similar to role function) improved in COPD patients participating in a pulmonary rehabilitation program, regardless of whether they were assigned to an individualized exercise program or were part of a group exercise program.

The decline in role-function scores for the age 57 and 67 prototypes in the DM-Exposure groups are both concerning and difficult to explain (Figure 5.2). While the

predicted declines were not statistically significantly, the overall pattern was distinctly different when compared to the DM and DM-Training group patterns (Figures 5.1 and 5.3, respectively). However, it should also be noted that the DM-Exposure group are predicted to have higher baseline scores. While the general direction of change for this outcome was the opposite of the other two groups, the observation does follow the notion that the intensity of the DSMP intervention can positively impact, but does not consistently influence the role functioning outcome. This difference may also be explained by the higher predicted SF-36 Role-Physical starting values for the 57 and 67 year old age prototypes.

The findings of this analysis suggest that the intensity or format of the exercise program may not have significant bearing on general self-reported functional performance outcomes, but does impact role-function measures and this was most notable in the older adult age prototypes. This finding validates the notion that older adults with COPD can significantly benefit from dyspnea self-management interventions and the format or intensity of the intervention may not be as important as just participation.

The lack of a moderating effect of age on two of the three self-reported physical function measures also provides some reassurance that advancing age does not necessarily diminish the effect of the DSMP interventions on self-reported functional performance outcomes. Given that normal aging gradually decreases physiological function, including the lung, it would be expected that the potential to improve physical function could be limited by the aging individual's physiological capacity. Certainly, physiological aging may not consistently correlate with chronological aging, and considering the decline in respiratory function associated with COPD described earlier in this paper, one could surmise that the "dose" or intensity of the intervention may influence the results, thinking that a stronger

"dose" of the intervention be necessary overcome age-related physiological detriments, or perhaps, improvements could not be achieved. This analysis did not provide any supporting evidence that this is idea necessarily true.

Functional Capacity Measures

Hypothesis #2: Age will moderate the effects of the three different DSMP interventions on functional capacity over time.

Functional capacity was measured by the 6MW, the ITT duration and stage and the ETT duration (addressed through research questions 2a-2c). In the original analysis, a significant group by time change was noted for the ETT minutes exercised (Likelihood ratio test p = .02) and for the ITT duration and ITT stage (Likelihood ratio test p = .02) (Carrieri-Kohlman et al., 2005). The 6MW distance did not change significantly for the entire sample or on group by time analysis (Carrieri-Kohlman et al., 2005).

Age was found to moderate the effect of the three different DSMP interventions on the ITT outcomes, partially supporting this hypothesis. Age was not found to moderate the effect of the three different DSMP interventions on the 6MW distance or the ETT duration.

In the case of ITT duration, predicted value plots for the DM group (Figure 5.7) and DM-Exposure group (Figure 5.8), the 57 year old prototype actually declined over the course of the study (p = .004, and p = .003 respectively). The only group where an improvement occurred and was sustained was in the DM-Training group and this was seen only for the age 77 prototype (p = .0001) (Figure 5.12). These findings present a very interesting contrast of results. It suggests that, when considering performance from an age group perspective, if improvement in exercise endurance for younger and middle-age participants is desired, a structured and more intensive exercise program may be necessary. This notion is supported

by the finding that the 77 year old prototype in the DM-Training group was predicted to demonstrate early improvements and be able to sustain the improvements over 12 months (p = .0001) (Figure 5.9). In the 77 year old prototype profile plot (Figure 5.12), it was noted that all three intervention groups had early (between baseline and two month follow up visit) improvements, but only the 77 year old individual in the most intensive intervention group (DM-Training) was able to sustain the improvements. This suggests that the "dose" or intensity of this exercise intervention was important in effecting a sustained improvement over time for the older adult prototype.

Incremental treadmill test performance was also evaluated by means of stage achieved. It is expected that changes seen in the ITT duration would mirror what is observed for ITT stage, but being the ITT stage has a much narrower range of possible values and the values are categorical, rather than interval (as compared to ITT duration), the results could differ. In the DM group, the 57 year old prototype had a decline over the study period (Figure 5.13, p = .0001), consistent with the decline in ITT duration described above. The 77 year old prototype in the DM group improved significantly (p = .0036) (Figure 5.13). There were no significant 12 month changes in the ITT stage achieved for either the DM-Exposure or DM-Training groups (Figures 5.14 and 5.15). Analysis by age within treatment group revealed that the 77 year old in the DM group had a significant improvement over 12 months (Figure 5.17, p = .003) which is consistent with the ITT duration findings. By evaluating by ITT stage, only the 77 year old prototype that was able to achieve and sustain improvements over time.

It is interesting to note that there was no moderating effect of age on the ETT duration or 6MW. It is recognized that both the ETT and 6MW are considered submaximal, constant

work exercise tests, whereas the ITT is a symptom-limited exercise test. The difference in the intent of the different tests may explain why the results were disparate. On the other hand, the findings from this analysis support the notion that ITT is a better modality to determine changes following an intervention (Sutherland & Make, 2005). This may be particularly true if the research question seeks to determine if advancing age has a moderating effect on a DSMP intervention and exercise performance is an outcome of interest.

The pattern of changes seen for ITT duration and stage reinforces the importance of the strength of this exercise intervention for this particular outcome. It appears that for the younger age prototype, the DM intervention alone is not sufficient to achieve an improvement, where as, significant improvement can be achieved and sustained in an older adult. To this author's knowledge, there have not been any other studies that have evaluated ITT performance in this manner.

Dyspnea with Activities of Daily Living and Exercise

Hypothesis #3: Age will moderate the effect of three different DSMP interventions on dyspnea outcomes over time.

For this analysis, the dyspnea subscale of the CRQ served as the measure of dyspnea with ADLs (research question 3a). In the original analysis, a significant group by time change was demonstrated for the CRQ-dyspnea (Likelihood ratio $p = .02$) (Carrieri-Kohlman et al., 2005). Through this analysis, advancing age was not found to be a significant moderator of the effect of treatment group over time on dyspnea with ADLs.

Dyspnea with Exercise.

Dyspnea intensity after exercise was measured by the modified Borg scale immediately after completing the 6MW (research question 3b) and dyspnea during the ITT (research question 3c.). In the original analysis, dyspnea intensity after the 6MW did not change significantly following the three different DSMP interventions (Carrieri-Kohlman et al., 2005) but did change significantly during the ITT, with a significant difference between the DM-Exposure group and the DM-Training group at 12 months (Likelihood ratio test .004) (Carrieri-Kohlman et al., 2005).

In this analysis of dyspnea intensity after 6MW, the mixed models analysis revealed a significant interaction term between age and treatment group (Model 2, $F = 4.48$, $df = 97$, Type 3 $p = .013$). Through examining plots of predicted values for age prototypes, there were no significant changes in dyspnea intensity after the 6MW for any of the three DSMP intervention groups at 12 months. However, there were significant early (baseline to two months) improvements for ages 67 and 77 in the DM-Exposure group (Figure 5.20) and for all ages in the DM-Training group (Figure 5.21). No significant changes occurred for any age in the DM group (Figure 5.19). Visual inspection of the plots reveals a similar pattern within all three intervention groups as well (Figures 5.19-5.21). Despite the significant interaction term indication that advancing age had a moderating effect on the outcome, the effect does not appear to be consistent or particularly potent. The early responses but later waning of the effect of the intervention is consistent with the overall findings of the parent study (Carrieri-Kohlman et al., 2005). This type of pattern suggests that in order to sustain improvements, a steady, supervised exercise program may be necessary.

Dyspnea intensity during ITT (a symptom-limited exercise test) was also evaluated by means of a dyspnea over time slope value (Carrieri-Kohlman et al., 2005). In the original analysis, there was a significant group by time change (Likelihood ration test .004) (Carrieri-Kohlman et al., 2005). Age was determined to have a moderating effect by a significant age by treatment group over time interaction in the mixed models analysis (F= 3.20, df = 262, Type 3 p = .004). Age prototype plots for each intervention group revealed a significant decline in dyspnea during ITT for the 67 year old in the DM-Training group (Figure 5.27, p = 006). There were early declines in dyspnea for the 57 year old in the DM-Training group (Figure 5.27, p = .01) and for 67 year old in the DM-Training group (Figure 5.29, p < .0001), but changes were not sustained for the 12 month study period.

While there was a significant moderating effect of age by intervention group, the clinical significance for this outcome is questionable, as no prominent patterns were revealed. Age does not appear to exert much of a moderating effect on dyspnea outcomes. This may indicate that interventions designed to reduce dyspnea are equally effective (or ineffective) in younger versus older adults or that the current outcome measures may not be sufficiently sensitive. It may also indicate that dyspnea intensity during exercise is not impacted by age. Little is known about how dyspnea intensity may change with aging, and this analysis does not truly provide any new or important information in this regard, other than to say that age did not consistently influence how dyspnea was rated over time during the ITT.

Recent Dyspnea Ratings

Hypothesis #4: Recent dyspnea ratings will change over time following a DSMP intervention.

Hypothesis #5: Age will moderate the effect of three different DSMP interventions on recent dyspnea ratings over time.

Recent dyspnea ratings were evaluated through a single-item instrument (designed by the parent study investigators) patterned after one of the pain questions on the SF-36 (question #7) (research questions 4a and 5a). This outcome has not been previously reported, and a minimal clinically important change value has not been established. There was a significant reduction of dyspnea (a lower ratings) for the entire sample ($F = 13.68$, Type 3 $p = < .0001$). The lowest score at 12 months was in the DM-Exposure group, but the baseline rating for this group were also significantly lower than the other two groups (see Table 5). The 12 month value for the DM group was significantly different from the DM-Exposure Group but not from the DM-Training group (see Table 5). Age was not found to be a significant moderator for the outcome.

The decline in recent ratings of dyspnea for all groups is significant as it demonstrates that this single-item question is sensitive in detecting a change in this symptom. It also demonstrates that all three versions of the DSMP achieved a reduction in recent dyspnea. Further study is needed to validate this instrument through comparison with similar measures such as the CRQ and to begin to establish what is the minimal clinically important difference value.

The fact that age did not moderate the outcome is favorable as it indicates that advancing age does not diminish the impact of any of the three DSMP interventions on recent dyspnea ratings. Furthermore, given all three intervention groups had significant reductions in the recent dyspnea ratings, it appears any of the three DSMP interventions tested here have the potential to reduce dyspnea.

Recent Dyspnea Impact on Activities of Daily Living.

Hypothesis #6: Recent dyspnea impact on activities of daily living ratings will change over time following a DSMP intervention.

Hypothesis #7: Does age moderate the effect of the three different DSMP interventions on recent dyspnea impact on activities of daily living ratings?

To evaluate this outcome, a single question instrument was employed to evaluate change and a possible moderating effect of advancing age (research questions 6a and 7a). This outcome was not included in the parent study analysis, and a minimal clinically important change value has not been established. The tool was also developed by the parent study investigators and was patterned after the SF-36 question #8 that queries impact of pain on ADLs over the past four weeks.

This analysis revealed the ratings significantly declined (indicating a lower impact of dyspnea on ADLs) for the entire sample over the course of the entire study period, supporting hypothesis # 6. However, only the DM and DM-Training groups had significant decreases over the entire 12-month study period. (See Table 6). While the baseline value for the DM-Exposure group was lower than the two other groups, the values were not significantly different from each other. Age was also not found to be a significant moderator for this outcome, thus not supporting hypothesis #7.

The findings that the dyspnea impact rating declined in both the lowest and highest intervention intensity groups makes interpretation somewhat difficult. The lack of change in the DM-Exposure group may be a floor effect as the ratings were relatively low at baseline (2.56) and the range of possible values for this instrument is only 1-5. The lack of moderating effect suggests that advancing age has neither a positive or negative impact on

this outcome. This instrument, along with the recent dyspnea rating instrument, should be further evaluated for their value in assessing the intensity and impact of recent dyspnea through comparison with other established instruments such as the CRQ dyspnea subscale, and to begin to establish a minimal clinically important change value.

