HEALTH LITERACY AND HEALTH NUMERACY'S EFFECTS ON INHALER TECHNIQUE AND PHYSICAL OUTCOMES IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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by

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Health Literacy and Health Numeracy's Effects on Inhaler Technique and Physical Outcomes in Patients with Chronic Obstructive Pulmonary Disease

Introduction

Chronic obstructive pulmonary disease (CODP) is the 3rd leading cause of death in the United States and the 5th leading cause worldwide (Centers for Disease Control and Prevention, 2012). Predictions indicate COPD will move to the 3rd leading cause of death worldwide by 2030 (Centers for Disease Control and Prevention, 2012; World Health Organization, 2008). In the United States alone, it is estimated that 24 million people have COPD, with 12 million of these individuals being formally diagnosed (National Heart Lung and Blood Institute, 2009). Additionally, it is estimated that those individuals with COPD cost the U.S. $49.9 billion dollars, $29.5 billion of that in direct health care costs alone making this disease a burden for not only those who suffer with it, but the healthcare system as well (National Heart Lung and Blood Institute, 2009). The current lifetime risk for developing COPD is 25% and with an ageing population it is certain that COPD will have an increasingly large impact on the healthcare system for years to come (Centers for Disease Control and Prevention, 2012).

Chronic obstructive pulmonary disease is often thought of as a preventable disease resulting from cigarette smoke; although, several other causes have been identified such as genetic syndromes like α1-antitrypsin deficiency and exposure to environmental pollutants (Eisner et al., 2010). Chronic obstructive pulmonary disease is a progressive respiratory disease that is characterized by breathlessness due to obstruction and a host of accompanying symptoms, such as weight loss and systemic inflammation (Decramer, De Benedetto, Del Ponte, & Marinari, 2005). Those suffering with the disease are left with coughing, phlegm, shortness of breath and exacerbations that lead to a decreased quality of life (Efraimsson, Hillervik, & Ehrenberg, 2008). Treatments that successfully slow disease progression are minimal and mainly consist of smoking cessation, if applicable (Anthonisen et al., 1994).

Because so few treatment options are available to slow disease progression, treatment primarily focuses on daily maintenance of symptoms at home. Most regimens consist of home oxygen use and multiple, complex inhaler-delivered prescription drugs that patients are typically left to self-administer (Anthonisen et al., 1994). The complex nature of the daily maintenance treatment often involves pharmacological interventions, such as inhaled bronchodilators and corticosteroids, as well as non-pharmacological interventions such as long-term oxygen therapy and pulmonary rehabilitation (Hanania et al., 2005). More specifically, when patients' medical regimens were explored, it was found that patients with COPD averaged 6.26 medications that all required different timing, administration routes, or dosing techniques (Dolce et al., 1991). Research with patients has found that managing treatment and medications at home is prevalent, complex, and confusing for patients, especially those with multiple inhalers (Coleman, Smith, Raha, & Min, 2005; van der Palen, Klein, van Herwaarden, Zielhuis, & Seydel, 1999).

Exacerbations, intense increases in COPD symptoms, are another common patient experience. Research has found that an increased number of exacerbations is related to the rate of disease progression, making it extremely important that patients accurately manage their medications at home in order to control these flare ups (Donaldson, Seemungal, Bhowmik, & Wedzicha, 2002). Because of this, having an action plan for when exacerbations do occur, including patients being able to recognize symptoms of exacerbations, is vital to patient self-management (Potter & Wilkinson, 2011). Unfortunately, appropriate understanding of exacerbations and knowledge of how they impact the disease is often lacking in patients (Kessler et al., 2006). Kessler et al. discovered that three fifths of their respondents had never heard the term ‘exacerbation’ or were unable to define it (2006). They also reported that just over half (64%) of their respondents reported being aware when an exacerbation was imminent and only 18% reported contacting their physician during these times (Kessler et al., 2006).

Because patient self-management of the disease is so important in COPD, it is vital that patients understand how to properly adhere to their regimens and why it is important for them to do so. Unfortunately, decreased arterial oxygen is a result of COPD’s cardinal symptom, restricted airflow. This decrease reduces oxygen flow to the brain, ultimately resulting in ischemia and cognitive impairments (Ortapamuk & Naldoken, 2006). Multiple cognitive domains have been found to be impacted by COPD and include verbal memory, delayed recall, executive functioning, attention, alertness and orientation, and learning and logical thinking (Corsonello, Pedone, & Antonelli Incalzi, 2007; Klein, Gauggel, Sachs, & Pohl, 2010; Ortapamuk & Naldoken, 2006).

Not surprisingly, with the combination of cognitive decline and complex treatment regimens in COPD, patients have poor adherence to their medications with one investigation reporting that only 28% of patients reached satisfactory levels of medication refill adherence (Krigsman, Moen, Nilsson, & Ring, 2007). In a separate investigation it was revealed that over 50% of patients were underutilizing their medications while nearly 50% were over-utilizing their medications with the authors concluding that the complex nature of medication routines make it difficult for patients to understand appropriate dosing directions (Dolce et al., 1991). In addition to having difficulties with proper refill adherence and dosing instructions, many patients with

COPD fail to use their metered-dose inhalers (MDI's) appropriately (Melani et al., 2004; Rand, 2005). Metered-dose inhaler technique is important in COPD as poor or inaccurate technique significantly decreases the effectiveness of these medications (Lahdensuo & Muittari, 1986). Despite these consequences, only 21% of patients in Shrestha et al.'s investigation completed all 7 steps for their MDI's correctly (1996). Similar rates were found in a more recent investigation of MDI technique, with over 80% of patients with COPD using their MDI incorrectly (Press et al., 2011). A 2012 investigation reported that, on average, 26% of the steps were performed improperly with 59% of participants making "critical errors" (Batterink, Dahri, Aulakh, & Rempel, 2012). This improper use of inhalers has been found to be associated with frequent emergency room utilization, infrequent routine follow-up appointments, and poorly controlled disease (AL-Jahdali et al., 2013).

Overall, COPD is a progressive disease that requires patients to engage in complex home-management routines in order to maintain their functioning. Patients also have to understand when they are having an exacerbation and how to appropriately manage the flare up (Dolce et al., 1991; Kessler et al., 2006). Unfortunately, adherence to these medication regimens is often poor and even positive effects of appropriate adherence can be thwarted by improper MDI technique (Krigsman et al., 2007; Lahdensuo & Muittari, 1986). Researchers have identified several important factors that may negatively impact a patient's ability to effectively manage their COPD and adhere to their treatments, including cognitive impairment, depression, and anxiety (Corsonello et al., 2007; Fan, Giardino, Blough, Kaplan, & Ramsey, 2008). The literature indicates that additional factors, including health literacy, disease knowledge, and health numeracy, may also impact disease management; however, little research has focused on these concepts in patients with COPD (Roberts, Ghiassi, & Partridge, 2008).

Health Literacy

Health literacy is a concept meant to describe the skills required by patients to successfully navigate the healthcare system (Parker et al., 1999). The Institute of Medicine defines health literacy as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" (Nielsen-Bohlman, Panzer, & Kindig, 2004; p. 32). Additionally, through the efforts of the Ad Hoc Committee on Health Literacy, the American Medical Association has defined health literacy as "…a constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the health care environment" (Parker et al., 1999; p. 552).

Rates of health literacy. According to the Institute of Medicine, an estimated 90 million Americans have low literacy skills, often thought of as a prerequisite of health literacy (Nielsen-Bohlman et al., 2004). When looking specifically at rates of health literacy in the United States, the National Assessment of Adult Literacy report revealed that 36% of American adults have basic or below basic health literacy levels with the majority falling in the intermediate range. Only 12% were classified in the proficient range (Kutner, Greenberg, Jin, & Paulsen, 2006). This particular assessment used 28 tasks from the National Assessment of Adult Literacy that focused on three health domains of clinical, prevention, and navigating the health care system. These tasks focused on realistic health care topics such as insurance information, medication directions, and preventative information (Kutner et al., 2006). Prior to this nation-wide assessment, Williams et al. had found similar rates of low health literacy in patients at two large, public hospitals using a popular health literacy measure, the Test of Functional Health Literacy-Adult (1995). At that time, they reported levels of low health literacy ranging from 22% to 61.7% (Williams et al., 1995). Recently, Herndon, Chaney, and Carden reviewed all studies assessing health literacy levels in emergency room patients (2011). Out of the studies they reviewed, low levels of health literacy ranged from 10.5% to 48%, with an overall average of 40% of adult patients reading at or below 8th grade health literacy levels (Herndon et al., 2011). Similar rates of low health literacy were found in Lee, Gazmararian, and Arozullah's 2006 investigation of health literacy rates in Medicare patients. Specifically, they found 36% of their respondents had low levels of health literacy (Lee, Gazmararian, & Arozullah, 2006).

Effects of low health literacy. The low health literacy rates are important to note because of research showing that those with poor health literacy often experience significant health differences than those with adequate health literacy (Lee, Arozullah, & Cho, 2004). These differences include health outcomes such as hospitalizations and general health status (Dewalt, Berkman, Sheridan, Lohr, & Pignone, 2004), adherence (Gazmararian et al., 2006), health care costs (Herndon et al., 2011), mortality rates (Wolf, Feinglass, Thompson, & Baker, 2010), and disease knowledge (Mancuso & Rincon, 2006).

Low health literacy is associated with both poorer physical health (Easton, Entwistle, & Williams, 2010) as well as lower subjective health ratings (Baker, Parker, Williams, Clark, & Nurss, 1997; Wolf et al., 2010). For example, Baker et al. administered a health literacy and subjective health rating questionnaire to 2,659 patients presenting at two major public hospitals (1997). They found that those with scores indicating low health literacy were significantly more likely to rate their physical health as poor, with odds ratios ranging from 1.89 to 2.55 (Baker et al., 1997). Additional findings from their 1997 investigation revealed that those with low health literacy were also more likely to have seen their physician in the last three months, have two or more doctor's visits, and have been hospitalized in the past year. These analyses all controlled for age, sex, education level, and socioeconomic status (Baker et al., 1997). Additional investigations have replicated these findings, again indicating that low health literacy is associated with increased health care usage (Herndon et al., 2011), in particular emergency department visits (Baker et al., 2004; Herndon et al., 2011) and hospital admission rates (Baker et al., 2002). In patients with congestive heart failure, those with adequate health literacy skills utilized less heart failure-specific emergency care and had a lower risk of hospitalization (Murray et al., 2009). Overall, these findings support the idea that low health literacy can negatively impact patients' health.

Along with the increased health care usage and worse health, it is not surprising that those with lower health literacy also have been found to have higher health care costs (Dewalt et al., 2004; Herndon et al., 2011). Weiss and Palmer examined the health care costs of 74 Medicaid recipients while controlling for age, ethnic group, education, and health status (2004). They found that those with low health literacy incurred average annual healthcare costs of $10,688 whereas those with higher health literacy incurred average annual healthcare costs of $2,891 (2004). Additionally, their analyses revealed that this large difference was mainly due to inpatient healthcare costs ($7,038 vs. $824; Weiss & Palmer, 2004).

