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Factors affecting quality of life and asthma control in older adults with asthma.

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FACTORS AFFECTING QUALITY OF LIFE AND ASTHMA CONTROL IN OLDER ADULTS WITH ASTHMA

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DEDICATION

This Dissertation is dedicated to my family

Greg Schuckmann, Isabelle Schuckmann and Evelynn Schuckmann

And to my parents and siblings

who provide me with unwavering support and love.

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ABSTRACT

FACTORS AFFECTING QUALITY OF LIFE AND ASTHMA CONTROL IN OLDER ADULTS WITH ASTHMA

Karen Schuckmann

April 13th, 2022

Introduction: Approximately 7.7 percent of adults over the age of 65 in the United States (U.S) have asthma and older adults in the U.S. will increase to 20% of the total population by 2030. HRQOL is low for this age group and asthma is often misdiagnosed and undertreated creating a need for research to improve factors that influence AQOL.

Aims: This study explored two aims. Aim 1 evaluates the relationship between medication numeracy and asthma self-management knowledge with asthma self-efficacy. Aim two evaluates medication numeracy, asthma self-management knowledge, asthma self-efficacy, and asthma control with asthma quality of life.

Methods: A secondary analysis of the study, "Asthma in Older Adults: Identifying Phenotypes and Factors Impacting Outcomes," were used to identify factors affecting quality of life in older adults with asthma. Descriptive statistics, Pearson Correlation Coefficients, and regression analysis were used to explore these factors. Variables were chosen with guidance from the medical literature and the Wilson and Cleary Health Related Quality of Life Theory,

Results: After analysis the data showed that the regression model for Aim 1 was not significant and the variables of ASMK and medication numeracy did not have a significant relationship with asthma self-efficacy. For aim 2 regression model showed significant relationships of age, number of comorbidities, medication numeracy and subjective asthma control with asthma quality of life.

Conclusions: A new model of AQOL based on Wilson and Cleary's HRQOL model was proposed that included the variables that were found to be significant predictors of AQOL.

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INTRODUCTION

Approximately 7.7 percent of adults over the age of 65 in the United States (U.S) have asthma (Centers for Disease Control and Prevention, 2021). Health and economic factors that older adults face are different than the health and economic factors of younger adults (Yanez et al., 2014). Older adults have barriers that make research in this population more difficult. Income changes, multiple diseases, polypharmacy, and physiologic aging are common challenges specific to older adults (Bowling et al., 2019). Physiologically, as the body ages, the immune system is weakened, elasticity in the lungs is lost, comorbidities can mask or exacerbate asthma and environmental and microbial factors may affect the development and severity of asthma (Yanez et. al., 2014). Cognitive decline, dementia and depression have also been shown to affect asthma outcomes and quality of life in older adults (Batgalia et al., 2015, Ross, 2013)). Enright (2002) reported that half of older adults with asthma were undiagnosed. Underdiagnosis and increased morbidity is reported in older adults with asthma as a result of undertreatment of symptoms (Enright, 1999). Due to advances in health services and education, the number of older adults in the U.S. will increase to 20% of the total population by 2030 (Baptist & Busse, 2018). With this increase in the older adult population and the barriers to research in this age group, this population is underserved and under researched (Yanez et al., 2014).

Improving health-related quality of life (HRQOL) is common goal of practitioners treating patients with obstructive lung diseases such as asthma (Moy, 2001; Juniper, 2004). HRQOL has been shown to decrease as individuals age (Etxeberria et al.; 2019, Kannan et al., 2015). More specifically, asthma quality of life (AQOL) addresses the functional impairments associated with asthma severity and includes asthma symptoms, activity limitations, emotional function, and environmental stimuli (Juniper, 1999). There is a lack of studies in the medical literature addressing AQOL in the older adult population that are guided by theory. This dissertation research will address this gap using Wilson and Cleary's HRQOL theory (Wilson and Cleary, 1995), as well as Bandura's Social Cognitive theory (Bandura, 1977), to guide the methodology and interpretation of the data. The inclusion of these theories will help to guide the concepts and definitions used in this study. From these definitions the appropriate variable measurements will be selected to gather data. The independent variables that have been identified within the HRQOL and Social Cognitive Theories that can impact asthma outcomes include asthma self-management knowledge, medication numeracy, and asthma control.