The fact that the recent dyspnea ratings did improve in all groups, where as the impact of dyspnea on ADLs did not improve in all groups suggests that recent dyspnea ratings may be distinctly different from ratings of how recent dyspnea impact ADLs. This could be further explored through principle component factor analysis with instruments that measure similar domains.

Self-Efficacy for Home Walking

Hypothesis #8: Predictors for self-efficacy for home walking and self-efficacy for managing shortness of breath will be similar.

Given the literature suggests that some demographic characteristics and socioeconomic factors influence self-efficacy for exercise (Clark et al., 1995), an exploration of possible predictors of self-efficacy for home walking were undertaken (research question #8a). Using regression analysis techniques, age, gender, baseline FEV-1 % predicted, ethnicity, educational level, martial status, annual income, baseline CRQ-mastery subscale score, and previous engagement in a walking exercise program were regressed on baseline self-efficacy for home walking scores. The full model that included all of the above variables explained 45% of the variance in baseline self-efficacy for home walking scores ($R^2 = .45$, $p < .0001$) (Table 7). Regression analysis revealed the following statistically significant regression coefficients: age (- .061, $p = .046$), ethnicity (1.45, $p = .023$), annual

income (-.394, p = .009), engaged in a walking program for exercise at study entry (2. 452, p < .000) and dyspnea intensity at end of baseline 6MW (- .317, p = .001).

The findings from this regression analysis are somewhat similar to other studies that have addressed self-efficacy for general exercise in older adults. The self-efficacy question in this analysis queries efficacy expectations and not outcome expectations, two distinctly different components of self-efficacy (Bandura, 1997). A study by Clark and colleagues (Clark et al., 1995) reported that age and socioeconomic status were directly associated with self-efficacy expectations and that age, annual income, educational level, depression and previous experience with exercise were indirectly associated with self-efficacy expectation for exercise. The findings from this study sample of adults and older adults with COPD (mean age 66.3 years ± 8) are similar to those of Clark et al. in finding that age, socioeconomic status, and prior exercise experience were significantly associated with this self-efficacy measure. The results differed in the respect that this analysis did not find depression to be a significantly associated. This may be explained by the fact that the mean CES-D score for the entire sample used for this analysis was below the threshold for depression (CES-D mean = 13.3, SD 8.9) (Nguyen & Carrieri-Kohlman, 2005). This analysis also did not find that educational level was significantly associated with self-efficacy for home walking scores. This difference may be due to the fact that the Clark study addressed general exercise self-efficacy outcome expectation, where as this analysis examined efficacy expectations for a specific behavior in a sample of participants with COPD. While this finding is very preliminary and needs further consideration, it suggests that self-efficacy outcome expectancies are influenced by educational level in older adults,

but education level may not be an important predictor of self-efficacy expectations in middle-aged to older adults with COPD.

The negative regression coefficient for age in this analysis indicates that as age increases by one year from the sample mean (66 years), the self-efficacy for home walking scores decline fractionally (-.06, t = -2.02, p = .04). This provides further evidence that advancing age has an impact on self-efficacy for physical activity ratings. It is not surprising to see that prior experience with an walking program predicts higher self-efficacy for home walking. This indirectly confers that just engagement in a regular walking program boosts self-efficacy ratings for performing that same task.

The same set of predictors were regressed on baseline ratings of self-efficacy for managing shortness of breath (R^2 = .342, F = 3.45, df = 13, p = .0003), but none of the individual variables in the model were significant predictors except for the CRQ-mastery subscale score (estimate = .19213, p = .01) (research question #8b) (see Table 8). Hypothesis #8 was not supported by the findings of this analysis.

Several variables not included in the Clark analysis were include here and are worth discussing. A measure of disease severity was included in this regression analysis and was significantly associated with self-efficacy for home walking scores (estimate = .058, t = 3.25, p = .001). In other words, as disease severity decreases (evidenced by a higher FEV-1 % predicted), the self-efficacy for home walking score improves fractionally. Dyspnea intensity at the end of the 6MW was also significantly (negatively) associated this self-efficacy measure (estimate = -.317, t = -3.21, p = .001). The negative regression coefficient for this variable indicates that with every one unit increase in dyspnea intensity at end of 6MW, the self-efficacy for home walking is reduced fractionally. While it is known that

physiological measures such as FEV-1 % predicted values do not consistently predict dyspnea intensity, exercise performance or health-related quality of life (ATS, 1999; P. W. Jones & Bosh, 1997), the findings from this analysis suggest that disease severity and dyspnea intensity with exercise do influence self-efficacy ratings for home walking.

This regression analysis provides some useful insights into predictors of self-efficacy for home walking in adult and older adult COPD patients. Most importantly, age predicts a reduced self-efficacy for home walking rating. How this may influence responsiveness to interventions that are aimed at improving self-efficacy or self-efficacy outcome expectations is unknown and was not tested in this study. It is interesting to relate the self-efficacy measures in this analysis to those of Resnick (Resnick et al., 2000) who interviewed a cohort of older adults to assess their self-efficacy for exercise-related behaviors. Resnick found that age was negatively correlated with exercise behaviors and indirectly influenced exercise behaviors via outcome expectations. This analysis revealed that advancing age reduced the individuals' baseline self-efficacy for home walking ratings, but it did not predict self-efficacy for managing shortness of breath (an outcome expectation). The difference here may lie in the fact that the self-efficacy for home walking is a physical-task behavior whereas the managing shortness of breath is an outcome expectation. This analysis further differentiates the two self-efficacy domains by demonstrating that predictors are not similar, and that task specific activities may be influenced by advancing age, where outcome expectations may not be as strongly influenced by age.

Self-Efficacy for Home Walking and Managing Shortness of Breath

Hypothesis #9: Self-efficacy for home walking ratings will improve following a DSMP intervention and the DM-Training groups will have the greatest improvement.

Hypothesis #10: Age will moderate self-efficacy for home walking following three different DSMP interventions.

Hypothesis #11: Self-efficacy for managing shortness of breath will improve following three different DSMP interventions and the changes will be the largest in the DM-Training group.

Hypothesis #12: Age will moderate self-efficacy for managing shortness of breath ratings over time following three different DSMP interventions.

Self-efficacy for home walking improved significantly over time for the entire sample (research question #9a). This finding extends Davis' earlier report from the same parent study that self–efficacy for home walking improved at two months (Davis et al., 2006). There was no difference between in self-efficacy for home walking scores between the groups, also consistent with Davis' report (Davis et al., 2006) (research question #9b). In this analysis, age did not moderate the effect of treatment group on change in self-efficacy for home walking over time (research question #10a).

The self-efficacy for managing shortness of breath ratings were found to change significantly over time, but no difference between the treatment groups were found (research questions #11a and 11b). Age did not have a moderating effect on this outcome (research question #12a). These findings indicate that the self-efficacy for managing shortness of breath instrument was sensitive to change over time, consistent with the findings of the instrument developer (Lorig et al., 1996).

Significance of Findings

In summary, age was a significant moderator of the effect of the three different DSMP interventions on role function, exercise performance and dyspnea during and after

exercise. While not a completely consistent pattern, there are indications that the more exercise intense DSMP intervention (the DM-Training group), may positively influence or perhaps temporize the lung function decline associated with advancing age in people with COPD. Age does not appear to be a consistent or potent moderator of changes in dyspnea following three different DSMP interventions. These findings are very preliminary and certainly require further consideration. However, it is useful to note that age did not appear to be a significant detriment to the effectiveness of the education and exercise interventions contained within this trial and in the case of role-physical performance and exercise test performance, advanced age was associated with favorable and sustained improvements, a finding that was not necessarily true for the younger age prototypes.

This analysis provided some preliminary insights into two domains of self-efficacy in adults with COPD. A set of predictors for self-efficacy for home walking was revealed, but further exploration to identify predictors of self-efficacy for managing shortness of breath is clearly needed. The other important finding of this analysis is that age negatively influences self-efficacy for home walking ratings. Future analyses should seek to connect self-efficacy with more outcomes and to determine if it serves as either a moderator or mediator of outcomes. Being the older adult health-related literature is putting more emphasis on self-efficacy, and given age was a significant predictor of decreased self-efficacy for home walking in this analysis, interventions that involve older adults with COPD should specifically design their programs to maximize improvements in self-efficacy. Resnick's four-year study of older adults' self-efficacy for exercise behavior revealed that age had an inconsistent influence on exercise activity and that both self-efficacy for exercise expectations and outcome expectancies, serving as both direct and indirect influencing

variables (Resnick, 2004). Further work to determine which specific domains of self-efficacy are relevant to older adults also seems potentially quite fruitful.

Limitations

Several limitations for this study must be addressed. The primary issue is that the parent study was not designed to address research questions specific to older adults with COPD, therefore the findings may not be widely generalizable. While it is true that most people with COPD are middle-aged or older adults, this analysis did uncover some significant differences among the age prototypes tested. This suggests that future studies could be designed to focus more specifically on answering questions that are unique and specific to older adults with COPD, including measures that are specifically designed for use in older adult populations. Secondly, a larger sample size would support more detailed analyses in specific age groups. The plots provide information regarding predicted values for age prototypes and age groups, but actual data derived from a larger sample would be preferable.

Implications for Nursing

The implications for nursing practice and healthcare of the chronically ill COPD patient are quite broad. The foremost finding is that advancing age does not diminish the potential benefits of a dyspnea self-management program intervention for the older adult with COPD. A dyspnea self-management intervention can effect significant changes for elements of the "Functional Status Staircase" (Figure 3.1). The elements of the "Functional Status Staircase" that can support or improve function in the older adult that were positively impacted by this DSMP intervention trial were exercise performance and self-efficacy.

While clearly our understanding of the benefits of smoking cessation and exercise have grown significantly over the past three decades, there may still be some barriers to achieving both in the older adult with COPD. This analysis addresses only the exercise component, but provides evidence that a DSMP intervention that includes exercise can yield positive role function, symptom and exercise performance improvements outcomes in adults and older adults with COPD. Additionally, it appears that the greatest benefit occurs when the older adult engages in exercise at a higher intensity level, but benefits can also be expected from engagement in lower intensity activities as well. This information should be conveyed in health counseling, primary care and rehabilitation settings.

Also of great interest to nursing is the role and impact of self-efficacy for physical activity or self-management in promoting exercise and self-care activities. This is particularly true for the older adult who is vulnerable to functional impairments associated with chronic illness. This analysis further corroborates that self-efficacy predictors are task specific and that at least for the two domains evaluated here, do not overlap. This analysis also highlights that advancing age alone reduces self-efficacy for home walking. This reinforces the notion that interventions for older adults that are designed to increase physical activity should include interventions that target self-efficacy for specific physical activities.

Implications for Research

With the constantly growing older adult population in the U.S., it is clear that the nursing profession needs to expand our understanding of how to live well and function independently in the face of chronic illness, particularly COPD. The need for nursing research in this area has been recently highlighted in the "American Thoracic Society Statement on Research Priorities for Respiratory Nursing" (Larson et al., 2006). The

statement recommends that nursing research further focus on interventions that are designed to optimize functional performance and physical activity, tailor activities to meet specific needs of the participants, and germane to this analysis, specifically address older adults and their unique functional performance issues. It is this author's opinion that future studies should seek to determine the essential components of exercise and self-management programs that are time efficient, cost effective, convenient and appealing to older adults. Outcomes should be appropriately focused on quality of life, supporting or improving physical function and promoting application of self-care knowledge. Whether or not the older adult experiences dyspnea (qualitatively or quantitatively) differently should also be explored, as there is some evidence that sensitivity to blood gas derangements and pressure loads may be different in the older adult. If this does turn out to be true, then interventions designed to reduce dyspnea may need to be re-considered and tested.