Despite these findings, few researchers have investigated health literacy's effect on inhaler technique. In one of the only investigations to do so, Williams et al. looked at inhaler technique in patients with asthma (Williams, Baker, Honig, Lee, & Nowlan, 1998). They found that those patients with the lowest level of health literacy performed an average of 1.6 out of 6 steps correctly compared to 3.3 steps out of 6 for those with adequate health literacy (1998). Similarly, Paasche-Orlow et al. found that patients with lower health literacy performed significantly more inhaler steps incorrectly than those with adequate health literacy (Paasche-Orlow et al., 2005). A review investigating health literacy and asthma concluded that low health literacy is a barrier to accurate inhaler usage and overall disease management (Thai & George, 2010).

However, despite the above outlined research regarding health literacy and adherence, outcomes, and disease knowledge as well as the complex nature of COPD home management, there is currently only one known investigation examining how reduced health literacy may impact someone with COPD (Omachi, Sarkar, Yelin, Blanc, & Katz, 2013).

Health Literacy and COPD

Previous health literacy research has focused on the chronic pulmonary condition of asthma. For example, in a study of discharges from asthma-related hospitalizations, it was found that those with lower health literacy also had lower asthma medication knowledge and improper MDI techniques (Paasche-Orlow et al., 2005). A 2010 literature review of asthma and health literacy concluded that patients with lower health literacy are significantly more likely to have poor MDI technique, less use of exacerbation action plans, and higher emergency department use and hospitalizations (Thai & George). Most recently, work by Federman and colleagues have echoed these findings (2014). Specifically, they reported that 36% of their older adult patients with asthma had inadequate levels of health literacy and low health literacy was associated with poorer medication adherence and worse inhaler technique (Federman et al., 2014).

Despite these important findings, this research has not been extended to other chronic pulmonary populations, such as patients with COPD. Additionally, significant differences between patients with asthma and those with COPD make it important that research is replicated with the COPD patient population. For example, in an investigation that utilized both patients with asthma and patients with COPD, those with COPD were found to have 3x greater rates of low health literacy (Press et al., 2011). Also, in a 2005 review of COPD adherence, Rand notes that patients with COPD often have much more complex and rigorous medication regimens than those with asthma making it even more imperative that health literacy in COPD be explored separately (Rand, 2005).

In a recent comprehensive literature review of factors affecting COPD, Disler, Gallagher, and Davidson were only able to locate three articles on the topic of health literacy and COPD (2012). Of those three articles, only two focus specifically on COPD and none were quantitative investigations (Disler et al., 2012).

In the first of these three articles, Jeon et al. examined health literacy, among other factors, and its effect on patients' with either congestive heart failure, diabetes mellitus, or COPD and their ability to pay for and access care (2009). Through interviews with patients and their caregivers, Jeon et al. conclude that limited health literacy negatively impacted both patients' and caregivers' ability to access care, financial support, and other services potentially available to the patient, such as free oxygen or taxi vouchers (2009). However, no formal health literacy measure was given and they determined someone's health literacy level based on their "…awareness of the system and services." (Jeon et al., 2009, p. 8).

The second article on health literacy and COPD listed in Disler, Gallagher, and Davidson's review is a 2010 report on the findings of an advisory board on ways to improve inhaler adherence in COPD (Lareau & Yawn, 2010). They go on to discuss different ways to define adherence in COPD and several individual factors that are known to affect patient adherence. Among these factors they list education, ability to retain verbal information, health beliefs, and ineffective communication; however, they never specifically state health literacy as one of these variables (Lareau & Yawn, 2010).

The final article identified as pertaining to COPD and health literacy is a 2008 review by Roberts, Ghiassi, and Partridge. After reviewing health literacy definitions and how it can impact patient knowledge, health status, and adherence, they briefly discuss how health literacy can lead to non-adherence in patients with COPD due to their reduced capacity to comprehend the medication directions, benefits, and requirements (Roberts et al., 2008). They go on to note the paucity of research on health literacy in patients with COPD and describe several areas where the healthcare system could tailor treatment for those with low health literacy, such as patient informational materials and consultations with physicians (Roberts et al., 2008).

In the time since Disler and colleagues' literature review was published in 2012, only one publication has focused on health literacy and physical outcomes in patients with COPD (Omachi et al., 2013). Specifically, utilizing a national sample of 277 self-reported or physician-diagnosed patients with COPD, Omachi and colleagues investigated the relationship between health literacy and healthcare utilization, health status, health-related quality of life, and COPD helplessness. Controlling for income and education, they found that lower health literacy was associated with greater COPD severity, greater learned helplessness, and worse health-related quality of life. Additionally, those patients with the lowest levels of health literacy, compared to those with the highest levels of health literacy, were more likely to seek medical advice or treatment for worsening symptoms and had higher rates of both emergency room admissions and hospitalization. Omachi and colleagues conclude that health literacy is an important factor in the successful management of COPD and future research is needed to further clarify the role it plays (2013).Unfortunately, no investigations between health literacy and disease knowledge or inhaler technique in those with COPD could be found. Further research is needed to better understand how low health literacy may impact patients with COPD and their ability to manage their complex treatment regimen.

Health Numeracy

A second concept related to health literacy is health numeracy. Whereas health literacy has been defined by some of the most influential medical groups in the world (i.e. the Institute of Medicine), health numeracy has received far less attention (Rothman, Montori, Cherrington, & Pignone, 2008). Broadly, health numeracy has been defined as "…a range of skills including: one's ability to perform basic math functions, understand time, money, measurement, graphs, probability, and the ability to perform multi-step math" as well as knowing what math skills to apply to a given situation (Rothman et al., 2008, p. 2). Golbeck has proposed a more specific definition and states that "Health numeracy is the degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probable health information needed to make effective health decisions." (Golbeck, Ahlers-Schmidt, Paschal, & Dismuke, 2005, p. 375).

A review of the health numeracy literature revealed a set of concepts considered integral to numeracy that include basic math computations, estimation skills, and a basic understanding of statistics and representational fluency (e.g. Understanding that 1 in 10 is equivalent to 10%; Ancker & Kaufman, 2007). Lipkus and Peters outline some of the most common reasons health numeracy is important for patients, including a better understanding of the information presented to them in order to make informed decisions and having the skills to know what math computations to apply and when to use them to enhance their understanding (2009).

Additionally, numeracy researchers propose that patients make decisions based on two thought processes. One is a deliberative, analytical process that is data-driven and the other is an intuitive process fueled by feelings. They theorize that those patients with better numerical skills will be more likely to make decisions based on data and evidence and less likely to make decisions based on emotions alone (Lipkus & Peters, 2009; Peters, 2008).

Having the skills to base decisions on accurate information, instead of intuition or emotion, would clearly be a benefit for patients. However, the question arises as to whether health numeracy is part of health literacy or a separate concept. When looking at numeracy rates and their relation to demographic variables, the relationships mirror those found in the health literacy literature, indicating the concepts may be the same. Specifically, Ginde, Clark, Goldstein, and Camargo investigated numeracy levels in emergency department patients (2008). They found that low numeracy was significantly related to minority race, increased age, low education, and low income, similar to relationships between health literacy and these demographics (Ginde, Clark, Goldstein, & Camargo, 2008). Additionally, Baker, a prominent health literacy theorist, notes that the National Adult Literacy Study considers quantitative literacy, or the ability to apply mathematical concepts, one of three skill sets that make up reading fluency (Baker, 2006). Similar to the National Adult Literacy Study, Baker considers health numeracy one of several skills that make up Individual Capacity, the component of his health literacy theory that consists of individual skills such as knowledge and vocabulary (2006). In addition to Baker and the National Adult Literacy Survey, the Institute of Medicine, in its 2004 report on health literacy states "Health literacy…includes a variety of components beyond reading and writing, including numeracy, listening, speaking, and relies on cultural and conceptual knowledge" (Nielsen-Bohlman et al., 2004, p. 6).

Despite several health literacy researchers including health numeracy in their definitions of health literacy, not all numeracy researchers feel these two skills should be included in the same construct (Nelson, Reyna, Fagerlin, Lipkus, & Peters, 2008). In defense of numeracy as a separate construct, Reyna and Brainerd present data showing that numeracy can impact patient decision making independent of education and intelligence (Reyna & Brainerd, 2007). When looking at health literacy and health numeracy and their independent effects on self-efficacy in managing diabetes, both constructs were directly related to diabetes self-efficacy and indirectly related to glycemic control. However, researchers found that when both health literacy and health numeracy were entered as part of the same model, health literacy was no longer significantly related to self-efficacy and health numeracy remained significant (C.Y. Osborn, Cavanaugh, Wallston, & Rothman, 2010). The researchers hypothesized that this finding was because diabetes management requires more numerical abilities compared to verbal abilities and that these two are separate skills (C.Y. Osborn et al., 2010). These results raise the question as to whether numeracy may be more important in other chronic diseases as well, such as COPD, due to the complex and often number focused treatment regimens.

Rates of low health numeracy. Multiple studies have looked at the rates of health literacy alone, but fewer have done so with health numeracy (Herndon et al., 2011). Despite this, it has been rather clear for some time that low health numeracy is quite prevalent (Kirsch, Kader, Jensen, & Kopher, 2002). Specifically, the National Adult Literacy survey showed that in 1992 approximately one in four adults could not perform the most basic math functions and were considered to have extremely low quantitative skills. Approximately one third of adults were considered to have basic quantitative skills (Kirsch et al., 2002). In a 2007 review of health numeracy, Ancker and Kaufman reported that only 25% of adults were able to answer four of four basic numeracy questions correctly (2007). While looking at health numeracy rates in emergency department patients, Ginde et al. found that when asked to complete four numeracy questions, 20% answered none correctly and 22% had only one correct answer. Only 11% of patients were able to answer all four questions correctly (2008). Finally, in one of the more recent national studies on literacy and numeracy, the National Assessment of Adult Literacy in 2003, only 13% of respondents were categorized as having proficient health numeracy skills (Kutner et al., 2006). Additionally, 22% were classified as having below basic quantitative skills and 66% fell in the basic category (Kutner et al., 2006).

It is also interesting to note that health numeracy is not a skill that is easily inferred based on patient education or intelligence (Nelson et al., 2008). For example, despite having a sample where 75% had a minimum of a high school education, patients still only answered 69% of questions regarding a food label correctly (Rothman et al., 2006). Taken together these results indicate that, as with health literacy, health numeracy in the average patient is likely to be basic at best.