Theoretical Framework

The literature reviewed for this study identified Wilson and Cleary's HRQOL as the primary theory used to guide research related to asthma control. Bandura's Social Cognitive theory and the concept of self-efficacy will also provide the framework for this

study. The concepts presented in these theories introduce and explain the proposed variables in this study.

Social Cognitive Theory was developed by Bandura (1977) and has two main concepts: self-efficacy and outcome expectancy. Bandura defined self-efficacy as one's belief in their ability to successfully complete an action. Outcome expectancy was defined as a person's belief that a given behavior will lead to certain outcomes, although it may not be believed by that person that they can achieve that behavior for the outcome to occur. It is proposed that outcome expectations are largely influenced by self-efficacy expectations (Bandura, 1977).

Wilson and Cleary's (1995) theory of HRQOL describes quality of life as related to health. (Figure 1) Overall quality of life is defined as subjective well-being and how happy or satisfied an individual is in life (Peterson & Bredow, 2004). Four main health-related factors are proposed to affect overall quality of life. They are biological/physiological factors, symptom status, functional status, and general health perceptions (Wilson & Cleary, 1995). Biological/physiological factors are alterations in the function of the cells and organs and are usually objective clinical tests such as laboratory values and physiologic measurements. Symptom status refers to the subjective report of changes in physiologic and psychologic status. Functional status is defined as, "the ability of the individual to perform particular defined tasks" (Wilson & Cleary, 1995, p 61). Symptom status is a determinant of functional status because severe disease symptoms can lead to decreased physical function. General health expectation is a subjective concept that builds upon and integrates all the previously discussed components of the theory (Wilson & Cleary, 1995). Self-efficacy, the main concept of

Bandura's Social Cognitive theory, is closely related to Wilson and Cleary's HRQOL theory's construct of General Health Perceptions that affect HRQOL and demonstrate an overlap in the two theories. The concepts that explain HRQOL are shown being connected with arrows which all lead to the outcome of HRQOL. HRQOL is proposed as a taxonomy, but the arrows in the model do not indicate lack of a reciprocal relationship between the variables (Wilson & Cleary, 1995). Overall quality of life is the outcome of the model and is also influenced by individual and environmental characteristics.

Wilson and Cleary's (1995) model is the most cited HRQOL theory in the literature (Bakas et al., 2012). Bandura's Social Cognitive theory overlaps and enhances the variables in the Wilson and Cleary model (Figure 2). In Social Cognitive Theory self-efficacy parallels the variable of general health perceptions by describing perceptions of health. The Wilson and Cleary's HRQOL model is related to the variable of AQOL. The concepts in the Wilson and Cleary model are explained with the measures in this study. Characteristics of the individual were age, sex, race, comorbidities, and level of education. Biophysiological and physiological variable includes asthma diagnosis. Symptom status can be described through the Asthma Control Test (ACT) and Forced Expiratory Volume (FEV1), functional status by self-management knowledge and medication numeracy, and general health perceptions with self-efficacy (Figure 2).

The variables identified through the HRQOL and Social Cognitive theories were searched in the literature to establish the current state of knowledge in AQOL, asthma self-efficacy, medication numeracy, self-management knowledge and asthma control. Exploring the relationship between asthma self-efficacy and AQOL in the older adult

population can help health care practitioners provide meaningful interventions to improve care to an underserved population which will be guided by theory.