The role of self-efficacy for physical activity and self-care behaviors clearly needs more attention, particularly in the older adult population, as self-efficacy is known to decline with aging and mounting physical limitations, but can be improved through targeted interventions (Bandura, 1997). Another area for further research is exploring the impact of symptom fear, such as dyspnea, as it has been recognized to negatively influence self-efficacy for exercise ratings in older adults (Clark & Nothwehr, 1999).
Replicating Clark's study might be difficult in the COPD population because dyspnea is the primary problematic symptom, but an assessment of the fear associated with the symptom may provide some very useful insights into the dynamics of self-efficacy for a variety of tasks such as walking or managing shortness of breath. This type of study would also provide important information regarding dyspnea, and fear associated with it, in older adults

with COPD. There is also a need for further work in determining if self-efficacy ratings act as moderator or mediators for exercise behaviors in older adults with COPD specifically.

REFERENCES

Aitken, R. B. (1969). A growing edge of measurement of feelings. *Proc R Soc Med, 62*, 989-993.

Akiyama, Y., Nishimura, M., Kobayashi, S., Yamamoto, M., Miyamoto, K., & Kawakami, Y. (1993). Effects of aging on respiratory load compensation and dyspnea sensation. *American Review of Respiratory Disease, 148*, 1586-1591.

Anderson, W. F., Anderson, A. E., Hernandez, J. A., & Foraker, A. G. (1964). Topography of the aging and emphysematous lung. *American Review of Respiratory Disease, 90*, 411-423.

Andreotti, L., Bussotti, A., Cammelli, D., Aiello, E., & Sampognaro, S. (1983). Connective tissue in aging lung. *Gerontology, 29*, 377-387.

Anthonisen, N. R. (1986). Tests of mechanical function. In *Handbook of Physiology, Section 3, The Respiratory System* (Vol. III, pp. 753-784). Bethesda: American Physiological Society.

Anthonisen, N. R., Danson, J., Robertson, P. C., & al., e. (1970). Airway closure as a function of age. *Respiratory Physiology, 8*, 58-65.

Archibald, C. J., & Guidotti, T. L. (1987). Degree of objectivity measured impairment and perceived shortness of breath with activities of daily living in patients with chronic obstructive pulmonary disease. *Canadian Journal of Rehabilitation, 1*, 45-54.

Arnold, R., Ranchor, A. V., DeJongste, M. J. L., Koeter, G. H., Ten Hacken, H. T., Aalbers, R., et al. (2005). The relationship between self efficacy and self-reported physical functioning in chronic obstructive pulmonary disease and chronic heart failure. *Behavioral Medicine, 31*, 107-115.

ATS. (1978). American Thoracic Society: Recommended respiratory questionnaires for use with adults and children in epidemiological research. *American Review of Respiratory Disease, 118*, 7-35.

ATS. (1987). Standardization of spirometry-1987 update. Statement of the American Thoracic Society. *American Review of Respiratory Disease, 136*(5), 1285-1298.

ATS. (1995). American Thoracic Society Statement: Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 152*, S77-S120.

ATS. (1999). American Thoracic Society Position Statement: Dyspnea. *American Journal of Respiratory and Critical Care Medicine, 159*, 321-340.

ATS. (2002). American Thoracic Society Statement: Guidelines for the Six-Minute Walk Test. *American Journal of Respiratory and Critical Care Medicine, 166*, 111-117.

ATS/ERS. (2005). *Standards for the diagnosis and management of patients with COPD*. Retrieved January 6, 2007, 206, from http://www.thoracic.org/sections/copd/resources/copddoc.pdf

ATS/ERS. (2006). American Thoracic Society/European Respiratory Society Statement on Pulmonary Rehabilitation. *American Journal of Respiratory and Critical Care Medicine, 173*, 1390-1413.

Baltes, M. M., & Baltes, P. B. (1986). *The psychology of control and aging*. Hillsdale, N. J.: Erlbaum.

Bandura, A. (1991). Self-efficacy in physiological activation and health-promoting behavior. In J. I. Madden (Ed.), *Neurobiology of Learning, Emotion and Affect*. New York: Raven Press.

Bandura, A. (1997). *Self-Efficacy: the Exercise of Control*. New York: W. H. Freeman and Company.

Banzett, R. B., Landsing, R. W., & Brown, R. (1987). High level quadriplegics perceive lung volume changes. *Journal of Applied Physiology, 62*, 567-573.

Banzett, R. B., Lansing, R. W., Brown, B. W., Topulos, G. P., Yager, D., Steele, S. M., et al. (1990). 'Air hunger' from increased PCO2 persists after complete neuromuscular block in humans. *Respiratory Physiology, 81*, 1-17.

Barlow, J., Wright, C., Sheasby, J., Turner, A., & Hainsworth, J. (2002). Self-management approaches for people with chronic conditions: a review. *Patient Education and Counseling, 48*, 177-187.

Barnes, P. J. (2000). Chronic obstructive pulmonary disease. *New England Journal of Medicine, 343*, 269-280.

Begin, R., Renzetti, A. D. J., Bigler, A. H., & Watanabe, S. (1975). Flow and age dependence of airway closure and dynamic compliance. *Journal of Applied Physiology, 38*, 199-207.

Bellman, M. J., Botnick, W. C., & Shin, J. W. (1996). Inhaled bronchodilators reduce dynamic hyperinflation during exercise in patients with chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 153*, 967-975.

Bergner, M., Bobbitt, R. A., Carter, W. B., & Gilson, B. S. (1981). The Sickness Impact Profile: Development and final revision of a health status measure. *Medical Care, 19*, 787-805.

Bickford, L. S., Hodgkin, J. E., & McInturff, S. L. (1995). National pulmonary rehabilitation survey. Update. *Journal of Cardiopulmonary Rehabilitation, 15*(6), 406-411.

Black, L. F., & Hyatt, R. E. (1969). Maximal respiratory pressures: Normal values and relationships to age and sex. *American Review of Respiratory Disease, 99*, 696-702.

Borg, G. A. V. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise, 14*, 377-381.

Bortz, W. M. (1982). Disuse and aging. *Journal of the American Medical Association, 248*, 1203-1208.

Bourbeau, J., Julien, M., Maltais, F., Rouleau, M., Beaupre, A., Begin, R., et al. (2003). Reduction of hospital utilization in patients with chronic obstructive pulmonary disease: a disease-specific self-management intervention. *Arch Intern Med, 163*, 585-591.

Bourbeau, J., Nault, D., & Dang-Tan, T. (2004). Self-management and behavior modification in COPD. *Patient Education and Counseling, 53*, 271-277.

Brischetto, M. J., Millman, R. P., Peterson, D. D., Silage, D. A., & Pack, A. I. (1984). Effect of aging on ventilatory response to exercise and CO2. *Journal of Applied Physiology, 56*(6), 1143-1150.

Briscoe, W. A., & DuBois, A. B. (1958). The relationship between airway resistance, airway conductance, and lung volume in subjects of different age and body size. *Journal of Clinical Investigation, 37*, 1279-1285.

Brody, J. S., & Thurlbeck, W. M. (1986). Development, growth and aging of the lung. In D. H. Simmon (Ed.), *Handbook of Physiology* (Vol. III, pp. 355-386). Bethesda: American Physiological Society.

Burdon, G. W., Juniper, E. F., Killian, K. J. A., Hargreave, F. E., & Campbell, E. J. M. (1982). The perception of breathlessness in asthma. *American Review of Respiratory Disease, 125*, 825-828.

Burns, B. H., & Howell, J. B. L. (1969). Disproportionately severe breathlessness in chronic bronchitis. *J Med, 38*, 277-294.

Campbell, E. J. M., Gandevia, S. C., Killian, K. J., Mahutte, C. K., & Riggs, J. R. A. (1990). Changes in the perception of inspiratory resistive loads during partial curarization. *Journal of Applied Physiology, 309*, 93-100.

Carrieri-Kohlman, V. (2003). Dyspnea. In V. Carrieri-Kohlman, A. M. Lindsey & C. West (Eds.), *Pathophysiological Phenomena in Nursing* (pp. 175-207). St. Louis, MO.: Saunders.

Carrieri-Kohlman, V., Gormley, J. M., Douglas, M. K., Paul, S. M., & Stulbarg, M. S. (1996). Exercise training decreases dyspnea and the distress and anxiety associated with it. *Chest, 110*, 1526-1535.

Carrieri-Kohlman, V., Nguyen, H. Q., Donesky-Cuenco, D., Demir-Deviren, S., Neuhaus, J., & Stulbarg, M. S. (2005). Impact of brief or extended exercise training on the benefit of a dyspnea self management program in COPD. *Journal of Cardiopulmonary Rehabilitation, 25*, 275-284.

CDC. (2003). *Functional Limitations of Medicare Beneficiaries by Age, Sex, Race and Ethnicity from the Medicare Current Beneficiary Survey (MCBS), 1992-2003.* Retrieved December 10, 2006, 2006, from http://209.217.72.34/aging/TableViewer/tableView.aspx?ReportId=363

CDC. (2006). *Healthy Aging: Preventing Disease and Improving Quality of Life Among Older Americans*. Retrieved December 30, 2006, 2006, from http://www.cdc.gov/nccdphp/publications/aag/aging.htm

CDC. (2007). *Centers for Disease Control: Facts about Chronic Obstructive Pulmonary Disease (COPD)*. Retrieved April 27, 2007, 2007, from http://www.cdc.gov/nceh/airpollution/copd/copdfaq.htm#who

Celli, B., & MacNee, W. (2004). American Thoracic Society/European Respiratory Society Task Force: Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. *European Respiratory Journal, 23*, 932-946.

Chan, E. D., & Welsh, C. H. (1998). Geriatric respiratory medicine. *Chest, 114*, 1704-1733.

Chonan, T., Mullholland, M. B., Cherniack, N. S., & Altose, M. D. (1987). Effects of voluntary constraining of thoracic displacement during hypercapnia. *Journal of Applied Physiology, 63*, 1822-1828.

Chronos, N., Adams, L., & Guz, A. (1988). Effect of hyperoxia and hypoxia on exercise-induced breathlessness in normal subjects. *Clinical Science, 64*, 531-537.

Clark, D. O., & Nothwehr, F. (1999). Exercise self-efficacy and its correlates among socioeconomically disadvantaged older adults. *Health Education & Behavior, 26*(4), 535-546.

Clark, D. O., Patrick, D. L., Grembowski, D., & Durham, M. (1995). Socioeconomic status and exercise self-efficacy in late life. *Journal of Behavioral Medicine, 18*(4), 355-376.

Clini, E., Foglio, K., Bianchi, L., Porta, R., Vitacca, M., & Ambrosino, N. (2001). In hospital short-term training program for patients with chronic airway obstruction. *Chest, 120*, 1500-1505.

Conn, V. S. (1998). Older adults and exercise. Path analysis of self-efficacy related constructs. *Nursing Research, 47*(3), 180-189.

Cotes, J. E., Chinn, D. J., & Miller, M. R. (2006). Physiology of exercise and changes resulting from lung disease. In J. E. Cotes, D. J. Chinn & M. R. Miller (Eds.), *Lung Function* (6th ed., pp. 385-415). Malden, Massachusetts: Blackwell Publishing Limited.

Crapo, R. O. (1993). The aging lung. In D. A. Mahler (Ed.), *Pulmonary disease in the elderly patient* (pp. 1-21). New York: Marcel-Dekker.

Crapo, R. O., Morris, A. H., & Gardner, R. M. (1981). Reference spirometric values using techniques and equipment that meet ATS recommendations. *American Review of Respiratory Disease, 123*, 659-664.

Crapo, R. O., Morris, A. H., & Gardner, R. M. (1982). Lung volumes in healthy nonsmoking adults. *Bulletin of European Physiopathology of Respiration*(18), 419-425.

Davies, S. F., McQuaid, K. R., Iber, C., McArthur, C. D., Path, M. J., Beebe, D. S., et al. (1987). Extreme dyspnea from unilateral pulmonary venous obstruction. Demonstration of a vagal mechanism and relief by right vagotomy. *American Review of Respiratory Disease, 136*, 184-188.