Effects of low health numeracy. Also similarly to health literacy, patients with low health numeracy often experience negative health-related outcomes and behaviors, such as poorer diabetes self-management and decreased cancer screening (Cavanaugh et al., 2008; Ciampa, Osborn, Peterson, & Rothman, 2010). For example, when looking at 398 Type I and II diabetes patients, Cavanaugh et al. found that those patients with lower health numeracy knew less about managing their diabetes correctly, including information such as identifying glucose values in an appropriate range and calculating correct insulin doses (2008). In addition, lower numeracy skills were associated with poorer glycemic control in patients (Cavanaugh et al., 2008). Estrada et al. found that those patients on anti-coagulation medication with poor health literacy or poor health numeracy spent significantly more time outside of their therapeutic range for their medication management (2004). Waldrop and colleagues have found that low health numeracy mediated the relationship between gender and poor HIV medication adherence as well as the relationship between race and HIV medication adherence (Waldrop-Valverde et al., 2009; Waldrop-Valverde et al., 2010).

Recently, Gardner et al. found a relationship between health numeracy and ability to accurately estimate side-effect risks of medications (Gardner, McMillan, Raynor, Woolf, & Knapp, 2011). More specifically, those with low health numeracy struggled to comprehend the level of risk involved in more unlikely side effects (Gardner et al., 2011). These findings highlight the theory commonly endorsed to explain how low health numeracy can affect patients. Specifically, it is proposed that those patients with a better understanding of numerical information will be more likely to make medical decisions based on the information provided to them, including data and facts, whereas those with poor health numeracy will be left to use their intuition, emotions, and trust or distrust in science (Peters, 2008; Reyna & Brainerd, 2007).

Health Numeracy and Chronic Disease

There are no studies of health numeracy in patients with COPD. Literature examining low health numeracy and other chronic diseases, such as asthma and diabetes, highlights why it is important to expand these findings to those with COPD. For example, Apter and colleagues assessed health literacy as well as asthma-specific numeracy in 74 patients with chronic asthma (2006). Only 16% of this sample was able to correctly answer all four numeracy questions, while 8% were unable to answer any questions correctly. Importantly, low numeracy skills, but not low health literacy skills, were associated with an increased rate of asthma-related hospitalizations or emergency department visits. Additionally, they noted that high health literacy skills did not guarantee adequate health numeracy, with a wide range of numeracy abilities in those with the highest health literacy skills (Apter et al., 2006). Apter and colleagues concluded that even those patients with asthma and an adequate ability to understand general health information may still struggle to comprehend quantitative-specific information, an important aspect of both asthma and COPD treatment (2006).

In a more recent investigation, Apter et al. examined quality of life, self-efficacy, and health numeracy in 80 patients with moderate to severe asthma (2009). They discovered that health numeracy was associated with asthma-related quality of life and reduced the relationships between low quality of life and income, race, and self-efficacy. Health literacy was not found to be associated to asthma-related quality of life (Apter et al., 2009). They reported that these findings indicate that low health numeracy may decrease patients' abilities to appropriately manage their illness, ultimately decreasing their quality of life (Apter et al., 2009).

Most recently, Apter and colleagues assessed health literacy, asthma-related health numeracy, and their relation to medication adherence and asthma control (2013). They reported that, controlling for both age and gender, higher health literacy and health numeracy were associated with better adherence and asthma control. After controlling for race, which they reported to be highly associated with education and income, only health literacy remained associated with better asthma control (Apter et al., 2013). They concluded that both health literacy and health numeracy likely impact health outcomes, such as adherence and disease control, through a variety of avenues and encourage further research to flush out these relationships. No additional investigations regarding health numeracy and COPD or other pulmonary diseases could be located; however, Osbourne et al. investigated health literacy, health numeracy, and self-efficacy in Type I and II diabetic patients, another chronic disorder that requires often complex management (C.Y. Osborn et al., 2010). They found that both health literacy and health numeracy significantly impacted self-efficacy and that increased self-efficacy was related to better diabetes management. However, when both literacy and numeracy were considered in the same model, health literacy was no longer related to self-efficacy (C.Y. Osborn et al., 2010). These researchers concluded that because successful diabetes management requires quantitative skills, those with higher health numeracy may be more confident in their abilities to appropriately manage their disease (C.Y. Osborn et al., 2010).

Osborn et al.'s findings indicate that health numeracy may be an important factor in accurately managing chronic diseases with treatments involving complex, numerical based regimens such as the pulse oximetry, liters per minute of oxygen, and multiple medications and dosing requirements often seen in COPD treatment. Additionally, research investigating health numeracy and chronic diseases is not the only area lacking and Reyna and colleagues point out that, compared to the health literacy field, there is a great need to explore health numeracy and its potential effects on physical outcomes (Reyna, Nelson, Han, & Dieckmann, 2009). Given discrepant findings as to whether health numeracy impacts chronic diseases above and beyond the influence of health literacy, more research is needed to help clarify these relationships (Apter et al., 2013; C.Y. Osborn et al., 2010)

Disease Knowledge

A topic that is often discussed alongside health literacy is patient knowledge of their chronic disease (Pleasant & Kuruvilla, 2008). Baker states that knowledge should be considered "…a resource that a person has that facilitates health literacy but does not in itself constitute health literacy." (Baker, 2006, p. 879). He points out that increasing one's knowledge will not always translate into knowing how and when to utilize that information and considers knowledge one facet of the complex concept known as health literacy (2006). Research has touched on this topic and has shown that those patients with chronic diseases, such as asthma, diabetes, and cardiovascular disease, and low health literacy know significantly less about their particular disease (Gazmararian, Williams, Peel, & Baker, 2003).

Controlling for other factors related to asthma knowledge, such as level of education, perceived understanding of asthma treatment, and regular care, Williams et al. found that health literacy was the strongest predictor of asthma knowledge (Williams, Baker, Honig, et al., 1998). Poor health literacy again predicted lower disease knowledge when looking at diabetic and hypertension patients. Health literacy remained the strongest predictor of disease knowledge even after controlling for age, duration of disease, and education level (Williams, Baker, Parker, & Nurss, 1998). The current author and colleagues recently found that health literacy predicted cardiac knowledge in a sample of patients in cardiac rehabilitation both before and after cardiac rehabilitation; however, education level did not. These results indicate that health literacy may be an important factor in how knowledgeable patients are regarding their disease and how much they are able to learn in a patient education setting (Mattson, Rawson, Hughes, Waechter, & Rosneck, 2014).

In a 2006 investigation on this topic, the relationship between low health literacy and asthma-related quality of life was mediated by a lack of knowledge regarding asthma. The same mediation, with the effects of health literacy being accounted for by asthma knowledge, was found when looking at physical outcomes and emergency department visits as well (Mancuso & Rincon, 2006). The researchers interpreted this to mean that low health literacy may impede a patient from learning the necessary amount of information about their disease, ultimately affecting their ability to appropriately manage it (Mancuso & Rincon, 2006). The Mancuso and Rincon findings highlight the importance of both health literacy and knowledge in patients with chronic diseases (2006). Given the above discussed research, it would be expected that higher levels of health literacy would be related to higher disease knowledge in patients, ultimately helping them to better manage their symptoms. Unfortunately, this has yet to be investigated in patients with COPD. Because of the complex treatment regimens necessary, it is important to learn as much as we can about factors, such as knowledge and health literacy, that affect their ability to understand and adhere to their treatments.

Present Study

Research has shown strong relationships between health literacy and worse inhaler technique and utilization of healthcare; however, only one investigation to date has explored this in a COPD population (Omachi et al., 2013). Additionally, despite conflicting findings and calls from researchers to further clarify the role of health numeracy in the management of complex chronic diseases, no investigations examining potential relationships between health numeracy and proper management of COPD could be located (Apter et al., 2013). Because COPD is primarily treated with complex medication regimens managed by patients at home and due to the rising number of individuals with this progressive disease, it would be advantageous to know what factors inhibit or improve appropriate self-care.

The current investigation aimed to identify how health literacy and health numeracy may impact patients with COPD and their ability to manage their disease. We expected that health literacy and health numeracy would both be negatively associated with healthcare utilization.

The ability to obtain greater disease knowledge is often considered a benefit of higher health literacy; because of this we also expected there to be a positive relationship between health literacy and extent of COPD knowledge. Because of the complex treatment regimens patients with COPD are expected to manage at home, and prior research linking health literacy to proper inhaler usage, we expected that health literacy would be positively related to correctly performing inhaler steps. However, given previous research showing that health numeracy contributes uniquely to the management of complex chronic diseases, we expected that health numeracy would be related to proper inhaler usage above and beyond that of health literacy.

Hypothesis 1. Health literacy will be negatively related to healthcare utilization such that as health literacy increases, healthcare utilization will decrease in patients with COPD.

Hypothesis 2. Health numeracy will be negatively related to healthcare utilization such that as health numeracy increase, healthcare utilization will decrease in patients with COPD.

Hypothesis 3. Health literacy will be positively related to knowledge of COPD such that as health literacy increases, knowledge of COPD will increase in patients with COPD.

Hypothesis 4. Health literacy will be positively related to correct inhaler usage such that as health literacy increases, number of correct inhaler steps will increase in patients with COPD.

Hypothesis 5. Health numeracy will be positively related to correct inhaler usage above and beyond that of health literacy such that as health numeracy increases, number of correct inhaler steps will increase in patients with COPD.

Method

Participants

Participants consisted of 50 patients (31 men and 19 women) from pulmonary medicine physicians' offices, pulmonary rehabilitation, and the pulmonary testing laboratory at SUMMA Health System in Akron, Ohio and Robinson Memorial Hospital in Ravenna, Ohio between August 2012 and August 2014. Patients were recruited if they were 30 years of age or older and diagnosed with moderate to very severe COPD, based on the most current Global Initiative for Chronic Obstructive Lung Disease (GOLD) standards (GOLD, 2014). The GOLD standards define COPD in four stages based on the results of post-bronchodilator spirometry testing (GOLD, 2014; Table 1). Patients ranged in age from 37 to 86 and were primarily Caucasian (92%). Disease severity ratings, based on current GOLD standards, consisted of moderate (46%), severe (24%), and very severe (30%) with 58% of patients previously attending pulmonary rehabilitation. Table 2 has further patient demographics.

Table 1
GOLD Standards – Post-Bronchodilator FEV1 Classification of COPD Disease Severity

Stage	Descriptor	Physical Requirements
Stage I:	Mild	$FEV_1/FVC < 0.70$ $FEV_1 \geq 80\%$ predicted
Stage II:	Moderate	$FEV_1/FVC < 0.70$ $50\% \leq FEV_1 \leq 80\%$ predicted
Stage III:	Severe	$FEV_1/FVC < 0.70$ $30\% \leq FEV_1 \leq 50\%$ predicted
Stage IV:	Very Severe	$FEV_1/FVC < 0.70$ $FEV_1 < 30\%$ or FEV_1 predicted plus chronic respiratory failure*

*Respiratory failure: arterial partial pressure of oxygen (PaO2) < 8.0 kPa (60 mm Hg) with or without arterial partial pressure of CO2 (PaCO2) > 6.7 kPa (50 mm Hg) while breathing air at sea level.