Purpose Statement

This research will be a secondary analysis of data from a longitudinal study of older adults with asthma. A cross-sectional approach will be used to evaluate the association between asthma self-management, medication numeracy, asthma control, asthma self-efficacy, and AQOL. The overall goal of the study is to identify specific factors that are amenable to interventions that can improve the quality of life for older adults with asthma. The specific aims for this study are:

Aim 1: Explore the relationship of asthma self-management knowledge and medication numeracy with asthma self-efficacy in older adults with asthma.

Aim 2: Explore the relationship of asthma self-efficacy, asthma self-management knowledge, medication numeracy, and asthma control with AQOL in older adults with asthma.

The hypotheses to be tested include:

In older adults with asthma:

Hypothesis 1: Self-management knowledge is positively related to asthma self-efficacy.

Hypothesis 2: Medication numeracy is positively related to asthma self-efficacy.

Hypothesis 3: Self-management knowledge and medication numeracy positively effect Self-efficacy.

Hypothesis 4: Medication numeracy is positively related to AQOL.

Hypothesis 5: Asthma self-management knowledge is positively related to AQOL.

Hypothesis 6: Self-efficacy is positively related to AQOL.

Hypothesis 7: Asthma control is positively related to AQOL.

Hypothesis 8: Self-management knowledge, medication numeracy, asthma self-efficacy, and asthma control positively affect AQOL.

Factors affecting quality of life in asthma need to be studied in the population of older adults to determine ways to improve asthma outcomes with future research. This research will fill a gap in the research of asthma in older adults by analyzing data from participants older than 60 years and will be guided using Wilson and Cleary's (1995) Health-Related Quality of Life theory.

REVIEW OF LITERATURE

Asthma is disease of chronic airway inflammation and hyperresponsiveness commonly associated with respiratory symptoms of cough, wheezing, shortness of breath, and chest tightness (Gina, 2021; Baptist et al., 2018). These symptoms vary in severity over time with changes in airflow limitations (GINA, 2021). Asthma is described as heterogenous meaning there are different causes and symptoms that arise from cellular changes. The symptoms that are expressed from the genetic and environmental differences are considered phenotypes (GINA, 2021). There are generally considered two phenotypes of interest in the older adult population: (1) Long standing asthma (LSA), and (2) Late onset asthma (LOA), (Hanania et al., 2011). Asthma is prevalent across the lifespan but is not often studied in the older adult population (Yanez et al., 2014). There are barriers to studying the prevalence and treatment in this age group that include: under-reporting of symptoms, physical inability to preform spirometry testing, misdiagnosis of COPD or heart failure, comorbidities, polypharmacy, and history of smoking (Yanez et al., 2014). Physiologic changes of aging also complicate diagnosis and treatment. In the older adult population there are physiologic changes in organ, tissue and cells that lead to lower functional reserve. At the cellular level, damage to protein and genetic material accumulates over time causing further physiologic damage leading to stiffening chest wall and weakened respiratory muscles (Hanania et al., 2011).

Hanania et al. (2011), state that asthma in the elderly is a common and underrecognized problem. Tools available to measure asthma outcomes include lung function and quality of life. Hanania et al. (2011), state that these psychometric instruments claim to measure the same outcome, produce different results, and are not targeted for the older adult population. Behavioral factors also have an impact on AQOL through self-management, daily symptom monitoring and treatment adherence influenced by asthma self-efficacy (Lavoie et al., 2008). A review of the medical literature was preformed to determine factors impacting asthma quality of life (AQOL) in older adults.

Medication Numeracy

Specific Aim 1 explores the relationship between medication numeracy and asthma self-management knowledge as variables that may change asthma-specific self-efficacy. Medication numeracy is a concept that supports Functional Status as described in the Wilson and Cleary Model (Wilson and Cleary, 1995). Medication Numeracy refers to the ability to understand and follow numerical direction given by a healthcare provider (Apter, et al., 2009). The concept of medication numeracy is not well studied in patients with asthma (Apter et al., 2006). Apter et al. (2006) recognized this gap and created a tool to measure asthma-specific numeracy and studied its link to health literacy. The tool used four items to measure the ability of people with asthma to understand and make decisions based on numerical medication directions prescribed for their asthma care. Apter et al. (2009) validated the Asthma Numeracy Questionnaire (ANQ) by using data collected from 73 adult asthma patients. A more recent study, as reported above, explored the

relationship of asthma self-management, medication numeracy, and AQOL (Apter et al., 2009). In this study the Asthma Numeracy Questionnaire and the mini-AQLQ were administered to measure the variables. Low medication numeracy and low AQOL were significantly ($p=0.03$) associated in a sample of 80 adults with low income (Apter et al., 2009).