Davis, A. H., Carrieri-Kohlman, V., Janson, S., Gold, W. M., & S., S. M. (2006). Effects of treatment on two types of self-efficacy in people with chronic obstructive pulmonary disease. *J Pain Symptom Manage, 32*(1), 60-70.

Dishman, R. K. (1994). The measurement conundrum in exercise adherence research. *Medical Science, Sports and Exercise, 26*, 1382-1390.

Dollfuss, R. E., Milic-Emili, J., & Bates, D. V. (1967). Regional ventilation of the lungs, studied with boluses of xenon. *Respiratory Physiology, 2*, 234-246.

Eakin, E. G., Resnikoff, P. M., Prewitt, L. M., Ries, A. L., & Kaplan, R. M. (1998). Validation of a new dyspnea measure: the UCSD shortness of breath questionnaire. *Chest, 113*, 619-624.

Eaton, T., Garrett, J. E., Young, P., Fergusson, W., Kolbe, J., Rudkin, S., et al. (2002). Ambulatory oxygen improves quality of life of COPD patients: a randomised controlled study. *European Respiratory Journal, 20*, 306-312.

Ferrini, R., Edelstein, S., & Barrett-Connor, E. (1994). The association between health beliefs and health behaviors change in older adults. *Preventative Medicine, 23*, 1-5.

Fix, A. I., & Daughton, D. M. (1988). *Human Activity Profile Professional Manual*. Odessa, FL: Psychological Assessment Resources.

Fletcher, C. M., Elmes, P. C., & Wood, C. H. (1959). The significance of respiratory symptoms and the diagnosis of chronic bronchitis in a working population. *British Medical Journal, 2*, 257-266.

Foglio, K., Bianchi, L., Bruletti, G., Battista, L., Pagani, M., & Ambrosino, N. (1999). Long-term effectiveness of pulmonary rehabilitation in patients with chronic airway obstruction. *European Respiratory Journal, 13*, 125-132.

Gadoury, M.-A., Schwartzman, K., Rouleau, M., Maltais, F., Julien, M., Beaupre, A., et al. (2005). Self-management reduces both short- and long-term hospitalisation in COPD. *European Respiratory Journal, 26*, 853-857.

Gallefoss, F., & Bakke, P. S. (1999). How does patient education and self-management among asthmatics and patients with chronic obstructive pulmonary disease affect medication? *American Journal of Respiratory and Critical Care Medicine, 160*, 2000-2005.

Gallefoss, F., Bakke, P. S., & Kjaersgaard, P. (1999). Quality of life assessment after patient education in a randomized controlled study on asthma and chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 159*, 812-817.

Gibson, G. J., Pride, N. B., O'Cain, C., & Quagliato, R. (1976). Sex and age differences in pulmonary mechanics in normal nonsmoking subjects. *Journal of Applied Physiology, 41*, 20-25.

Gift, A. (1989). Validation of a vertical visual analogue scale as a measure of clinical dyspnea. *Rehabilitation Nursing, 14*, 323-325.

Gigliotti, F., Coli, C., Bianchi, L., Romangnoli, I., Lanini, B., Binazzi, B., et al. (2003). Exercise training improves exertional dyspnea in patients with COPD: evidence of the role of mechanical factors. *Chest, 123*, 1794-1802.

Gold, W. M. (2005). Chapter 24: Pulmonary Function Testing. In R. J. Mason, V. C. Broaddus, J. F. Murray & J. A. Nadel (Eds.), *Murray & Nadel's Textbook of Pulmonary Medicine, 4th Ed.* (Vol. 1, pp. 671-740). Philadelphia: Elsevier Saunders.

Gormley, J. M., Carrieri-Kohlman, V., Douglas, M. K., & Stulbarg, M. S. (1993). Treadmill self-efficacy and walking performance in COPD patients. *Journal of Cardiopulmonary Rehabilitation, 13*, 424-431.

Gray, R. (2006). Exercise self-efficacy in older women with diastolic heart failure: results of a walking program and education intervention. *Journal of Gerontological Nursing, 32*, 31-39.

Graydon, J. E., Ross, E., Webster, P. M., Goldstein, R. S., & Avendano, M. (1995). Predictors of functioning of patients with chronic obstructive pulmonary disease. *Heart & Lung, 24*, 369-375.

Grembowski, D., Patrick, D. L., Diehr, P., Durham, M., Beresford, S., Kay, E., et al. (1993). Self-efficacy and health behaviors among older adults. *Journal of Health and Social Behavior, 34*(2), 89-104.

Guyatt, G. H., Berman, L. B., Townsend, M., Pugsley, S. O., & Chambers, L. W. (1987). A measure of quality of life for clinical trials in chronic lung disease. *Thorax, 42*, 773-778.

Guz, A., Noble, M. I. M., Eisle, J. H., & Trenchard, D. (1970). Experimental results of vagal block in cardiopulmonary disease. In R. Porter (Ed.), *Breathing: Hering Breuer Centenary Symposium* (pp. 315-328). London: Churchill.

Hagberg, J. M., Yerg, J. E., & Seals, D. R. (1988). Pulmonary function in young and older athletes and untrained men. *Journal of Applied Physiology, 65*, 101-105.

Hasleton, P. S. (1972). The internal surface of the adult human lung. *Journal of Anatomy, 112*, 391-400.

Hernandez, M. T., Rubio, T. M., Ruiz, F. O., Riera, H. S., Gil, R. S., & Gomez, J. C. (2000). Results of a home-based training program for patients with COPD. *Chest, 118*, 106-114.

Holland, J., Milic-Emili, J., Macklem, P. T., & Bates, D. V. (1968). Regional distribution of pulmonary ventilation and perfusion in elderly subjects. *Journal of Clinical Investigation, 47*, 81-92.

Howland, J., Nelson, E. C., Barlow, P. B., McHugo, G., Meier, F. A., Brent, P., et al. (1986). Chronic obstructive airway disease. Impact of health education. *Chest, 90*, 233-238.

Hurd, S. (2000). The impact of COPD on lung health worldwide: Epidemiology and incidence. *Chest, 117*, 1-4.

IOM. (2001). *Crossing the Quality Chasm: A New Health System for the Twenty-First Century*. Washington, D. C.: National Academy Press.

Janssens, J. P., Pache, J. C. & Nicod, L. P. (1999). Physiological changes in respiratory function associated with ageing. *European Respiratory Journal, 13*, 197-205.

John, R., & Thomas, J. (1972). Chemical composition of elastins isolated from aortas and pulmonary tissues of humans of different ages. *Biochemical Journal, 127*, 261-269.

Johnson, B. D., Reddan, W. G., Pegelow, D. F., Seow, K. C., & Dempsey, J. A. (1991). Flow limitation and regulation of functional residual capacity during exercise in a physically active aging population. *American Review of Respiratory Disease, 143*, 960-967.

Jones, P. W., & Bosh, T. K. (1997). Quality of life changes in COPD patients treated with a salmeterol. *American Journal Respiratory and Critical Care Medicine, 155*, 1283-1289.

Jones, P. W., Quirk, F. H., & Baveystock, C. M. (1991). The St. George's Respiratory Questionnaire. *Respiratory Medicine, 85*, 25-31.

Kaplan, R. M., & Anderson, A. E. (1988). The quality of well-being scale: a rationale for a single quality of life index. In S. R. Walker & R. M. Rosser (Eds.), *Quality of life: assessment and application* (pp. 51-77). London: MTP Press.

Kaplan, R. M., & Atkins, C. J. (1984). Specific efficacy expectations mediate exercise compliance in patients with COPD. *Health Psychology, 3*, 223-242.

Killian, K. J., Gandevia, S., Summers, E., & Campbell, E. J. M. (1984). Effect of increased lung volume on perception of breathlessness, effort and tension. *Journal of Applied Physiology, 57*, 686-691.

Kim, W.-D., Kim, W.-S., Koh, Y., Lee, S.-D., Lim, C.-M., Kim, D.-S., et al. (2002). Abnormal peripheral blood t-lymphocyte subsets in a subgroup of patients with COPD. *Chest, 122*, 437-444.

Klocke, R. A. (1977). Influence of aging on the lung. In C. E. Finch & L. Hayflick (Eds.), *Handbook of the biology of aging* (pp. 432-444). New York: VanNostrand Reinhold.

Knudson, R. J. (1991). Physiology of the aging lung. In R. Crystal & J. West (Eds.), *The Lung* (pp. 1749-1759). New York: Raven Press.

Knudson, R. J., Lebowitz, M. D., Holberg, C. J., & Burrows, B. (1983). Changes in the normal maximal expiratory flow-volume curve in growth and aging. *American Review of Respiratory Disease, 127*, 725-734.

Knudson, R. J., Slatin, R. C., Lebowitz, M. D., & Burrows, B. (1976). The maximal expiratory flow-volume curve. Normal standards, variability and effects of age. *American Review of Respiratory Disease, 113*, 587-600.

Kronenberg, R. S., & Drage, C. W. (1973). Attenuation of the ventilatory and heart rate responses to hypoxemia and hypercapnia. *Journal of Clinical Investigation, 52*, 1812-1819.

Krumpe, P. E., Knudson, R. J., Parsons, G. & Reiser, K. (1985). The aging respiratory system. *Clinical Geriatric Medicine, 1*, 143-175.

Lacasse, Y., Brosseau, L., Milne, S., Martin, S., Wong, E., Guyatt, G. H., et al. (2001). Pulmonary rehabilitation for chronic pulmonary disease (Review). *Cochrane Database Systematic Review* (4), CD003793.

Lachman, M. E. (1986). Personal control in later life: Stability, change and cognitive correlates. In M. M. Baltes & P. B. Baltes (Eds.), *The psychology of control and aging*. Hillsdale, N. J.: Erlbaum.

Lane, R., Cockcroft, A., Adams, L., & Guz, A. (1987). Arterial oxygen saturation and breathlessness in patients with chronic obstructive pulmonary disease. *Clinical Science, 72*, 693-698.

Larson, J., Ahijevych, K., Gift, A., Hoffman, L., Janson, S. L., Lanuza, D. M., et al. (2006). American Thoracic Society Statement on Research Priorities in Respiratory Nursing. *American Journal of Respiratory and Critical Care Medicine, 174*, 471-478.

Larson, J., Covey, M. K., Wirtz, S. E., Berry, J. K., Alex, C. G., Langbein, W. E., et al. (1999). Cycle ergometry and inspiratory muscle training in chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 160*, 500-507.

Lee, I. S., Le, D. T. F., & Mackenzie, A. E. (2006). Correlates of functional limitations in older Chinese patients with chronic obstructive pulmonary disease. *Heart & Lung, 35*, 324-333.

Lee, K. W., Chung, S. Y., Yang, I., Lee, Y., Ko, E. Y. & Park, M. J. (2000). Correlation of aging and smoking with air trapping at thin-section CT of the lung in asymptomatic subjects. *Radiology, 214*, 831-836.

Lee, Y. S., & Laffrey, S. C. (2006). Predictors of physical activity in older articles with borderline hypertension. *Nursing Research, 55*(2), 110-120.

Leidy, N. (1994). Functional status and the forward progress of merry-go-rounds: Toward a coherent analytical framework. *Nursing Research, 43*, 196-202.

Levitsky, M. G. (1984). Effects of aging on the respiratory system. *Physiologist, 27*, 102-107.

Littlejohns, P., Baveystock, C. M., Parnell, H., & Jones, P. W. (1991). Randomised controlled trial of the effectiveness of a respiratory health worker in reducing impairment, disability, and handicap due to chronic airflow limitation. *Thorax, 46*, 559-564.

Lorig, K., Stewart, A., Ritter, P., Gonzales, V., Laurent, D., & Lynch, J. (1996). *Outcome measures for health education and other health care interventions*. Thousand Oaks, CA: Sage Publications.

Macklin, C. C. (1936). Alveolar pores and their significance in the human lung. *Archives of Pathology, 21*, 202-226.

Mador, M. J., Rodis, A., & Magalang, U. L. (1995). Reproducibility of Borg scale measurements of dyspnea during exercise in patients with COPD. *Chest, 107*, 1590-1597.