Table 2
Demographics of Study Population

Characteristic	M ± SD	%
N	50	
Age	63.72 ± 12.33	
Gender (% male)		62
Race (% Caucasian)		92
Education (years)	12.94 ± 2.80	
Admitted to ER		42
No. ER Admissions	2.38 ± 1.83	
Hospitalized		34
No. Hospitalizations	2 ± 1.06	
Length of Hospitalization	5.46 ± 3.13	

Procedure

Study protocol was approved by the institutional review boards of Kent State University, SUMMA Health System, and Robinson Memorial Hospital. Patients were recruited in person from SUMMA Health System's and Robinson Memorial Hospital's pulmonary function testing lab, pulmonary physicians' offices, pulmonary rehabilitation, as well as through an informational letter.

Patients who agreed to enroll in the study were asked to read and sign an informed consent form agreeing to participate in the over-arching study titled IMPACT COPD

(Investigating the Management of Patient and Caregiver Treatment in COPD), which aimed to investigate factors in patients and their caregivers that impact the proper management of COPD at home. Regarding the present study, the participants agreed to complete a background and demographics questionnaire, cognitive screen, and questionnaire packet (Appendix). The background and demographics questionnaire covered age, gender, ethnicity, education level, income, living arrangement, and employment status. It also contained questions regarding health status, including co-morbid conditions, current medications, and pervious participation in pulmonary rehabilitation. The potential impact of study fatigue was controlled for by counterbalancing the measures contained in the questionnaire packet through use of a computerized random number generator.

Participants granted permission to access their medical records in order to determine healthcare utilization in the preceding 12 months. Also, the participants demonstrated for the researchers how they use their inhaler. Researchers were trained to recognize the steps necessary for appropriate inhaler technique. The present study occurred in the participants' home and consisted of a single visit. Participants were provided monetary compensation for their time.

Measures

Health literacy. The Medical Term Recognition Test (METER) was one of two measures used to assess health literacy in patients. The METER consists of 40 medical terms and 30 non-words. Respondents are instructed to mark which words they recognize as actual words. Scores are based on the number of "true hits," or actual medical terms the respondent correctly identified, and can range from 0-40. Three score ranges, consisting of 0-20, 21-34, and 35-40 indicate low, marginal and functional health literacy, respectively. The METER takes approximately 2 minutes to complete.

Initial validation efforts found the METER to have good reliability in outpatient cardiac patients (Cronbach's alpha = 0.93) and a high correlation with the Rapid Estimate of Adult Literacy in Medicine, an interviewer-administered health literacy measure (r = .74; Rawson et al., 2010). Subsequent utilization of the instrument found that METER scores predict gains in cardiac knowledge in a sample of cardiac rehabilitation patients (Mattson et al., 2014). Additionally, higher METER scores were found to predict fewer emergency room visits and hospitalizations in those with multiple sclerosis (Marrie, Salter, Tyry, Fox, & Cutter, 2014).

The Short Test of Functional Health Literacy in Adults (s-TOFHLA) consists of two reading passages that employ a modified Cloze procedure. These passages center on health related scenarios and have every fifth to seventh word missing. Respondents must choose the correct answer from a list of four possible answers, with the three incorrect answers being grammatically or contextually incorrect (Baker, Williams, Parker, Gazmararian, & Nurss, 1999). One point is given for each correct response with a total of 36 points possible. Scores 0-16 are considered low health literacy, scores 17-22 are considered adequate health literacy, and scores 23-36 are considered functional health literacy. The s-TOFHLA takes approximately 12 minutes to complete.

Utilizing an outpatient medical sample, the s-TOFHLA has been shown to have good internal consistency(Cronbach's alpha = 0.97) and to correlate highly with the interviewer-administered REALM (r = 0.80; Baker et al., 1999). Further research with the s-TOFHLA found scores were independently related to hospitalization rates in patients with congestive heart failure

(Murray et al., 2009). Additionally, in patients with chronic asthma, s-TOFHLA scores were found to be related to hospitalization rates as well as levels of disease knowledge (Paasche-Orlow et al., 2005)

General Literacy. The V-4, Advanced Vocabulary test has respondents answer 18 multiple-choice synonym questions with 5 answer choices each. Each correct response is worth one point with a total of 18 points possible. The V-4 is recommended for use with adults completing 11 years of schooling or greater and takes approximately four minutes to complete (French, Ekstrom, & Price, 1963). Vocabulary has been found to correlate highly with reading comprehension and is considered an essential component of understanding written material (Curtis, 2005; Kruidenier, MacArthur, & Wrigley, 2010).

Health numeracy. The Newest Vital Sign (NVS) has respondents answer six questions regarding the information found on an accompanying nutrition label by completing basic math calculations. The questions ask things such as "If you eat the entire container, how many calories will you eat?" and require the participant to identify and complete the correct math computation necessary to answer the question. Each correct response is worth one point with a total of six points possible. Scores greater than four are considered to be evidence of adequate health numeracy whereas scores below four are considered to be evidence of low health numeracy. The NVS takes approximately three minutes to complete and in initial validation studies utilizing primary care patients it was shown to be internally consistent (Cronbach's alpha = 0.76; Weiss et al., 2005). Further investigation of the NVS with primary care patients as well as patients with diabetes determined that the NVS is likely assessing a separate, more complex construct than common health literacy measures such as the REALM or s-TOFHLA (C. Y. Osborn et al., 2007; Shigaki, Kruse, Mehr, & Ge, 2012)

COPD knowledge. The Bristol COPD Knowledge Questionnaire (BCKQ) consists of 65 items covering 13 topics such as common symptoms, etiology, exercise, immunizations, and inhaled steroids (White, Walker, Roberts, Kalisky, & White, 2006). Each topic is followed by 5 related statements that respondents mark as true, false, or that they do not know. Approximately half of the questions are correct if marked true with the other half being correct if marked false. One point is assigned for each correct answer and a zero is received for any incorrect answer or answer marked 'don't know' (White et al., 2006). Face validity was rated as good by a panel of 24 healthcare professionals who regularly teach patients with COPD. The questionnaire takes approximately15 minutes to complete and was found to be internally consistent (Cronbach's alpha = 0.73). Finally, eight week test-retest reliability for patients not enrolled in pulmonary rehab was strong ($r = 0.71$, $p<.001$; White et al., 2006).

Cognitive functioning. The Montreal Cognitive Assessment (MoCA) is a brief screening tool to detect mild cognitive impairment. The MoCA assesses 10 cognitive domains including short-term memory, executive functioning, and working memory and is more sensitive to early or mild cognitive decline than other global cognitive screens. Tasks used to assess various domains include a clock-drawing task, serial subtraction, 3-dimensional cube drawing, and confrontation naming (Nasreddine et al., 2005). A total of 30 points are available with scores 25 and below indicating clinical levels of impairment. The one-page assessment takes approximately 10 minutes to complete. Both test-retest reliability and internal consistency were found to be high during initial validation efforts with both health elderly individuals and those with Alzheimer's disease (correlation coefficient = 0.92, $p > .001$; Cronbach's alpha = 0.83; Nasreddine et al., 2005). Further research utilizing the MoCA found that patients with COPD who were experiencing an acute exacerbation had significantly decreased cognitive functioning when compared to patients with COPD not experiencing an exacerbation (Crisan et al., 2014). Additionally, when utilizing both the MoCA and the Min-Mental Status Exam to identify cognitive impairment in patients with COPD, research found the MoCA to have good sensitivity (75%) and specificity (79%) resulting in 76% correct classification while no acceptable cut-off for the Mini-Mental Status Exam could be found (Villeneuve et al., 2012).

Inhaler technique. Inhaler technique was assessed by study researchers utilizing the Inhaler Technique Score Checklists (Kiser et al., 2012). This measure identifies eight essential steps necessary to properly use 4 of the most commonly prescribed inhalers. Participants, without actually consuming a dose of medication unless it was time for them to do so, demonstrated to the researcher how they administer 2 puffs from their inhaler. During this demonstration the researcher observed the participant and assigned one point for each correct step performed. A total of up to 8 points were possible per inhaler. Checklist items were determined by inhaler directions included in the medication packaging and a review of previous checklist items found in the literature, including national guidelines (Kiser et al., 2012) This checklist system was found to have adequate inter-rater reliability when used with adult patients with a confirmed diagnosis of COPD (average 82.5% agreement; Kappa 0.64; Kiser et al., 2012). In order to assess for inter-rater reliability in the current sample, two researchers were present for the first 10 participants. Both researchers completed the checklist while observing the participant demonstrate their inhaler. Inter-rater reliability of checklist scores for these 10 participants suggests substantial agreement (Kappa: 0.72; Landis & Koch, 1977).

Medical chart review. Health service utilization was determined by summing the total number of emergency room visits and the total number of hospital admissions in the 12 months prior to participation. Participants' electronic and paper medical records were reviewed by researchers to determine number of emergency room visits and hospitalizations in the preceding 12 months. In order to avoid duplication, if records indicated a patient was admitted to the hospital following their presentation to the emergency room, only the emergency room visit was counted. This medical record review was also be used to determine disease severity based on pulmonary function testing.

Statistical Analyses

Statistical analyses were conducted using SPSS Data Editor 16.0 for descriptive statistics, assumptions testing, bivariate correlations, and regression analyses. Preacher and Leonardelli's Interactive Calculation Tool for Mediation Tests was used to test for the significance of indirect effects in mediation analyses (Preacher & Leonardelli, 2010). Statistical significance was set at $p \leq .05$ for all analyses.

Descriptive analyses including frequencies, means, and standard deviations were used to assess the sample characteristics. Health literacy and health numeracy variables were treated as continuous, as opposed to categorical, in order to reduce artificial truncation of variability associated with categorical data (Royston, Altman, & Sauerbrei, 2006). Additionally, due to the clearly identified difficulties of accurately measuring a concept as broad as health literacy, scores from the METER and s-TOFHLA were aggregated into a composite variable (Jordan, Osborne, & Buchbinder, 2011). This variable was computed by summing the Z-scores of METER true hits and s-TOFHLA total correct.

Covariates. Bivariate correlational analyses were conducted to identify potential confounding variables that might explain observed relationships between the dependent and predictor variables in the regression analyses. Correlation results can be found in Table 3.

Cognitive functioning, highest level of education completed, and general literacy were found to be potential confounding variables and were thus controlled for in subsequent regressions.

Table 3
Correlations between Variables of Interest

	Health Lit	Age	Edu Yrs	Cog	Gen Lit	Numer	Disease Severe	HC Utilize	COPD Know
Age	.01								
Edu Yrs	.34*	.06							
Cog	.55***	-.02	.31*						
Gen Lit	.56***	.01	.56***	.51**					
Numer	.56***	-.11	.52***	.58***	.52**				
Disease Severe	.10	.12	-.07	-.06	-.22	.07			
HC Utilize	-.04	-.27†	-.14	-.24	-.21	-.14	.26†		
COPD Know	.48**	.12	.41**	.13	.45**	.28†	.03	-.02	
Correct Usage	.27†	-.13	.19	.29†	.23	.39**	-.23	-.25†	.09

Note. †$p < .10$ indicating a trend.*$p < .05$, **$p < .01$, ***$p<.001$ indicating significant relationships. Health Lit = Health Literacy; Edu Yrs = Highest Level of Education; Cog = Cognitive Functioning; Gen Lit = General Literacy; Numer = Health Numeracy; Disease Severe = Severity of COPD; HC Utilize = Healthcare Utilization; COPD Know = Knowledge of COPD Correct Usage = Correctly Performed Inhaler Steps.