This literature review identified only two articles measuring medication numeracy in individuals with asthma (Apter et al., 2006 and Apter et al., 2009). Nelson et al. (2008) completed a literature review addressing numeracy. Two articles addressed medication numeracy in chronic diseases, but neither specifically addressed asthma. One of the articles by Cavanaugh, Huizing et al. (2008) found that low numeracy was associated with low self-efficacy and low self-management in diabetes. The second article by Moore et al. (2011) found that low numeracy was related to low medication adherence in HIV (Table 4). Neither of these articles focused on older adults or mentioned a guiding framework.

Asthma Self-Management Knowledge

Asthma self-management knowledge refers to specific asthma knowledge that one may use to maintain asthma control (Schaffer & Yarandi, 2007), (Table 3). Asthma self-management knowledge supports the Functional Status concept in Wilson and Cleary's HRQOL model. The studies in the literature reviewed either addressed asthma self-management or asthma knowledge but not asthma self-management knowledge.

In the literature reviewed, only one study was conducted on asthma self-management knowledge. Schaffer and Yarandi (2007) developed an instrument to

measure asthma self-management knowledge. The factor analysis identified six distinct content areas of knowledge needed for asthma self-management. These factors include environmental control, inhaler technique, knowledge of steroid medication, knowledge of asthma management, and knowledge of asthma symptoms subjects. The concept of asthma self-management knowledge encompasses the factors contributed to both, asthma self-management and asthma knowledge.

Asthma self-management and asthma knowledge are commonly studied separately. Mancuso et al. (2010) defined asthma knowledge as a person's ability to identify triggers, understand how and when to use rescue and maintenance inhalers, and have a plan to manage exacerbations. Mancuso et al. (2010), states that, "knowledge of asthma is necessary to be an effective self-manager" (p. 886). Similarly, Federman et al. (2014) measured the avoidance of triggers, use of inhalers, and self-monitoring of asthma control to determine asthma self-management.

Research of asthma self-management found that poor asthma self-management in older adults with asthma may be attributed to non-adherence to controller medications, asthma inhaler technique, self-monitoring of asthma control and avoidance of asthma triggers (Federman et al., 2014). Federman et al. (2014) used the Short Test of Functional Health Literacy in Adults (S-TOFHLA) and the Medication Adherence Reporting Scale (MARS) questionnaires to measures asthma self-management. These questionnaires did not include a measure for asthma knowledge. Federman et al. (2014) found that older adults with low or marginal health literacy had lower adherence to inhaler medications and worse inhaler technique.

Ngamvitroj and Kang (2007) measured asthma knowledge with the Knowledge, Attitude, and Self-Efficacy Asthma Questionnaire (KASE-AQ) and found that increased asthma knowledge was associated with higher peak expiratory flow meter (PEFM) use. Mancuso et al. (2010) also measured asthma knowledge with the KASE-AQ and reported that higher levels of knowledge were associated with higher quality of life (Table 4).

The literature reviewed did not differentiate between asthma self-management, asthma knowledge, and self- management knowledge. Another limitation to these studies is that only asthma knowledge or asthma self-management were measured. Only one study measured asthma self-management knowledge. Asthma self-management and asthma knowledge do not explain the variable of asthma self-management knowledge independently. Asthma self-management knowledge encompasses both concepts resulting in a more comprehensive variable.