Mahler, D. A. (1993). Chronic obstructive pulmonary disease. In D. A. Mahler (Ed.), *Pulmonary Disease in the Elderly Patient* (pp. 159-188). New York: Marcel Dekker, Inc.

Mahler, D. A., & Baird, J. C. (2005). Dyspnea in the elderly. In D. A. Mahler & D. E. O' Donnell (Eds.), *Dyspnea: Mechanisms, Measurement and Management* (pp. 19-28). Boca Raton, FL: Taylor & Francis Group, LLC.

Mahler, D. A., Faryiniarz, K., Lentine, T., Ward, J., Olmstead, E. M., & O'Connor, G. T. (1991). Measurement of breathlessness during exercise in asthmatics. *American Review of Respiratory Disease, 144*, 39-44.

Mahler, D. A., & Harver, A. (1992). A factor analysis of dyspnea ratings, respiratory muscle strength, and lung function in patients with chronic obstructive pulmonary disease. *American Review of Respiratory Disease, 145*, 467-470.

Mahler, D. A., Huang, S., Tabrizi, M., & Bell, G. M. (2004). Efficacy and safety of monoclonal antibody recognizing interleukin-8 in COPD. *Chest, 126*, 926-934.

Mahler, D. A., Rosiello, R. A., & Loke, J. (1986). The aging lung. *Geriatric Clinics of North America, 2*, 215-225.

Mahler, D. A., Weinberg, D. H., Wells, C. K., & Feinstein, A. R. (1984). The measurement of dyspnea: contents, interobserver agreement, and physiologic correlates of two new clinical indexes. *Chest, 85*, 751-758.

Manning, H. L., Shea, S. A., Schwartzstein, R. M., Lansing, R. W., Brown, B. W., & Banzett, R. B. (1992). Reduced tidal volume increases "air hunger" at fixed PCO2 in ventilated quadriplegics. *Respiratory Physiology, 90*, 19-30.

Martinez, F. J., Montes de Oca, M., Whyte, K., Stetz, J., Gay, S. E., & Celli, B. (1997). Lung-volume reduction improves dyspnea, dynamic hyperinflation, and respiratory muscle function. *American Review of Respiratory and Critical Care Medicine, 155*, 1984-1990.

Mauderly, J. L. (1979). Effect of age on pulmonary structure and function of immature and adult animals and man. *Fed Proc, 38*, 173-177.

McAuley, E., Konopack, J. F., Morris, K. S., Motl, R. W., Hu, L., Doerksen, S. E., et al. (2006). Physical activity and functional limitations in older women: Influence of self-efficacy. *Journal of Gerontology B: Psychological Science and Soc Science, 61B*(5), P270-P277.

McClaran, S. R., Babcock, M. A., Pegelow, D. F., Reddan, W. G., & Dempsey, J. A. (1995). Longitudinal effects of aging on lung function at rest and exercise in health active fit elderly adults. *Journal of Applied Physiology, 78*, 1957-1968.

McConnell, A. K., & Davies, C. T. M. (1992). A comparison of the ventilatory responses to exercise of elderly and younger humans. *Journal of Gerontology, 47*, B137-B141.

McElvaney, G. L., Blackie, S., Morrison, N. J., Wilcox, P. G., Fairbarn, M. S., & Pardy, R. L. (1989). Maximal static respiratory pressures in the normal elderly. *American Review of Respiratory Disease, 139*, 277-281.

McGavin, C. R., Artvinli, M., & Naoe, H. (1987). Dyspnea, disability and distance walked: comparison of estimates of exercise performance in respiratory disease. *Br Med J, 2*, 241-243.

Mellemgaard, K. (1966). The alveolar-arterial oxygen difference: its size and components in normal men. *Acta Physiologica Scandinavia, 67*, 10-20.

Miller, R. A. (1996). The aging immune system: primer and prospectus. *Science, 273*, 70-74.

Milne, J. S., & Williamson, J. (1972). Respiratory function tests in older people. *Clinical Science, 42*, 371-381.

Mizuno, H. (1991). Human respiratory muscles: fiber morphology and capillary supply. *European Respiratory Journal, 4*, 587-601.

Monninkhof, E., van der Valk, P., Schermer, T., van der Palen, J., van Herwaarden, C., & Zielhuis, G. (2004). Economic evaluation of a comprehensive self-management programme in patients with moderate to severe chronic obstructive pulmonary disease. *Chronic Respiratory Disease, 1*, 7-16.

Monninkhof, E., van der Valk, P., van der Palen, J., van Herwaarden, C., & Zielhuis, G. (2003). Effects of a comprehensive self-management programme in patients with chronic obstructive pulmonary disease. *European Respiratory Journal, 22*, 815-820.

Monninkhof, E., van der Valk, P. D. L. P. M., van der Palen, J., van Herwaarden, C. L. A., Partridge, M. R., Walters, E. H., et al. (2002). Self-management education for chronic obstructive pulmonary disease. *The Cochrane Database of Systematic Reviews*(4), 1-28.

Murray, J. F. (1986). Aging. In J. F. Murray (Ed.), *The Normal Lung* (pp. 339-360). Philadelphia: W. B. Saunders.

Muza, S. R., Silverman, M. T., Grover, G. C., Hellerstein, H. K., & Kelsen , S. G. (1990). Comparison of scales used to quantitate the sense of effort to breath in patients with chronic obstructive pulmonary disease. *American Review of Respiratory Disease, 141*, 909-913.

Nagai, A., Yamawaki, I., Takizawa, T., & Thurlbeck, W. M. (1991). Alveolar attachments in emphysema of human lungs. *American Review Respiratory Disease, 144*, 888-891.

Newham, D. M., & Hamilton, S. J. C. (1997). Sensitivity of the cough reflex in young and elderly subjects. *Age Aging, 26*, 185-188.

Nguyen, H. Q., Altinger, J., Carrieri-Kohlman, V. K., Gormley, J. M., Paul, S., & Stulbarg, M. S. (2003). Factor analysis of laboratory and clinical measurements of days in patients with chronic obstructive pulmonary disease. *Journal of Pain and Symptom Management, 25*(2), 118-127.

Nguyen, H. Q., & Carrieri-Kohlman, V. (2005). Dyspnea self-management in patients with chronic obstructive pulmonary disease: moderating effects of depressed mood. *Psychosomatics, 46*(5), 402-410.

NHLBI/WHO. (2001). National Heart, Lung and Blood Institute/ World Health Organization: Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 163*, 1256-1276.

NHLBI/WHO, N. H., Lung and Blood Institute/ World Health Organization. (2001). Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 163*, 1256-1276.

Niewoehner, D. E., & Kleinerman, J. (1974). Morphologic basis of pulmonary resistance in the human lung and effects of aging. *Journal of Applied Physiology, 36*, 412-418.

Nunn, A. J., & Gregg, I. (1989). New regression equations for predicting peak expiratory flow rates in adults. *British Medical Journal, 298*, 1068-1070.

O' Donnell, D. E., & Webb, K. A. (2005). Mechanisms of dyspnea in COPD. In D. A. Mahler & D. O'Donnell (Eds.), *Dyspnea* (pp. 29-58). Boca Raton, Florida: Taylor & Francis Group, LLC.

Pack, A. I., & Millman, R. P. (1988). The lungs in later life. In A. P. Fishman (Ed.), *Pulmonary Diseases and Disorders* (pp. 79-90). New York: McGraw Hill Book Company.

Peruzza, S., Sergi, G., Vianello, A., Pisent, C., Tiozzo, F., Manzan, A., et al. (2003). Chronic obstructive pulmonary disease (COPD) in elderly subjects: impact on functional status and quality of life. *Respiratory Medicine, 97*, 612-617.

Peterson, D. D., Pack, A. I., Silage, D. A., & Fishman, A. P. (1981). Effects of aging on ventilatory and occlusion pressure responses to hypoxia and hypercapnia. *American Review of Respiratory Disease, 124*, 387-391.

Pitta, F., Troosters, T., Spruit, M. A., Probst, V. S., Decramer, M., & Gosselink, R. (2005). Characteristics of physical activities in daily life in chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine, 171*, 972-977.

Puente-Maestu, M. L., Sanz, M. L., P., S., Cubillo, J. M., Mayol, J., & Casaburi, R. (2000). Comparison of effects of supervised versus self-monitored training programmes in patients with chronic obstructive pulmonary disease. *European Respiratory Journal, 15*, 517-525.

Pump, K. K. (1976). Emphysema and its relation to age. *American Review of Respiratory Disease, 114*, 5-13.

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*(3), 385-401.

Raine, J., & Bishop, J. (1963). Aa difference in O2 tension and physiological dead space in normal man. *Journal of Applied Physiology, 18*, 284-288.

Reardon, J. Z., Lareau, S. C., & Zuwallack, R. (2006). Functional status and quality of life in chronic obstructive pulmonary disease. *American Journal of Medicine, 119*, S32-S37.

Redelmeier, D. A., Bayoumi, A. M., Goldstein, R. S., & Guyatt, G. H. (1997). Interpreting small differences in functional status: the six-minute walk test in chronic lung disease patients. *American Journal of Respiratory and Critical Care Medicine, 155*, 1278-1282.

Reishtein, J. L. (2005). Relationship between symptoms and functional performance in COPD. *Research in Nursing & Health, 28*, 39-47.

Resnick, B. (2000). Path analysis of efficacy expectations and exercise behavior in older adults. *Journal of Advanced Nursing, 31*(6), 1309-1315.

Resnick, B. (2001). Testing a model of exercise behavior in older adults. *Research in Nursing & Health, 24*, 83-92.

Resnick, B. (2004). A longitudinal analysis of efficacy expectations and exercise in older adults. *Research and Theory in Nursing Practice, 18*, 331-344.

Resnick, B., & Nigg, C. (2003). Testing a theoretical model for exercise behavior for older adults. *Nursing Research, 52*(2), 80-88.

Resnick, B., Palmer, M. H., Jenkins, L., & Spellbring, A. M. (2000). Efficacy expectations and exercise behaviors in older adults: A path analysis. *Journal of Advanced Nursing, 32*, 16-23.

Reuben, D. B. (2003). Chapter 8: Principles of geriatric assessment. In W. R. Hazzard, J. P. Blass, J. B. Halter, J. G. Ouslander & M. E. Tinetti (Eds.), *Principles of Geriatric Medicine & Gerontology* (5th ed., pp. 99-110). New York: McGraw-Hill Companies.

Ries, A. L. (2005). Minimally clinically important difference for the UCSD Shortness of Breath Questionnaire, Borg Scale, and Visual Analog Scale. *COPD: Journal of Chronic Obstructive Pulmonary Disease, 2*, 105-110.

Roberts, C. M., MacRae, K. D., Winning, A. J., Adams, L., & Seed, W. A. (1991). Reference values and prediction equations for normal lung function in a non-smoking white urban population. *Thorax, 46*, 643-650.

Sassi-Dambron, D. E., Eakin, E. G., Ries, A., & Kaplan, R. M. (1995). Treatment of dyspnea in COPD: a controlled clinical trial of dyspnea management strategies. *Chest, 107*, 724-729.

Scherer, Y. K., & Schmeider, L. E. (1997). The effect of a pulmonary rehabilitation program on self-efficacy, perception of dyspnea, and physical endurance. *Heart Lung, 26*, 15-22.

Scherer, Y. K., & Schmieder, L. E. (1996). The role of self-efficacy in assisting patients with chronic obstructive pulmonary disease to manage breathing difficulty. *Clinical Nursing Research, 5*(3), 343-355.

Schwartzstein, R. M., Simon, P. M., Weiss, J. W., Fencl, V., & Weinberger, S. E. (1989). Breathlessness induced by dissociation between ventilation and chemical drive. *American Review of Respiratory Disease, 139*, 1231-1237.

Sewell, L., Singh, S. J., Willimas, J. E., Collioer, R., & Morgan, M. (2005). Can individualized rehabilitation improve functional independence in elderly patients with CO PD? *Chest, 128*, 1194-1200.