Multiple linear regressions. Hierarchical multiple linear regressions were deemed most appropriate to assess the hypothesized relationships due to their ability to assess the association between two or more independent variables and a single, continuous dependent variable. All assumptions of hierarchical multiple linear regressions were met, including the assumption of normality of the variables which was determined through visual inspection of data and descriptive statistics (skewness < 2 and kurtosis < 3). Additionally, the assumption of multicollinearity between predictor variables was assessed by the variable inflation factor (VIF). The VIF is obtained by regressing each predictor variable against all additional predictor variables utilized (Cohen, Cohen, West, & Aiken, 2003). Analyses with the current data resulted in all VIF scores of < 2, which indicates the assumption of multicollinearity was not violated. As mentioned, all regression analyses controlled for cognitive functioning, highest level of education completed, and general literacy.

Mediation analyses. Post-hoc mediation analyses were conducted to further explore relationships identified through multiple linear regressions. Because no multilevel mediation models were tested the Barron and Kenny four-step approach to mediation in combination with the Sobel test was utilized (Baron & Kenny, 1986). Utilizing a series of linear regressions, the significance of the relationship between the initial independent variable and the dependent variable was confirmed first. Next, the significance of the relationship between the initial independent variable and the mediator was confirmed. Third, the relationship between the mediator and the dependent variable was deemed significant in the presence of the independent variable. Finally, for full mediation to be observed, the complete reduction of the relationship between the initial independent variable and the dependent variable in the presence of the mediator variable had to be confirmed. For partial mediation to be observed, a significant reduction of the relationship between the independent variable and the dependent variable in the presence of the mediating variable had to be confirmed. The Sobel test was then used to test the significance of the indirect effect.

Power analyses. Power analyses were completed using G-Power Version 3.1.5 (Faul, Erdfelder, Buchner, & Lang, 2009). These analyses estimated that in order to attain the critical F value, $F(5,86) = 2.32$, in a multiple regression with five predictor variables, with .05 alpha, when power is .80, and estimated effect size is .15 (medium effect size for F-test multiple regression), a sample size of 92 would be needed. The final sample analyzed in this study consisted of 50 participants, indicating that the study may be underpowered.

Results

Descriptive Statistics

In the current sample, 72% of individuals had scores above the 35 point cutoff on the METER, indicating functional health literacy. Further, METER scores ranged from 15-40, with an average score of 35.15 ± 5.98. When using the s-TOFHLA to measure health literacy, 80% of individuals had scores above the 23 point cutoff, indicating adequate health literacy. Scores ranged from 6-36, with an average score of 29.98 ± 8.44. When considering adequate health numeracy, 30% of individuals had scores above the 4 point cutoff on the NVS. Scores ranged from 0-6, with an average score of 2.82 ± 2.25. Health literacy was related to health numeracy; however, the two health literacy measures were not related to one another. See Table 4 for correlations between health literacy and health numeracy measures.

Table 4
Correlations Between Health Literacy and Health Numeracy Measures

Measure	METER	s-TOFHLA	NVS
METER		.134	.320*
s-TOFHLA			.546**

Note. * $p < .05$, ** $p < .01$

Regarding healthcare utilization, 50% of participants utilized either the emergency room or were hospitalized in the prior 12 months. Forty-two percent of the sample visited the emergency room and 34% were admitted to the hospital within the last 12 months. Within the 42% of individuals who visited the emergency room, there was an average of 2.38 ± 1.83 emergency room visits. Within the 34% of the current sample that was admitted to the hospital within the last 12 months, the average number of hospital admissions for was 2 ± 1.06 with average length of stay 5.46 ± 3.13 days.

Regarding inhaler technique errors, 20% of the sample correctly completed eight out of eight steps. The average number of correctly completed steps was 6.38 ± 1.32. See Table 5 for percentage of correctly completed steps by inhaler type. Bristol COPD Knowledge Questionnaire scores ranged from 13-55 with an average score of 35.10 ± 9.16 out of 65.

Table 5

Percent of Participants Correctly Completing Each Inhaler Step by Inhaler Type

Metered Dose (n = 21)		MDI w/Spacer (n = 1)		Diskus (n = 9)		Handihaler (n = 17)	
Step	% Correct	Step	% Correct	Step	% Correct	Step	% Correct
1	100	1	100	1	100	1	100
2	95.2	2	100	2	77.8	2	100
3	47.6	3	0	3	100	3	100
4	95.2	4	100	4	44.4	4	100
5	85.7	5	100	5	100	5	52.9
6	71.4	6	100	6	88.9	6	100
7	38.1	7	100	7	44.4	7	94.1
8	47.6	8	100	8	55.6	8	70.6
Average Total Correct	5.81 ± 1.40	Average Total Correct	7.0	Average Total Correct	6.11 ± 1.27	Average Total Correct	7.18 ± 0.82

Note. Individual steps for each inhaler type can be found in Appendix A

Hierarchical Multiple Linear Regressions

Healthcare Utilization. In evaluation of hypothesis 1, that health literacy is negatively related to healthcare utilization, a hierarchical multiple linear regressions was carried out. This analysis found that, prior to including health literacy in the model, cognitive functioning (β = -.12, p = .58), level of education (β = .12, p = .59), and general literacy (β = -.18, p = .46) were not significantly and uniquely related to extent of healthcare utilization (see Table 6). The addition of health literacy did not significantly improve model fit [$\Delta R^2 = .03$, F-change (1, 27) = .98, p = .33]. Health literacy does not appear to influence health care utilization.

Table 6
Hierarchical Linear Regression Examining Health Literacy in relation to Healthcare Utilization after Controlling for the Effects of Cognitive Functioning, Education, and General Literacy

		B (SE B)	β	*t*	*p*	ΔR^2	ΔF	*df*	*P*
Step 1						.05	.52	3, 28	.67
	Cog	-.09 (.16)	-.12	-.57	.58				
	Edu Yrs	.12 (.22)	.12	.54	.59				
	Gen Lit	-.15 (.20)	-.18	-.75	.46				
Step 2						.03	.98	1, 27	.33
	Hlth Lit	.41 (.41)	.24	.99	.33				

Note. Cog = Cognitive Functioning; Edu Yrs = Highest Level of Education; Gen Lit = General Literacy; Hlth Lit = Health Literacy.

In evaluation of hypothesis 2 that health numeracy is negatively related to health care utilization, a hierarchical linear regression found that prior to including health numeracy in the model, cognitive functioning (β = -.30, p = .15), years of formal education (β = .00, p = .99), and general literacy (β = -.05, p = .83) were not significantly and uniquely related to extent of healthcare utilization (see Table 7). The addition of health numeracy did not significantly improve model fit [$\Delta R^2 = .01$, F-change (1, 29) = .29, p = .60]. Health numeracy does not appear to influence health care utilization.

Table 7

Hierarchical Linear Regression Examining Health Numeracy in relation to Healthcare Utilization after Controlling for the Effects of Cognitive Functioning, Education, and General Literacy

		B (SE B)	β	*t*	*p*	ΔR^2	ΔF	*Df*	*P*
Step 1						.11	1.17	3, 30	.34
	Cog	-.24 (.16)	-.30	-1.47	.15				
	Edu Yrs	.00 (.24)	.00	-.04	.99				
	Gen Lit	-.05 (.21)	-.05	-.22	.83				
Step 2						.01	.29	1, 29	.60
	Numer	.15 (.28)	.13	.54	.60				

Note. COG = Cognitive Functioning; Edu Yrs = Highest Level of Education; Gen Lit = General Literacy Numer = Health Numeracy.

COPD Knowledge. In order to evaluate health literacy's relationship to knowledge of COPD, hypothesis 3, a hierarchical linear regression found that prior to including the health literacy in the model, there was a trend for general literacy ($\beta = .37$, p = .08) to be significantly and uniquely related to extent of knowledge of COPD (see Table 8). The overall model was significant [F (3, 28) = 4.16, p < .05]; however, cognitive functioning ($\beta = .14$, p = .46) and years of formal education ($\beta = .17$, p = .35) were not related to extent of knowledge of COPD. The addition of health literacy significantly improved model fit [$\Delta R^2 = .11$, F-change (1, 27) = 5.25, p < .05] and health literacy was significantly and uniquely related to extent of knowledge of COPD ($\beta = .44$, p < .05). Additionally, it was noted that general literacy no longer significantly contributed to the model when health literacy was added (β = .21, p = .32) indicating that health literacy may mediate the relationship between general literacy and knowledge of COPD. This was further explored through post-hoc analyses described below. It appears that individuals' health literacy is linked to their understanding of their own disease, and that this relationship cannot be accounted for by individual's cognitive functioning, education, or general literacy.

Table 8

Hierarchical Linear Regression Examining Health Literacy in relation to Knowledge of COPD after Controlling for the Effects of Cognitive Functioning, Education, and General Literacy

		B (SE B)	β	*T*	*p*	ΔR^2	ΔF	*df*	*P*
Step 1						.31	4.16	3, 28	.02
	Cog	.40 (.53)	.14	.75	.46				
	Edu Yrs	.71 (.75)	.17	.95	.35				
	Gen Lit	1.19 (.66)	.37	1.81	.08				
Step 2						.11	5.25	1, 27	.03
	Hlth Lit	2.92 (1.27)	.44	2.29	.03				

Note. Cog = Cognitive Functioning; Edu Yrs = Highest Level of Education; Gen Lit = General Literacy; Hlth Lit = Health Literacy.

In order to determine whether this relationship was unique to health literacy, health numeracy was also added to the model. Health numeracy (β = -.23, p = .26) was not significantly and uniquely related to extent of knowledge of COPD (see Table 9).

Table 9

Hierarchical Linear Regression Examining Health Literacy and Health Numeracy in relation to Knowledge of COPD after Controlling for the Effects of Cognitive Functioning, Education, and General Literacy

		B (SE B)	β	*T*	*p*	ΔR^2	ΔF	*df*	*P*
Step 1						.31	4.16	3, 28	.02
	Cog	.40 (.53)	.14	.75	.46				
	Edu Yrs	.71 (.75)	.17	.95	.35				
	Gen Lit	1.19 (.66)	.37	1.81	.08				
Step 2						.14	3.31	2, 26	.05
	Hlth Lit	3.73 (1.33)	.51	2.54	.02				
	Numer	-.95 (.83)	-.23	-1.14	.26				

Note. Cog = Cognitive Functioning; Edu Yrs = Highest Level of Education; Gen Lit = General Literacy; Hlth Lit = Health Literacy; Numer = Health Numeracy.