Shapiro, S. D., Snider, G. L., & Rennard, S. I. (2005). Chapter 36: Chronic bronchitis and emphysema. In R. J. Mason, V. C. Broaddus, J. F. Murray & J. A. Nadel (Eds.), *Murray and Nadel's Textbook of Pulmonary Medicine* (Vol. 1, pp. 1115-1167). Philadelphia: Elsevier Saunders.

Silverman, M., Barry, J., Hellerstein, H., Janos, J., & Kelsen, S. (1988). Variability of the perceived sense of effort in breathing during exercise in patients with chronic obstructive pulmonary disease. *American Review of Respiratory Disease, 137*, 206-209.

Skumlien, S., Haave, E., Morland, L., Bjortuft, O., & Ryg, M. S. (2006). Gender differences in the performance of activities of daily living among patients with chronic obstructive pulmonary disease. *Chronic Respiratory Disease, 3*, 141-148.

Solway, S., Brooks, D., Lacasse, Y. & Thomas, S. (2001). A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiopulmonary domain. *Chest, 119*, 256-270.

Sorbini, C. A., Grassi, V., Solinas, E., & Muiesan, G. (1968). Arterial oxygen tension in relation to age in healthy subjects. *Respiration, 25*, 3-13.

Speilberger, C. D., Gorusch, R. L., Lushene, R., & Jacobs, G. A. (1984). *Manual for the State-Trait Anxiety Inventory (form Y)* (1st ed.). California: Consulting Psychologists Press.

Stulbarg, M. S., Carrieri-Kohlman, V., Demir-Deviren, S., Nguyen, H. Q., Adams, L., Tsang, A. H., et al. (2002). Exercise training improves outcomes of a dyspnea self-management program. *Journal of Cardiopulmonary Rehabilitation, 22*, 109-121.

Sutherland, E. R., & Make, B. J. (2005). Maximum exercise as an outcome in COPD: Minimal clinically important difference. *COPD: Journal of Chronic Obstructive Pulmonary Disease, 2*, 137-141.

Tack, M., Altose, M., & Cherniak, N. (1982). Effect of aging on the perception of resistive loads. *American Review of Respiratory Disease, 126*, 463-467.

Tack, M., Altose, M. D., & Cherniack, N. S. (1981). Effect of aging on respiratory sensations produced by elastic loads. *Journal of Applied Physiology, 50*, 844-850.

Tack, M., Altose, M. D., & Cherniack, N. S. (1983). Effects of aging on sensation of respiratory force and displacement. *Journal of Applied Physiology, 55*, 1433-1440.

Thomas, R. A., Green, R. H., Brightling, C. E., Birring, S. S., Parker, D., Wardlaw, A. J., et al. (2004). The influence of age on induced sputum differential cell count in normal subjects. *Chest, 126*(6), 1811-1814.

Thurlbeck, W. M. (1967). The internal surface of the emphysematous lungs. *American Review of Respiratory Disease, 95*.

Thurlbeck, W. M. (1991). Morphology of the aging lung. In R. G. Crystal & J. B. West (Eds.), *The Lung* (Vol. 2). New York: Raven Press.

Tolep, K., & Kelsen, S. G. (1991). Transdiaphragmatic pressure generation in elderly health subjects. *American Review of Respiratory Disease*, A366.

Turner, J. M., Mead, J., & Wohl, M. E. (1968). Elasticity of human lungs in relation to age. *Journal of Applied Physiology, 25*, 664-671.

Vestbo, J., Prescott, E., & Lange, P. (1996). Association of chronic mucus hypersecretion with FEV1 decline and chronic obstructive pulmonary disease morbidity. *American Journal of Respiratory and Critical Care Medicine, 153*, 1530-1535.

Wagner, E. H., Austin, B., Davis, C., Hindmarsh, M., Schaefer, J., & Bonomi, A. (2001). Improving chronic illness care: Translating evidence into action. *Health Affairs, 20*(6), 64-78.

Wahba, W. M. (1983). Influence of aging on lung tissue: clinical significance of changes from age twenty. *Anesthesia and Analgesia, 62*, 764-776.

Wallston, K. A., & Kaplan, G. D. (1976). Development and validation of the health locus of control (HCL) scale. *Journal of Counseling and Clinical Psychology, 44*, 508-545.

Ware, J. E., & Sherbourne, C. D. (1992). The MOS-36 Item Short Form Health Survey (SF-36). *Med Care, 30*, 473-483.

Ware, J. E., Snow, K. K., Kosinski, M., & Gandek, B. (1997). *SF-36 Health Survey Manual and Interpretation Guide*. Boston, MA: Nimrod Press.

Waterer, G. W., Wan, J. Y., Kritchevsky, S. B., Wunderink, R. G., Satterfield, S., Bauer, D. C., et al. (2001). Airflow limitation is under recognized in well-functioning older people. *Journal of the American Geriatrics Society, 49*, 1032-1038.

Watson, P. B., Town, G. I., Holbrook, N., Dwan, C., Toop, L. J., & Drennan, C. J. (1997). Evaluation of a self-management plan for chronic obstructive pulmonary disease. *European Respiratory Journal, 10*, 1267-1271.

Weaver, T. E., Richmond, T. S., & Narsavage, G. L. (1997). An explanatory model of functional status in chronic obstructive pulmonary disease. *Nursing Research, 46*(1), 26-31.

West, J. (1987). Obstructive diseases. In J. West (Ed.), *Pulmonary Pathophysiology* (pp. 59-91). Baltimore: Willimas & Wilkins.

WHO. (2007). *World Health organization: Chronic respiratory diseases: Burden*. Retrieved April 27, 2007, 2007, from http://www.who.int/respiratory/copd/burden/en/index.html

Wigal, J., Creer, T., & Kotses, H. (1991). The COPD self-efficacy scale. *Chest, 99*, 1193-1196.

Wilson, R., & Jones, P. W. (1989). A comparison of the visual analog scale and the modified Borg scale for the measurement of dyspnoea during exercise. *Clinical Science, 76*, 277-282.

Wilson, R., & Jones, P. W. (1990). Influence of prior ventilatory experience on the estimation of breathlessness during exercise. *Clinical Science, 78*, 149-153.

Wilson, R., & Jones, P. W. (1991). Long-term reproducibility of Borg scale estimates of breathlessness during exercise. *Clinical Science, 80*, 309-312.

Zautra, A. J., Reich, J. W., & Newson, J. T. (1995). Autonomy and sense of control among older adults: An examination of their effects on mental health. In L. Bond, S. Culter & A. Grams (Eds.), *Promoting successful and productive aging*. Newbury Park, Calif.: Sage Publications.

Zeleznik, J. (2003). Normative aging of the respiratory system. *Clinics in Geriatric Medicine, 19*, 1-18.

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatric Scandinavia, 67*, 361-370.

Zimmerman, B. W., Brown, S. T., & Bowman, J. M. (1996). A self-management program for chronic obstructive pulmonary disease: relationship to dyspnea and self-efficacy. *Rehabilitation Nursing, 21*(5), 253-257.

Zung, W. W. K. (1974). The measurement of affect: depression and anxiety. In P. Pichot (Ed.), *Psychological measurements in psychopharmacology, modern problems of pharmacopsychiatry* (Vol. 7). Paris: S. Karger.

Zuwallack, R. (2005). The effect of pulmonary rehabilitation on dyspnea. In D. A. Mahler & D. E. O' Donnell (Eds.), *Dyspnea: Mechanisms, Measurement and Management*. Boca Raton, Florida: Taylor & Francis Group.

APPENDICES

Table 1: Overview of COPD Self-Management Studies

Study & Design	Sample	Intervention	Primary outcome (s)	Outcome measures	Major findings
(Howland et al., 1986) Controlled, pre-test-post test cohort study 12 month study	N= 538 Intervention group n= 213 Control group n = 325 Separated by disease severity Mean age 56 in "mild group;" 66 in "severe group"	•Health education program •Educational program content tailored to disease severity •Severe group attended 6-two hour sessions •Mild group attended 3-two hour sessions •No exercise component	Health Perceptions, symptom status, mental health, physical function, social function	•ATS Respiratory Health Questionnaire(ATS, 1978) •Sickness Impact Profile (Bergner, Bobbitt, Carter, & Gilson, 1981) •Zung depression scale (Zung, 1974) •Health Locus of Control Scale (Wallston & Kaplan, 1976) •Self-designed questionnaire to assess impact of program	Only difference in scores post intervention were in health perceptions and locus of control Strength: separate content based on disease severity Dyspnea not measured
(Littlejohns et al., 1991) Randomized-controlled trial 12 month study	N = 152 Age range 30-75	•Test effect of respiratory health worker home visits, care liaison •Frequency of visits not specified •No exercise component	Spirometry Degree of respiratory impairment and disability	•Spirometry •MRC Dyspnea Scale (Fletcher et al., 1959) •6MW (ATS, 2002) •SIP •Hospital Anxiety and Depression (Zigmond & Snaith, 1983) •Diaries	No differences on any major outcome measures Reported increased mortality risk in control group Mean change in SIP physical subscale score greater in intervention group More frequent use of

Study & Design	Sample	Intervention	Primary outcome (s)	Outcome measures	Major findings
					bronchodila-tors & antibiotics in intervention group
(Sassi-Dambron et al., 1995) Randomized controlled trial Six month study period	N= 89 Mean age: 67 years	•"Limited" home rehab program •Six weekly educational sessions, specifically target dyspnea-self - management •No exercise component	Evaluate effect of a dyspnea management intervention: clinical dyspnea ratings, HRQoL, anxiety, depression	•Baseline Dyspnea Index/Transitional Dyspnea Index (D. A. Mahler, Weinberg, Wells, & Feinstein, 1984) •ATS Dyspnea Scale •Oxygen Cost Diagram (McGavin, Artvinli, & Naoe, 1987) •Modified Shortness of Breath Questionnaire (SOBQ)(Archibald & Guidotti, 1987) •Visual Analog Scale (VAS) (Aitken, 1969) •Borg CR scale for dyspnea (Borg, 1982) •6MW •Quality of well-being scale (QWB) (Kaplan & Anderson, 1988) •Speilberger State-Trait Anxiety Inventory (SSTI) (Speilberger, Gorusch, Lushene, & Jacobs, 1984) •Center for Epidemiological Study Depression Scale (CES-D)(Radloff, 1977) •Spirometry	Only significant change on TDI for intervention group change @ 6 mos. Strength: Self-reported and performance-based measures of physical functioning

Study & Design	Sample	Intervention	Primary outcome (s)	Outcome measures	Major findings
(Zimmerman et al., 1996) Quasi-experimental design Six week study period	N=10 Mean age 67.3 years, 70% female Included both COPD and asthma	•Six week educational program •No exercise component	Self-efficacy and dyspnea	•COPD Self-Efficacy Scale (Wigal et al., 1991) •Vertical VAS for dyspnea(Gift, 1989)	•Significant improvement in CSES score only •Very small sample •No control group
(Watson et al., 1997) Randomized, controlled trial Six month study period	N = 54 Mean age 68 Intervention group n = 29; control group n = 27 N = 64	•Written self-management plan •Two individual instruction sessions only •No exercise component	Effect of a written self treatment plan for COPD patients	•Spirometry •St. George Respiratory Questionnaire (SGRQ) (P. W. Jones, Quirk, & Baveystock, 1991)	•No change in spirometry or SGRQ Improved "self-management behaviors"
(Gallefoss et al., 1999) Randomized, controlled trial 12 month study period	Mean age intervention group 57 ± 10 ; 58 ± 10 in control group Included both COPD and asthma	•Self-management educational program and a treatment plan •Four educational sessions •No exercise component	Effect of self-management education and treatment plan on HRQoL	•SGRQ •Spirometry	No improvements on outcome measures in COPD participant group Weakness: No clinical dyspnea measure
(Gallefoss & Bakke, 1999) Same as above	Same as above	•Same as above	Effect of self-management program on inhaled medication use	•Measure of inhaled medication use/adherence	COPD group did not demonstrate any change in inhaled medication use after educational intervention

Study & Design	Sample	Intervention	Primary outcome (s)	Outcome measures	Major findings
(Monninkhof et al., 2003) Longitudinal, randomized controlled trial 12 month study period	N = 248 Mean age 65 ± 7 years	• Comprehensive self-management program for COPD patients • Included both educational and exercise components • Educational session at beginning of study and at intervals later in study period	Disease specific quality of life; walking performance	• SGRQ • 6MW	No differences on outcome measures between groups at 6 and 12 months Weakness: no clinical dyspnea measure
(Bourbeau et al., 2003) Randomized, controlled trial 12 month study period	N = 79 Intervention group n = 86; mean age 69.4 ± 6.5 years Control group n = 79; mean age 69.9 ± 7.4 years	• Self-management educational program; included an individualized action plan • Educational sessions: one hour (in home) over 7-8 weeks • Exercise component optional *(if willing, introduced at week 7)*	Utilization of hospital services	• Hospitalizations, ED visits, planned and unplanned medical office visits • Exacerbations • Medication profiles • Spirometry • SGRQ • 6MWD • Clinical dyspnea measurement after exercise	Reduced number of hospital days, ED visits, and unscheduled visits to family physician in intervention group only Health-related quality of life measures did not sustain improvement over course of study No clinical dyspnea ratings
(Monninkhof et al., 2004) Same as Monninkhof et al. 2003	Same as Monninkhof et al. 2003	• Same as Monninkhof et al. 2003	Adjusted quality of life years	• Quality of adjusted life years (QALYs) • Costs	Self-management program twice as expensive as usual care

Study & Design	Sample	Intervention	Primary outcome (s)	Outcome measures	Major findings
(Carrieri-Kohlman et al., 2005) (Stulbarg et al., 2002) Longitudinal, randomized controlled trial 12 month study period	N =103 Mean age 66 ± 8; 55% female	•Dyspnea self-management education combined with varying exercise regimens; one group had education and home walking only; one group had education, home walking and 4 supervised laboratory exercise sessions; one groups had education, home walking and 24 supervised laboratory exercise sessions group had same as and •Included laboratory exercise in two of three groups and home walking for all participants exercise •Individualized educational sessions delivered in 4 one-hour sessions over first 8 weeks of study	Evaluate effect of three different versions of a dyspnea self-management program	•PFTs •Incremental Treadmill Tests (ITTs) •Endurance Treadmill Tests (ETTs) •6MWD •Borg CR dyspnea ratings •Chronic Respiratory Questionnaire (CRQ) (Guyatt et al., 1987) •BDI/TDI •SOBQ	24 supervised exercise session group had greatest improvements and ITT duration. Dyspnea with ADLs and self-reported physical functioning improved for all groups over time Early (2 months) improvement in dyspnea with exercise, but not sustained over course of study

Study & Design	Sample	Intervention	Primary outcome (s)	Outcome measures	Major findings
(Gadoury et al., 2005) Randomized controlled trial	Same as Bourbeau et al 2003	• Same as Bourbeau et al 2003	All cause hospitalizations	Hospitalization and ED visit frequency	Statistically significant reduced rate of hospitalization and ED visits in group that received self-management educational intervention

Table 2: Age-related & COPD-related Changes in the Lung

Component	Physiological correlates of dyspnea in bold Age-related change	COPD-related change
Chest wall	•**Increased anterior-posterior diameter** (due to age-related changes in bony thorax) (Anderson, Anderson, Hernandez, & Foraker, 1964; Janssens, 1999; Thurlbeck, 1991)	•**Increased anterior-posterior diameter** (due to chronic hyperinflation) (ATS, 1995)
	•**Increased elastic work of breathing** (Janssens, 1999; Klocke, 1977)	•**Increased elastic work of breathing** (Mahler, 1993)
Chest wall compliance	•**Decreased compliance** (Janssens, 1999; Krumpe, 1985; Mahler, Rosiello, & Loke, 1986; Murray, 1986)	•**Decreased compliance** (ATS, 1995)
Muscles of respiration	•**Atrophy of intercostal muscles** (Mizuno, 1991)	•**Diaphragm displaced downward** (due to hyperinflation) (Mahler, 1993)
	•**Decreased strength of diaphragm** (Tolep & Kelsen, 1991)	•**Vertical diaphragm muscles are shortened resulting in a mechanical disadvantage** (Mahler, 1993)
	•**Decreased maximal inspiratory pressure and maximal voluntary ventilation** (Hagberg, Yerg, & Seals, 1988; McElvaney et al., 1989)	•**Decreased maximal voluntary ventilation** (Gold, 2005)
Airways	•Large airways increase slightly in size (Wahba, 1983)	•Metaplasia of bronchial squamous cells (chronic bronchitis) (ATS, 1995; Mahler, 1993)
	•Membranous bronchioles decrease in size (Niewoehner & Kleinerman, 1974)	•Submucosal bronchial mucous glands increase (chronic bronchitis) (Mahler, 1993)
	•Enlargement of alveolar ducts (Murray, 1986)	•Goblet cells in small airways increase in number (chronic bronchitis) (ATS, 1995)
	•**Gradual decline in expiratory airflow rates**	•Bronchial smooth muscle

Component	Age-related change	COPD-related change
Airways	(Crapo et al., 1981; Gibson, Pride, O'Cain, & Quagliato, 1976; Knudson, Lebowitz, Holberg, & Burrows, 1983)	hypertrophy and constriction (chronic bronchitis) (Shapiro, Snider, & Rennard, 2005) • Alterations in connective tissue (Barnes, 2000; Celli & MacNee, 2004) • Inflammation of airways (NHLBI/WHO, 2001) • **Gradual decline in expiratory airflow rates** (ATS, 1995; NHLBI/WHO, 2001)
Airspaces	• Alveolar size and volume decreases (Klocke, 1977; Thurlbeck, 1967) • Number of alveolar septa decreases (Brody & Thurlbeck, 1986; Macklin, 1936; Nagai, Yamawaki, Takizawa, & Thurlbeck, 1991; Pump, 1976) • Number or size of pores of Kohn increases (Brody & Thurlbeck, 1986; Macklin, 1936; Nagai et al., 1991; Pump, 1976) • Distance between alveoli increases (Hasleton, 1972; Thurlbeck, 1967) • **Increased collapsibility of small airways** (Lee, Chung, Yang, Lee, Ko & Park, 2000)	• Loss of functional alveoli (emphysema) (West, 1987) • Loss of effective alveolar-pulmonary capillary membrane surface area (emphysema) (West, 1987)

Component	Age-related change	COPD-related change
Lung parenchyma	Loss of elastic recoil (Janssens, 1999; Turner, Mead, & Wohl, 1968) •30% reduction in lung tissue (between ages 20-80) (Thurlbeck, 1991) •**Loss of tethering of small airways** (Janssens, 1999) •Decreases elastin in airways and pulmonary vessels & increased elastin in pleura and alveolar septa (Andreotti, Bussotti, Cammelli, Aiello, & Sampognaro, 1983; Brody & Thurlbeck, 1986; John & Thomas, 1972; Klocke, 1977; Pack & Millman, 1988; Thurlbeck, 1991)	•**Loss of tethering of small airways** (emphysema) (Nagai et al., 1991; West, 1987) •Imbalance of lung proteases and elastases (Shapiro et al., 2005)
Lung compliance	•**Increased compliance (decreased elastic recoil)** (Janssens, 1999; Turner et al., 1968)	•**Increased compliance (decreased elastic recoil)** (Nagai et al., 1991; West, 1987)
Lung volumes and flows	•**Increased functional residual capacity** (FRC) (Anthonisen, 1986; Crapo, Morris, & Gardner, 1982; Knudson, 1991; Levitsky, 1984; Turner et al., 1968) •Tidal breathing initiated at higher lung volumes (Janssens, 1999) •Increased residual volume (RV); increases by 50% between ages 20 and 70 years (Crapo, 1993; Knudson, 1991) •RV/Total lung capacity (TLC) ratio increases (Crapo, 1993) •Vital capacity (VC) decreases by 75%	•Increased TLC (Mahler, 1993) •Increased RV (West, 1987) •**Decreased FEV-1**, FVC and FEV-1/FVC ratio, forced expiratory volume 25-75 ($FEF_{25-75\%}$) (ATS, 1995; West, 1987) •**Increased closing volume** (West, 1987)

Component	Age-related change	COPD-related change
Lung volumes and flows	(Janssens, 1999; Murray, 1986) • **Forced expiratory volume, one second (FEV-1) decreases by 30%** (evidence of airway obstruction); begins at about age 20; increases around age 36 (Crapo et al., 1981; Gibson et al., 1976; Knudson et al., 1983; Milne & Williamson, 1972) • Decreased flow rates at lower lung volumes (Johnson, Reddan, Pegelow, Seow, & Dempsey, 1991; Knudson, 1991) • Peak expiratory flow rate (PEFR) declines (Nunn & Gregg, 1989) • **Increased closing volume** (Anthonisen, Danson, Robertson, & al., 1970; Dollfuss, Milic-Emili, & Bates, 1967; Holland, Milic-Emili, Macklem, & Bates, 1968)	
Airway resistance	• Probably does not change (Anthonisen, 1986; Briscoe & DuBois, 1958; Mauderly, 1979)	• **Increased** (ATS, 1995)
Gas exchange and blood gases	• **Increase in V_A/Q mismatch** (Begin, Renzetti, Bigler, & Watanabe, 1975; Chan & Welsh, 1998; Roberts, MacRae, Winning, Adams, & Seed, 1991) • **Diffusing capacity decreases** (Chan & Welsh, 1998) • **PaO_2 gradually declines** (Mellemgaard, 1966; Murray, 1986; Raine & Bishop, 1963; Sorbini, Grassi, Solinas, & Muiesan, 1968) • Decreased ventilatory responsiveness to hypercapnia	• **Increase in V_A/Q mismatch** (Mahler, 1993) • **Diffusing capacity decreases** (Gold, 2005) • **Hypoxemia due to increased V_A/Q mismatch** (Mahler, 1993) • Increase in alveolar-arterial PaO_2 difference (Mahler, 1993) • **Moderate-severe cases, hypercapnia occurs** (Mahler, 1993)

Component	Age-related change	COPD-related change
Gas exchange and blood gases	and hypoxia (Brischetto, Millman, Peterson, Silage, & Pack, 1984; Kronenberg & Drage, 1973; McConnell & Davies, 1992; Peterson et al., 1981)	
	• **Increased dyspnea intensity in hypercapnic states** (Akiyama et al., 1993)	
Responsiveness	• Decreased responsiveness to increase chest elastic and expiratory pressure loads (Tack et al., 1982; Tack et al., 1981; Tack, Altose, & Cherniack, 1983)	
	• Decreased responsiveness to methacholine bronchial provocation (Janssens, 1999; Newham & Hamilton, 1997)	
Immune function	• Increased neutrophil activity, chemotaxis and respiratory burst (Miller, 1996)	• Increased number of macrophages and neutrophils in bronchoalveloar lavage fluid (Barnes, 2000; Kim et al., 2002; Mahler, Huang, Tabrizi, & Bell, 2004)
	• Increased neutrophils in sputum (Thomas et al., 2004)	
	• Decreased macrophages(Thomas et al., 2004)	• Inflammatory mediators found in the lung: leukotriene B_4, cytokines tumor necrosis factor-alpha and interleukin-8 (Barnes, 2000; Kim et al., 2002; Mahler et al., 2004)

Table 3: Outcome Measurement Schedule

	Baseline Testing	2 Months	4 Months	6 Months	8 Months	10 Months	12 Months
Demographic Questionnaire	**X**						
Borg Scale		**X**	**X**	**X**	**X**	**X**	**X**
Dyspnea	**X**						
CES-D	**X**						
CRQ-D	**X**	**X**	**X**		**X**		**X**
ETT	**X**	**X**		**X**			**X**
ITT	**X (2)**	**X**		**X**			**X**
Spirometry	**X**						
MOS SF-36	**X**	**X**	**X**		**X**		**X**
Self-Efficacy for Home Walking	**X**	**X**	**X**		**X**		**X**
Self-Efficacy for Managing SOB	**X**	**X**	**X**		**X**		**X**
Six Minute Walk	**X (up to 3)**	**X**	**X**		**X**		**X**

CES-D: Center for Epidemiological Studies Depression Scale
CRQ-D: Chronic Dyspnea Questionnaire- Dyspnea Subscale
MOS SF-36: Medical Outcomes Study Short Form-36
ITT: Incremental Treadmill Exercise Test
ETT: Endurance Treadmill Exercise Test

Box 1: Plan for Mixed Models Regression Analyses

Model	Effects
1	Age, Visit, TxGroup, Age x Visit, Age x TxGroup, Visit x TxGroup, Age x Visit x TxGroup
2	Age, Visit, TxGroup, Age x Visit, Age x TxGroup, Visit x TxGroup
3	Age, Visit, TxGroup, Age x Visit, Age x TxGroup
4	Age, Visit, Age x Visit for Education
5	Age, Visit, Age x Visit for Exposure
6	Age, Visit, Age x Visit for Training

The strategy was as follows:
Fit Model 1, then

a) If Age x Visit x TxGroup significant ($P < 0.07$ or so), fit models 4,5,6.
b) If Age x Visit x TxGroup not significant, fit Model 2.
c) If Model 2 Visit x TxGroup is significant, fit models 4,5,6.