Correct Inhaler Usage. In order to evaluate hypothesis 4 that health literacy is positively related to proper use of inhalers, a hierarchical linear regression found that prior to including health literacy in the model, cognitive functioning (β = .39, p = .08), years of formal education (β = .00, p = .99), and general literacy (β = -.04, p = .14) were not significantly and uniquely related to number of correct inhaler steps (see Table 10). The addition of health literacy did not significantly improve model fit [ΔR^2 = .08, F-change (1, 25) = 2.36, p = .14]. Health literacy does not appear to significantly influence proper inhaler usage.

Table 10

Hierarchical Linear Regression Examining Health Literacy in relation to Correct Usage of Inhaler after Controlling for the Effects of Cognitive Functioning, Education, and General Literacy

		B (SE B)	β	*t*	*p*	ΔR^2	ΔF	*Df*	*P*
Step 1						.13	1.34	3, 26	.28
	Cog	.15 (.08)	.39	1.83	.08				
	Edu Yrs	.00 (.12)	.00	-.01	.99				
	Gen Lit	-.02 (.11)	-.04	-.18	.86				
Step 2						.08	2.37	1, 25	.14
	Hlth Lit	.35 (.23)	.36	1.54	.14				

Note. COG = Cognitive Functioning; Edu Yrs = Highest Level of Education; Gen Lit = General Literacy; Hlth Lit = Health Literacy.

In order to evaluate hypothesis 5 that health numeracy would significantly contribute to the model above and beyond health literacy, health numeracy was also added to the model. Health numeracy (β = .28, p = .25) was not significantly and uniquely related to number of correct inhaler steps. Health numeracy does not appear to significantly influence proper inhaler usage (see Table 11).

Table 11
Hierarchical Linear Regression Examining Health Literacy and Health Numeracy in relation to Correct Usage of Inhaler after Controlling for the Effects of Cognitive Functioning, Education, and General Literacy

		B (SE B)	β	*t*	*p*	ΔR^2	ΔF	*Df*	*P*
Step 1						.13	1.34	3, 26	.28
	Cog	.15 (.08)	.39	1.83	.08				
	Edu Yrs	.00 (.12)	.00	-.01	.99				
	Gen Lit	-.02 (.11)	-.04	-.18	.86				
Step 2						.12	1.90	2, 24	.17
	Hlth Lit	.27 (.23)	.28	1.15	.26				
	Numer	.16 (.13)	.28	1.19	.25				

Note. COG = Cognitive Functioning; Edu Yrs = Highest Level of Education; Gen Lit = General Literacy; Hlth Lit = Health Literacy; Numer = Health Numeracy.

Exploratory Mediation Analyses

The relationships between general literacy, health literacy, and COPD knowledge were further explored with meditational analyses after hierarchical regression results showed the addition of health literacy reduced general literacy’s impact on COPD knowledge. These findings, as well as the possibility that the relationship between general literacy and COPD knowledge is mediated by health literacy, are in line with health literacy theory (Ayotte, Allaire, & Bosworth, 2009). Specifically, health literacy theorists acknowledge that general literacy or reading ability is a necessary prerequisite to health literacy; however, they contend that health literacy is a separate construct, unique from overall literacy or reading ability (Baker, 2006). Given these assumptions, it was expected that the relationship identified between general literacy and knowledge of COPD is mediated by health literacy.

In order to investigate this possibility, a series of three linear regressions were conducted in accordance with Baron and Kenny's four-step approach to mediation (1986). First, the relationship between the independent variable (general literacy) and the dependent variable (COPD knowledge) was established. These factors accounted for 20.4% of the variance [$F(1, 36) = 9.25$, $p < .01$] and general literacy significantly predicted knowledge of COPD ($\beta = .45$, $p < .01$). Second, the relationship between the independent variable (general literacy) and the mediator (health literacy) was established. These factors accounted for 31.4% of the variance [$F(1, 33) = 15.12$, $p < .01$]. General literacy significantly predicted health literacy ($\beta = .56$, $p < .01$). Third, the relationship between the mediator (health literacy) and the dependent variable (COPD knowledge) was established while controlling for the independent variable (general literacy). This resulted in 37.9% of the variance being accounted for [$F(2, 32) = 9.75$, $p < .001$] and health literacy was found to significantly predict knowledge of COPD ($\beta = .45$, $p < .01$). Finally, a reduction in the relationship between the independent variable (general literacy) and dependent variable (COPD knowledge) was noted when the mediator (health literacy) was considered (general literacy $\beta = .23$, $p = .18$). Lastly, the Sobel Test was used to determine that the indirect effect of the independent variable (general literacy) on the dependent variable (COPD knowledge) via the mediator (health literacy) was statistically significant from zero ($Z = 2.22$, $p < 05$), indicating the presence of partial mediation. It is important to note that true mediation is assumed to be causal and requires the appropriate temporal relationships necessary for causality (Baron & Kenny, 1986). Because of this the partial mediation described above is merely statistical mediation as no temporal relationships regarding the variables can be determined due to the cross-sectional nature of the data.

Discussion

Summary

Both health literacy and health numeracy are continuing to be recognized as important factors in the appropriate management of chronic diseases (Apter et al., 2009; Williams, Baker, Honig, et al., 1998). Only one known study to date has partially explored these relationships in patients with COPD, a complex disease that requires vigilant home management. The current investigation sought to further the understanding of what factors impact patients' abilities to appropriately manage it.

Health literacy was found to be adequate in the majority of the sample, while health numeracy was adequate in less than a third. Additionally, knowledge of COPD information was low with the average participant correctly answering just over half of the questions. Nearly two-thirds of the current sample reported attending pulmonary rehabilitation. Within the last year, 42% of the sample had visited the emergency room and one-third had been admitted to the hospital. Twenty percent of participants were able to complete all steps of their inhaler correctly.

As hypothesized, health literacy significantly predicted patients' knowledge of their disease, controlling for the effects of cognitive functioning, general literacy, and highest level of education attained. Additionally, exploratory analyses revealed that the relationship between general literacy and disease knowledge was mediated by health literacy. Contrary to hypotheses, neither health literacy nor numeracy significantly predicted number of correct inhaler steps or healthcare utilization.

Health Literacy and Numeracy Rates

When using the METER, 72% of the current sample was found to have adequate health literacy, meaning they correctly identified at least half of the actual medical terms. When using the s-TOFHLA to measure health literacy, 83% of participants were found to have adequate health literacy, meaning they correctly filled in 23 or more of the 36 blanks. These rates are higher than most national samples reported, with these investigations revealing approximately 60% or less of individuals scoring in adequate ranges (Herndon et al., 2011; Kutner et al., 2006; Lee et al., 2006). However, investigations utilizing patients with asthma or chronic lung diseases have found similar rates as the current study, with adequate health literacy rates between 66-80% (Federman et al., 2014; Mancuso & Rincon, 2006; Paasche-Orlow et al., 2005). Given that samples utilizing patients with chronic lung disease have generally found higher rates of adequate health literacy than national samples, it is possible that health literacy improves with the repeated and consistent exposure to the healthcare system associated with managing a chronic disease.

Rates of health numeracy were much lower than rates of health literacy. Less than a third (31%) of participants scored in the adequate range of health numeracy, meaning that they answered more than four out of six numeracy questions correctly. This rate is in line with previous research that reports adequate health numeracy ranging between 25-66% (Ancker & Kaufman, 2007; Kutner et al., 2006).

Healthcare Utilization Rates

Of the 50 participants in the current study, 42% visited the emergency room within the 12 months preceding participation. Of those who presented to the emergency room, patients visited an average of 2.38 ± 1.83 times in the 12 month span. Thirty-four percent were admitted to the hospital within the 12 months preceding participation. Average length of hospital stay was 5.46 ± 3.13 days. Of those hospitalized, patients averaged of 2 ± 1.06 hospitalizations in the preceding year. No relationship between health literacy or health numeracy and healthcare utilization was detected. This is in contrast to years of robust findings to the contrary (Baker et al., 2002; Baker et al., 2004; Herndon et al., 2011; Murray et al., 2009). This lack of expected relationship could be attributed to the small sample size, as discussed below. It is believed that inadequate health literacy impacts rates of healthcare usage several ways, such as patients' inability to apply disease-specific knowledge leading to worse management of the disease or a misunderstanding of when a visit to the emergency room is needed (Herndon et al., 2011).

COPD Knowledge

Patients in the current sample correctly answered an average of 54% of questions about COPD. Questions covered a range of topics including common causes and symptoms of COPD, exacerbations, healthy behaviors, and medication use. It is unknown how this compares to other samples as the literature on disease knowledge in patients with COPD is quite lacking. It is interesting to note that COPD knowledge was not associated with reported participation in pulmonary rehabilitation, particularly since a large component of pulmonary rehabilitation programs is typically disease education. This lack of association points to barriers to patient learning that are not being considered by the current healthcare system.

Analyses supported hypotheses. Specifically, health literacy significantly predicted knowledge of COPD, even after controlling for factors such as cognitive functioning, level of education, and general literacy. Additionally, these findings appear to be unique to health literacy as health numeracy was not found to contribute significantly when added. Lastly, exploratory analyses revealed that general literacy, a measure of standard literacy, was significantly related to knowledge of COPD, but this relationship was partially mediated by health literacy. Previous research has found similar results in those with other chronic diseases; however, no investigation to date has explored these relationships in those with COPD.

Several important conclusions can be drawn from the current findings. First, these results further support the idea that general literacy is a necessary, but not sufficient prerequisite to health literacy (Baker, 2006). Second, results linking health literacy, but not health numeracy to knowledge of COPD indicate that these may be two separate constructs, as theorized by health numeracy researchers (Nelson et al., 2008). Given the high correlations noted between the health literacy measures (METER and s-TOFHLA) and the health numeracy measure (NVS), it is likely that there is some overlap between the constructs; however, they do not appear to have similar influences on knowledge of COPD. Finally, the strong relationship between health literacy and disease knowledge highlights the importance of considering health literacy when treating patients with COPD.

Specifically, health literacy appears to be related to patients' ability to learn pertinent and relevant information regarding how to effectively manage their disease. Because exacerbations are associated with disease progression, a large portion of properly managing COPD includes patients understanding signs and symptoms of exacerbations and how to proceed with appropriate care (Donaldson et al., 2002; Potter & Wilkinson, 2011). A recent review of self-management of COPD highlights this, noting that obtaining relevant information about the disease is the most important factor in successful self-management (Disler et al., 2012). This review goes on to note how complex and challenging the self-management of COPD can be for patients, including the need to use information to make informed decisions about their disease. This is concerning given that the current sample was only able to answer approximately 50% of COPD knowledge questions, on average, and further speaks to the importance of not only understanding patients' health literacy levels, but also tailoring information to ensure they are able to comprehend and utilize it effectively.

However, there is concern about how best to accurately measure a concept as broad as health literacy (Jordan et al., 2011). As described above, a composite variable was created for the current study's analyses due to concerns that one measure of health literacy would not be broad enough to capture the complex skill set. This is not a realistic approach for assessing health literacy in the healthcare system and future research could focus on parsing out what aspects of the construct are most important to disease management and how to accurately and quickly assess these in the healthcare setting.