These models were all fit with maximum likelihood and an unrestricted correlation pattern.

TxGroup= Treatment Group (either DM, DM-Exposure or DM-Training)

Table 4: Baseline Demographic Characteristics by Treatment Group

	DM (n= 36)	DM-Exposure (n = 33)	DM-Training (n = 34)
Gender: m/f	20/16	14/19	12/22
Age in years	65.7 ± 8.8	67.2 ± 7.6	66.2 ± 6.4
Height, cm	169.1 ± 8.2	165.4 ± 7.81	65.4 ± 9.3
Weight, kg	72.7 ± 15.2	73.2 ± 15.2	70.6 ± 15.8
Current or past smoker	33	31	33
Pulmonary Function Indices			
FEV-1 L:	1.06 ± 0.4	1.16 ± 0.3	1.03 ± 0.3
(% pred)	(42.5 ± 18.4)	(48.5 ± 12.6)	(43.7 ± 9.9)
FEV-1/FVC %	36.9 ± 13.8	43.6 ± 8.7	43.6 ± 11.2
RV/TLC, %	54.2 ± 9.7	53.3 ± 10.1	55.4 ± 10.6
D_LCO ml/min	12.8 ± 4.5	13.2 ± 4.8	12.0 ± 4.0
(% pred)	(62.3 ± 21.7)	(68.2 ± 21.7)	(64.4 ± 17.6)
MVV, L/min	43.5 ± 15.5	48.2 ± 13.4	42.9 ± 14.6
(% pred)	(38.6 ± 15.9)	(46.5 ± 15.3)	(41.0 ± 11.8)
PaO2, mm Hg (n = 99)*	76.2 ± 8.8	76.5 ± 11.0	73.8 ± 8.1
PaCO2, mm Hg (n = 99)*	40.0 ± 5.1	39.7 ± 4.1	38.4 ± 5.0
Exercise Testing			
Dyspnea end exercise			
Incremental Test End SOB	5.0 ± 1.9	5.3 ± 2.5	5.0 ± 1.8
Endurance Test End SOB	5.7 ± 2.1	5.0 ± 2.5	4.7 ± 1.9

DM: Dyspnea self-management; DM-exposure: DM plus exposure; DM-training: DM plus training
FEV-1 : Forced expiratory volume, one second; FVC: Forced vital capacity; RV: Residual Volume; TLC: Total lung capacity; D_LCO : diffusion capacity of carbon monoxide; MVV: maximum voluntary ventilation
SOB: shortness of breath
Dyspnea end exercise: dyspnea intensity reported by examinee at end of exercise session
Using modified Borg CR scale

All values reported are in mean (standard deviation); all baseline characteristics are non- significant ($p > .05$)
* Arterial blood gases drawn at rest and breathing room air

(Stulbarg et al., 2002)

Table 5: Recent Dyspnea Ratings
Regression Equation Estimates by Treatment Group over Time

Treatment Group	**Time**	**Regression estimate (possible range 1-5)**	**SE**	**95% Confidence Interval**
DM	**Baseline**	4.4167	.1341	4.1507- 4.6827
	2 months	3.9488‡	.1288	3.6932– 4.2044
	4 months	3.7440	.1620	3.4227– 4.0654
	8 months	3.8379	.1508	3.5387– 4.1371
	12 months	3.9742*	.1402	3.6960- 4.2524
DM-Exposure	**Baseline**	3.7879†	.1400	3.5101- 4.0657
	2 months	3.4719	.1350	3.2041- 3.7396
	4 months	3.4981	.1714	3.1580- 3.8382
	8 months	3.4556	.1682	3.1218- 3.7893
	12 months	3.4381*	.1515	3.1376- 3.7387
DM-Training	**Baseline**	4.4412	.1380	4.1675- 4.7149
	2 months	3.6471‡	.1314	3.3863- 3.9078
	4 months	3.7318	.1656	3.4033- 4.602
	8 months	4.1234	.1522	3.8215- 4.4253
	12 months	4.1360*	.1470	3.8442- 4.4277

†DM-Exposure baseline ratings significantly lower than baseline ratings for DM or DM-Training groups

‡ Baseline to 2 months ratings are significantly different $p < .001$

* $p < .05$ comparing baseline value to 12 month value

Table 6: Recent Dyspnea Impact on Activities of Daily Living
Regression Equation Estimates by Treatment Group over Time

Treatment Group	Time	Regression estimate (possible range 1-5)	SE	95% Confidence Interval
DM	**Baseline**	3.1775	.1791	2.8222- 3.5328
	2 months	2.7329	.1522	2.4310- 3.0348
	4 months	2.7431	.1561	2.4334- 3.0528
	8 months	2.6661	.1575	2.3537- 2.9785
	12 months	2.6856*	.1752	2.3379- 3.0332
DM-Exposure	**Baseline**	2.5608	.1872	2.1894- 2.9322
	2 months	2.2254	.1594	1.9092- 2.5416
	4 months	2.2923	.1657	1.9636- 2.6210
	8 months	2.2154	.1750	1.8683- 2.5625
	12 months	2.5781	.1893	2.2026- 2.9536
DM-Training	**Baseline**	3.1765	.1828	2.8137- 3.5392
	2 months	2.5294	.1554	2.2211- 2.8377
	4 months	2.5701	.1592	2.2543- 2.8860
	8 months	2.8513	.1592	2.5356- 3.1671
	12 months	2.777*	.1837	2.4131- 3.1422

Baseline values not significantly different from each other.
* $p < .05$ comparing baseline value to 12 month value

Table 7: Linear Regression Model for Baseline Self-Efficacy for Home Walking

Model $R^2 = .4558$

Variable	Regression estimate	SE	t value	P value	Squared semi partial correlation type II
Intercept	8.65424	2.4039	3.61	.0005	
Baseline FEV-1% predicted	.05891	.01813	3.25	.0017	.06762
Female	.01487	.49403	.03	.9761	.00000
Age	-.06186	.03061	-2.02	.04645	.02614
White (ethnicity)	1.45508	.62529	2.33	.0233	.03467
Educational level (highest achieved)	.08614	.17166	.50	.6171	.00161
Married	.97743	.52187	1.87	.0645	.02246
Annual income	-.39497	.14874	-2.66	.0095	.04515
Regular walking program	2.45226	.52614	4.66	< .0001	.13908
Previous pulmonary rehabilitation	.98717	.57350	1.72	.0888	.01897
Baseline CRQ-dyspnea subscale score	.05551	.04836	1.15	.2543	.00843
Baseline CRQ Mastery subscale score	-.02251	.05106	-.44	.6604	.00124
Baseline CESD score	-.04026	.02590	-1.55	.1237	.01547
Dyspnea intensity after baseline	-.31705	.09885	-3.21	.0019	.06586

CRQ: Chronic Dyspnea Questionnaire; CESD: Center for Epidemiological Studies-Depression Scale

Table 8: Linear Regression Model for Baseline Self-Efficacy for Managing Shortness of Breath (SEMSOB) Scale

Model $R^2 = .3426$ ($F = 3.45$, $p < .0003$)

Variable	Regression estimate	SE	t value	P value	Squared semi partial correlation type II
Intercept	3.5345	2.73666	1.29	.2000	
Baseline FEV-1% predicted	-.01472	.02055	-.72	.4757	.00392
Female	-.31269	.55899	-.56	.5774	.00239
Age	-.00025528	.03471	-.01	.9941	4.135973 E-7
White (ethnicity)	-.50038	.71033	-.70	.4831	.00379
Educational level (highest achieved)	-.09125	.19531	-.47	.6415	.00167
Married	-.51315	.58980	-.87	.3867	.00579
Annual income	-.03813	.16927	.-23	.8223	.00038789
Regular walking program	.53529	.59551	.90	.3712	.00618
Previous pulmonary rehabilitation	.72315	.65048	1.11	.2694	.00945
Baseline CRQ-dyspnea subscale score	.08304	.05505	1.51	.1351	.01739
Baseline CRQ Mastery subscale score	.19213	.05805	3.31	.0014	.08374
Baseline CESD score	-.05499	.02949	-1.86	.0656	.02658
Dyspnea intensity after baseline	-.12017	.11229	-1.07	.2875	.00876

CRQ: Chronic Dyspnea Questionnaire; CESD: Center for Epidemiological Studies-Depression Scale

Table 9: Dependent variable: Self-efficacy for Home Walking
(F = 8.08, Type 3 p = < .0001)
Least squares mean regression coefficient values

	Estimate	**Standard Error**	**95% Confidence Interval**
DM: Baseline	7.1111	.4219	6.2740-7.9482
2 months	7.8667	.3609	7.1506-8.5828
4 months	7.7983	.4006	7.0036- 8.5931
8 months	7.4646	.4163	6.6387-8.2905
12 months	7.4349	.4081	6.6252-8.2445
DM-Exposure: Baseline	7.2149	.4435	6.3350-8.0947
2 months	8.0398	.3782	7.2893-8.7902
4 months	8.1489	.4217	7.3122-8.9855
8 months	7.7327	.4496	6.8408-8.6247
12 months	7.8311	.4349	6.9682-8.6939
DM-Training: Baseline	6.9441	.4342	6.0827-7.8055
2 months	7.9559	.37	7.2218-8.69
4 months	7.4581	.4109	6.6428-8.2733
8 months	7.0937	.4256	6.2494-7.9381
12 months	7.3374	.4240	6.4962-8.1785

No significant differences in scores between groups

Table 10: Dependent variable: Self-efficacy for Managing Shortness of Breath
(F = 7.12, Type 3 p = < .0001)
Least squares mean regression coefficient values

	Estimate	**Standard Error**	**95% Confidence Interval**
DM: Baseline	4.3899	.4213	3.5530-5.2248
2 months	5.7361	.3884	4.9696-6.5066
4 months	5.7023	.3656	4.9770-6.4275
8 months	5.6434	.4130	4.8241-6.4627
12 months	6.3773	.3864	5.6108-7.1439
DM-Exposure: Baseline	5.6970	.4401	4.8239-6.5701
2 months	6.4568	.407	5.6464-7.2643
4 months	6.6449	.3874	5.8762-7.4135
8 months	6.6205	.4534	5.7210-7.5200
12 months	6.4049	.4180	5.5757-7.2341
DM-Training: Baseline	6.0882	.4336	5.2281-6.9484
2 months	7.000	.3970	6.2124-7.7876
4 months	7.1390	.3733	6.3984-7.8796
8 months	6.575	.4202	5.7139-7.3811
12 months	6.2435	.4054	5.4393-7.0478

No significant differences in scores between groups

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