Inhaler Techniques

Less than 20% of the current sample was able to correctly perform all 8 inhaler steps and participants correctly performed an average of 78% of inhaler steps. These rates are similar to other studies which have reported 21% of patients performing all steps correctly and 17-24% of individuals missing at least one step (Melani et al., 2004; Shrestha et al., 1996). Looking at inhaler type, MDI's were the most commonly prescribed (42% of participants), but also had the fewest number of steps performed correctly (an average of 5.81 out of 8 ± 1.40). The Handihaler was the next most commonly prescribed (34% of participants) and had the most number of steps performed correctly (an average of 7.18 out of 8 ± 0.82). When looking at which steps were most commonly missed with MDI use, step 3 (breathing out completely), step 7 (holding breath for 10 seconds or as long as possible), and step 8 (waiting at least one minute before repeating steps 3-8) were missed by 52.4%, 61.9%, and 52.4% of participants, respectively.

As mentioned previously, proper use of inhalers is necessary to ensure patients are receiving correct doses of medications and reducing their risk of exacerbations (Lahdensuo & Muittari, 1986). Poor inhaler technique has been linked to increased emergency room use, poorly controlled chronic disease, and less utilization of regular doctor appointments, further highlighting the importance of identifying those patients who may struggle to comprehend inhaler directions (AL-Jahdali et al., 2013). Additionally, there has been debate in the research as to whether health numeracy impacts chronic disease management differently than health literacy (Apter et al., 2013). The current study found that health numeracy was significantly correlated with number of correct inhaler steps, but neither health literacy nor health numeracy were significantly related to correct inhaler steps when examined in a regression analyses controlling for other factors. No previous studies examining health numeracy and its effects on inhaler use could be found. however, prior research has revealed that cognitive functioning, particularly executive function, is related to proper inhaler technique (Allen, Jain, Ragab, & Malik, 2003; Allen & Ragab, 2002). Additionally, health literacy has also previously been found to significantly predict inhaler technique (Paasche-Orlow et al., 2005). It is possible that directions for inhalers are not as complex as some other chronic disease management techniques, such as those involved in diabetes mellitus, and thus is not specific to health numeracy.

Limitations

The most prominent limitation of the current study is the small sample size. Power analyses were initially completed using G-Power Version 3.1.5 (Faul et al., 2009). These analyses estimated that in order to attain the critical F value, $F(5,86) = 2.32$, in a multiple regression with five predictor variables, with .05 alpha, when power is .80, and estimated effect size is .15 (medium effect size for F-test multiple regression), a sample size of 92 would be needed. This recommended sample size is far greater than the achieved sample of 50. It is possible that the hypothesized relationships between health literacy and health numeracy and healthcare utilization are present, but were unable to be detected due to the low power.

A second limitation is the difficulties encountered recruiting patients at physician offices. Recruitment efforts covered a two year period from August 2012 to August 2014 and consisted of informational letters and in-person recruitment. Specifically, 900 informational letters were mailed out to potentially eligible patients identified by the physicians' office. Seventy-six potential participants were approached about participating. These individuals were either identified at the physicians' office or contacted researchers after receiving informational letters. Of these 76 potential participants, four were not eligible, three were not interested, and 16 did not answer their phone when called to schedule a time to participate and did not return voicemail requests to schedule. Fifty participants were scheduled and successfully completed the study requirements and three cancelled their scheduled participation time. Of the 50 participants to complete the study, 36 were recruited as a result of their response to the informational letter. It is unknown how many of the 76 potential participants were identified through their response to the letter. However, even if it is assumed that all 76 were approached due to the letter, the response rate is only 8%. Out of the 76 patients who discussed potential participation with the researchers, 50 or 67% successfully completed the study. These ratios indicate that face-to-face contact with the researchers is a valuable way to recruit participants and informational letters are overlooked or discarded by the majority who receive them. Unfortunately, a lack of support from the physicians' office made it difficult for the researchers to gain access to patients in order to recruit in-person. Specifically, lists of potential participants were provided in order to send out informational letters; however, the physician office staff was not willing or able to recruit patients themselves or identify scheduled patients who may have qualified for the study. This resulted in researchers having to be present in the office for extended periods of time in order to screen patients scheduled for the day and approach those who could potentially qualify. Additionally, a large percentage of appointments were for non-COPD patients, such as sleep apnea, which resulted in large amounts of time spent in the office for minimal potential patients. Without direct support from physicians through recruitment or patient identification, researchers were left to rely heavily on the informational letters, as patients hospitalized with COPD were too sick to participate.

The data gathered from the current study, as originally proposed, was intended to be pilot data for a larger grant proposal. However, recruiting difficulties have suggested that recruiting 100 patients with COPD from physicians' offices is not feasible. With only one source of access to potential subjects it is not possible to recruit enough patients with COPD to carry out larger scale research projects. Future research in this area will have to seek pulmonologists willing to actively recruit patients or directly refer potentially eligible and interested patients.

A final limitation to the current study is the use of the V-4 Advanced Vocabulary test. Specifically, this assessment is a subscale of a larger cognitive battery created in 1963 and no validation studies could be found. While the original test manual identifies it as a component of verbal comprehension, no formal validation of the items ability to assess reading ability or verbal comprehension could be found. Despite this, the measure appears to have high face validity and vocabulary has been found to be highly correlated with reading comprehension (Curtis, 2005; Kruidenier et al., 2010). Additionally, vocabulary has been deemed essential to understanding meaning in text (Kruidenier, 2002). Finally, the V-4 was significantly correlated with other variables as expected, including cognitive functioning, education, and health literacy.

Conclusions and Ways Forward

Overall, the current study found that health literacy significantly predicted knowledge of COPD, even after controlling for cognitive functioning, general literacy, and level of education. This finding indicates that higher levels of health literacy in those with COPD are related to greater knowledge of their disease. Additionally, health literacy was found to partially mediate the relationship between general literacy and health literacy. These findings echo previous research with other chronic diseases showing that health literacy is an important factor that can have serious implications for patients' health (Cavanaugh et al., 2008; Williams, Baker, Honig, et al., 1998).

Specifically, inadequate health literacy may make it difficult for patients to learn important information on how to properly manage their COPD. Herndon and colleagues note that awareness of the determinants of exacerbations is a key component of the successful management of chronic diseases (Herndon et al., 2011). This is particularly important in a disease like COPD where exacerbations are directly related to the rate of disease progression, making patients' understanding of these events and how to proceed essential to proper self-management (Donaldson et al., 2002; Potter & Wilkinson, 2011). Unfortunately, research has shown that patients with COPD often do not know what is meant by the term exacerbation. Over a third of patients were unable to determine when an exacerbation was imminent, resulting in calls for more extensive patient education (Kessler et al., 2006). It is important to note, however, that two-thirds of the current sample had reported attending pulmonary rehabilitation, a program containing COPD-specific education. Despite attending this specialized education-based program, the majority of participants were still unable to correctly answer half of the questions about COPD. Patient health literacy may play an important role in the effectiveness of chronic disease-focused education. This is evidenced by both the current findings linking health literacy to knowledge of COPD and previous investigations showing a consistent association between level of health literacy and amount of information learned in chronic disease education programs (Mattson et al., 2014). Both are strong indicators that inadequate health literacy is a significant barrier to learning appropriate health knowledge necessary for effective disease management.

While evidence continues to build that these factors have a significant impact on the health and management of patients with chronic illnesses, Paasche-Orlow and colleagues contend that "…inadequate health literacy is a surmountable barrier to learning" (Paasche-Orlow et al., 2005; p. 980). One way to help improve health literacy/numeracy's potential negative impact on health outcomes has been education-based training specifically designed to be understood by a wide array of health literacy and health numeracy abilities. A 2005 randomized controlled trial found that a disease-specific, self-management education significantly reduced hospitalization and emergency room use rates over a two year period in those with moderate to severe COPD (Gadoury et al., 2005). This treatment program focused on teaching patients the signs and symptoms of exacerbations and how to properly take and taper off a steroid medication in addition to a safe, at-home exercise plan.

Overall, current results indicate that health literacy is an important barrier that can have significant impact on the management of COPD through decreased disease knowledge. Future research should focus on developing effective methods of patient education. These protocols should be sure to assess for patient health literacy and health numeracy and provide additional education at appropriate difficulty levels based on these assessments with the goal of improving self-management of COPD.

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Appendix

Patient Demographics and Information

1. What is your age? _______ years old. Date of Birth: ______________

2. What is your gender? _____ Male(0) ______ Female(1)

3. What is your ethnic group? (please select only one)

_____ African American(1)

_____ Asian(2)

_____ Caucasian, non-Hispanic(3)

_____ Hispanic (Cuban, Latino, Mexican, Puerto Rican, Spanish)(4)

_____ Native American/Hawaiian-Pacific Islander(5)

_____ Other (describe)(6)_____________________________________

4. How many years of formal education have you competed? _____ years

_____ 0-8 years (0)

_____Some high school (1)

_____Graduated high school (2)

_____ Some college (3)

_____ Associates degree or equivalent (4)

_____ Bachelor's degree or equivalent (5)

_____ Master's degree or above (6)

_____ Completed doctorate degree (7)

5. What is your current marital status? (please select only one)

_____ Married (1)

_____ Separated (2)

_____ Divorced (3)

_____ Widowed (4)

_____ Single (5)

_____ Live-in Partner (6)

6. What is your relationship with the caregiver? (please select only one)

_____ Spouse(1)

_____ Son(2)

_____ Daughter(3)

_____ Father(4)

_____ Mother(5)

_____ Brother(6)

_____ Sister(7)

_____ Other(8) (please describe)_______________

7. What is your current living arrangement? (please select only one)

_____ Live alone(1)

_____ Live with spouse/partner(2)

_____ Live with spouse/partner and children(3)

_____ Live with roommates (not spouse or partner)(4)

_____ Live with parent(s)(5)

_____ Other(6) (please describe)____________________

8. Which best describes your current location? (please select only one)

_____ Rural(1) _____ Industrial(3)

_____ Residential(2) _____ City(4)

_____ Other (5) (please describe)_________________________

9. What is your current employment status? (please select only one)

_____ Disabled and unable to work(1)

_____ Full-time homemaker(2)

_____ Retired(3)

_____ Working full time (35 hours or more a week)(4)

_____ Working part-time (less than 35 hours a week)(5)

_____ Unemployed(6)

_____ Other(7) (please describe)____________________

10. If currently employed, does your job involve exposure to smoke, fumes, dust or other environmental toxins? _____ No(0) _____ Yes(1)

11. What type of health insurance coverage do you have? (please select only one)

_____ None(1)

_____ Medicare(2)

_____ Medicaid(3)

_____ Both Medicare and Medicaid(4)

_____ Private health insurance(5)

_____ Both private health insurance and Medicare(6)

_____ Other(7) (please describe)_____________________

12. What is your approximate annual total household income? (please select only one)

_____ Less than $10,000 per year(1)

_____ More than $10,000 but less than $25,000 per year(2)

_____ More than $25,000 but less than $50,000 per year(3)

_____ More than $50,000 but less than $75,000 per year(4)

_____ More than $75,000 but less than $100,000 per year(5)

_____ More than $100,000 per year(6)

13. Please list any additional medical problems (examples: diabetes, high blood pressure):

____

____

____

____

____

____

14. Please list all medication, including herbal medications, which you are currently taking:

____

____

____

____

____

15. Do you currently use any home health care services? _____ Yes(1) _____ No(0)

If yes, how often do they come to your home? __________________________________

16. Do you currently smoke? _____ Yes(1) _____ No(0)

If yes, how much do you smoke a day? _____________________________

17. Did you ever smoke? _____ Yes(1) _____ No(0)

If yes, how many years did you smoke ? ______ How many packs per week?_________

18. Does anyone in your home smoke? _____ Yes(1) _____ No(2)

19. How long have you had your respiratory illness? ______________________

20. Do you attend a support group (COPD or Other)? _____ No(0) _____ Yes(1)

If yes, what type?____

21. Do you or did you ever attend Pulmonary Rehabilitation? _____ No(0) _____ Yes(1)

22. If you use oxygen, how is it prescribed?

_____ Full Time(1)

_____ At night only(2)

_____ During the day only(3)

_____ During activities requiring physical exertion only(4)

_____ As Needed(5)

23. If you use oxygen, do you use it as prescribed? _____ Yes(1) _____ No(0)

If no, why not?____

24. If you use oxygen, approximately how many hours a day do you use it?

_____Hours per day

25. Does your caregiver accompany you to your doctor's appointments?

_____ Yes, they attend ALL appointments(1)

_____ Yes, they attend MOST appointments(2)

_____ Yes, they attend SOME appointments(3)

_____ No, they do not attend appointments(0)

26. If your caregiver attends doctor's appointments with you, are they an active participant (ask questions, seek information from doctor, etc.)? _____No(0) _____Yes(1)

If yes, how do they participate?

____

____

____

____

____

METER

The following list contains some real medical words. For example, some of the words have to do with body parts or body functions, kinds of diseases, or things that can make your health better or worse. The list also contains some items that may look or sound like medical words but that are not actually real words.

As you read through the list, put an “X” next to the items that you know are real words. You should not guess. Only put an “X” next to an item if you’re sure it’s a real word.

______ Irrity
______ Arthritis
______ Obesity
______ Flu
______ Behaviose
______ Syphilis
______ Potassium
______ Hormones
______ Nerves
______ Pilk
______ Rection
______ Blout
______ Boweling
______ Exercise
______ Pustule
______ Cerpes
______ Kidney
______ Emergency
______ Potient
______ Menopause
______ Diagnosis
______ Depretion
______ Jaundice
______ Gallbladder
______ Miscarriage

______ Hepatitis
______ Astiringe
______ Nutral
______ Asthma
______ Inflammatory
______ Anemia
______ Allagren
______ Prognincy
______ Stress
______ Ellargic
______ Inlest
______ Pollent
______ Malories
______ Cancer
______ Alcoheliose
______ Antibiotics
______ Antiregressant
______ Colitis
______ Diabetes
______ Occipitent
______ Nausion
______ Impetigo
______ Menstrual
______ Abghorral
______ Seizure

______ Appendix
______ Fam
______ Infarth
______ Dose
______ Hemorrhoids
______ Testicle
______ Eye
______ Midlocation
______ Insomniate
______ Bloodgatten
______ Sexually
______ Pelvince
______ Vacilly
______ Prescription
______ Germs
______ Gonorrhea
______ Tumic
______ Fatigue
______ Osteoporosis
______ Constipation

Newest Vital Signs (NVS)

Nutrition Facts	
Serving size	½ cup
Servings per container	4
Amount per serving	
Calories 250	Fat Cal 120
	% DV
Total Fat 13g	20%
Sat Fat 9g	40%
Cholesterol 28mg	12%
Sodium 55mg	2%
Total Carbohydrate 30g	12%
Dietary Fiber 2g	
Sugars 23g	
Protein 4g	8%

*Percent daily values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Ingredients: Cream, Skim Milk, Liquid Sugar, Water, Egg Yolks, Brown Sugar, Milkfat, Peanut Oil, Sugar, Butter, Salt, Carrageenan, Vanilla Extract.

Based on the information in the nutritional label, please answer the following questions:

1. If you eat the entire container of ice cream, how many calories will you eat?

2. If you are allowed to eat 60 grams of carbohydrates as a snack, how much ice cream could you have?

3. Your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42 grams of saturated fat each day, which includes 1 serving of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be consuming each day?

4. If you usually eat 2500 calories in a day, what percentage of your daily value of calories will you be eating if you eat one serving?

5. Pretend that you are allergic to the following substances: penicillin, peanuts, latex gloves, and bee stings. Is it safe for you to eat this ice cream?

YES NO

6. If you answered 'no' to the last question, explain why it would not be safe to eat this ice cream.

Bristol COPD Knowledge Questionnaire (BCKQ)

This questionnaire is designed to find out what you know about your lung problem. It should be completed without help from anyone else, and usually this takes between 10 and 20 minutes. For each item please place a check under True, False or Don't Know.

In COPD:	**True(1)**	**False(0)**	**Don't Know(2)**
In COPD, the word "chronic" means severe.			
COPD can only be confirmed by breathing tests			
In COPD, there is usually gradual worsening over time.			
In COPD, oxygen levels in the blood are always low.			
COPD is unusual in people less than 40 years old.			
COPD:			
More than 80% of COPD cases are caused by cigarette smoking.			
COPD can be caused by occupational dust exposure.			

Long standing asthma can develop into COPD.			
COPD is commonly an inherited disease.			
Women are less vulnerable to the effects of cigarette smoking than men.			
The following symptoms are <u>common</u> in COPD:			
Swelling of ankles			
Fatigue (tiredness)			
Wheezing			
Crushing chest pain			
Rapid weight loss			
Breathlessness in COPD:			
Severe breathlessness prevents travel by air.			
Breathlessness can be worsened by eating large meals.			
Breathlessness means that your oxygen levels are low.			
Breathlessness is a normal response to exercise.			
Breathlessness is normally caused by narrowing of the bronchial tubes.			

Phlegm (sputum):			
Coughing phlegm is a common symptom in COPD.			
Clearing phlegm is more difficult if you get dehydrated.			
Bronchodilator inhalers can help clear phlegm.			
Phlegm causes harm if swallowed.			
Clearing phlegm can be assisted by breathing exercises.			

Chest infections/exacerbations:	True(1)	False(0)	Don't Know(2)
Chest infections often cause coughing of blood.			
With chest infections phlegm often becomes colored (green or yellow).			
Exacerbations (episodes of worsening) can occur in the absence of a chest infection.			
Chest infections are always associated with a high temperature.			
Steroid tablets should be taken whenever			

there is an exacerbation.			
Exercise in COPD:			
Walking is better than breathing exercises to improve fitness.			
Exercise should be avoided as it strains the lungs.			
Exercise can help maintain your bone density.			
Exercise helps relieve depression.			
Exercise should be stopped if it makes you breathless.			
Smoking:			
Stopping smoking will reduce the risk of heart disease.			
Stopping smoking will slow down further lung damage.			
Stopping smoking is pointless as the damage is done.			
Stopping smoking usually results in improved lung function.			
Nicotine replacement therapy is only available by prescription.			
Vaccination:			

A flu shot is recommended every year.			
You can get flu from having a flu shot.			
You can only have a flu shot if you are 65 or over.			
A pneumonia shot protects against all forms of pneumonia.			
You can have a pneumonia shot and a flu shot on the same day.			
Inhaled bronchodilators:			
All bronchodilators act quickly (within 10 minutes).			
Both short- and long-acting bronchodilators can be taken on the same day.			
Spacers (e.g. nebuhalers, aerochamber) should be dried with a towel after washing.			
Using a spacer device will increase the amount of drug deposited in the lungs.			
Tremor may be a side effect of bronchodilators			

Antibiotic treatment in COPD:	True(1)	False(0)	Don't

			Know(2)
To be effective, the course should be at least 10 days.			
Excessive use of antibiotics can cause resistant bacteria (germs).			
Antibiotics will clear all chest infections.			
Antibiotics are necessary for an exacerbation (worsening) no matter how mild.			
You should seek advice if antibiotics cause severe diarrhea.			
Steroid tablets given for COPD (e.g. prednisone):			
Steroid tablets help strengthen muscles.			
Steroid tablets should be avoided if there is a chest infection.			
The risk of long-term side effects due to steroids is less with short courses than with continuous treatment.			
Indigestion is a common side effect from using steroid tablets.			
Steroid tablets can increase your appetite.			
Inhaled steroids (brown, red, or			

orange):			
Inhaled steroids should be stopped if you are given steroid tablets.			
Steroid inhalers can be used for rapid relief of breathlessness.			
Spacer devices reduce the risk of getting thrush in the mouth.			
Steroid inhaler should be taken before your bronchodilator.			
Inhaled steroids improve lung function in COPD.			

Inhaler Usage

Metered Dose Inhaler (MDI)

1. Remove cap ________

2. Shake the inhaler _________

3. Breathe out completely _________

4. Place inhaler 1–2 inches away from mouth OR in mouth and close lips tightly around mouthpiece________

5. Activate the MDI* at the start of inhalation _________

6. Slowly and deeply breathe in _________

7. Hold breath for 10 seconds or as long as possible _________

8. Wait at least 1 minute before repeating steps 3 through 8 ________

Metered Dose Inhaler (MDI) with spacer

1. Remove cap________

2. Shake the inhaler and then insert mouthpiece of inhaler into the spacer________

3. Breathe out completely_________

4. Close lips tightly around mouthpiece of spacer _________

5. Activate the MDI and then start inhalation_________

6. Slowly and deeply breathe in (should only hear a light whistling sound)_________

7. Hold breath for 10 seconds or as long as possible_________

8. Wait at least 1 minute before repeating steps 3 through 8_________

Diskus®

1. Open inhaler by pushing the thumb grip away from mouthpiece until it clicks_________

2. Hold inhaler level with ground_________

3. Slide lever away until it clicks to prepare dose_________

4. Breathe out completely away from device_________

5. Close lips tightly around mouthpiece_________

6. Breathe in deeply_________

7. Hold breath for 10 seconds or as long as possible_________

8. Rinse mouth with water and spit out_________

Handihaler®

1. Open the inhaler device and the capsule blister_________

2. Insert the capsule into the inhaler and close mouthpiece_________

3. Hold inhaler with mouthpiece upwards_________

4. Press green button once to prepare dose_________

5. Breathe out completely away from device_________

6. Close lips tightly around mouthpiece_________

7. Breathe in deeply (should hear capsule vibrate)_________

8. Hold breath for 10 seconds or as long as possible_________