Asthma Control

This variable addresses the Symptom Status concept in the Wilson and Cleary model. The variable has been measured as a self-report questionnaire, biophysiological spirometry measures such as Forced Expiratory Volume (FEV1), and as Peak Expiratory Flow (PEF), demonstrating its multidimensional nature (GINA, 2019). Asthma control is often a measure of symptom status, use of suggested therapy, and the impact of asthma on a person's everyday life.

Subjective asthma control measures

Two studies that were reviewed used subjective asthma control as the dependent variable (Ozturk et al., 2015; Eilayyan et al., 2015). Eilayyan et al. (2015) used the Asthma Control Test (ACT) as the dependent variable with asthma-quality of life and

self-efficacy as the independent variables. Higher self-efficacy was found to be positively correlated with better asthma QOL and asthma control. Ozturk et al. (2015) also used the ACT as the dependent variable to measure asthma control but did not find an association between asthma self-management knowledge and asthma control.

Five studies used subjective measures of asthma control as an independent variable (Ngamvitroi & Kang, 2007; Lavoie et al., 2008; Eilayyan, et al., 2015; Vollmer et al., 1999; Chen et al., 2007). Ngamvitroi and Kang (2007) found that PEFM use was not associated with asthma control, asthma self-efficacy or asthma knowledge. Lavoie et al. (2008) and Eilayyan, et al. (2015) both found that higher asthma control was associated with higher self-efficacy, and Lavoie et al. (2008), Vollmer et al. (1999), and Chen et al. (2007), found a positive relationship between higher asthma control and better AQOL.

There were three different subjective instruments for asthma control used in the studies reviewed (Table 4). The ACT was used in the studies by, Eilyyan et al. (2015) and Ozturk et al. (2015). The Asthma Control Questionnaire (ACQ) was used by Lavoie, (2008), and the Asthma Therapy Assessment Questionnaire (ATAQ), was used by Vollmer et al. (1999), and Chen et al. (2007). The subjective measures of asthma control differed, but the results were consistent.

Objective asthma control measures

Forced Expiratory Volume (FEV1) is an objective measure of asthma control obtained from spirometry. FEV1 is the volume of air expelled in the first second after a full inhalation (Miller et al., 2005). FEV1 is often expressed as a percent which is the measured FEV1 compared with the FEV1 predicted for a person of the same age, height,

and gender (Miller et al., 2005). FEV1 percent predicted was used as a biophysiologic measure of asthma control in four studies (Chen et al., 2007; Lavoie et al., 2008; Juniper et.al., 2004,;Ngamvitroj & Kang, 2007). Juniper et al. (2008), and Lavoie et al. (2004) used FEV1 percent predicted as an independent variable and found a significant positive association with AQOL. FEV1 percent predicted was used in two studies as a co-variate that helped explain the severity of asthma in participants (Chen et al., 2007; Ngamvitroj & Kang, 2007). FEV1 percent predicted was used in combination with subjective questionnaires to help validate and strengthen the measurement of asthma control.

These asthma control studies showed lack of consistency in the variables used, either as independent or dependent variables (Table 4). The combination of independent variables in each study also differed. There were no studies conducted on older adults with asthma, and they were not guided by a theory. This demonstrated a further need for research in these areas.

Asthma Self-efficacy

Self-efficacy is a modifiable variable that has been shown to be associated with asthma control and AQOL. Self-efficacy is described as the belief in one's ability to complete a task successfully (Bandura, 1977), in this case referring to management and control of asthma. A total of seven studies were reviewed that included self-efficacy. However, there are inconsistencies in the predictor and outcome variables assessed in these studies. Each study used a different combination of independent and dependent variables. The variations in the variables studied resulted in difficulty determining the effect of self-efficacy on asthma outcomes.

Eilayyan et al. (2015), Mancuso et al. (2001) and Mancuso, et al. (2010) included self-efficacy as a dependent variable to assess different aims. Mancuso et al. (2001) and Mancuso et al. (2010) found that increased asthma knowledge was associated with higher self-efficacy, while Eilayyan et al. (2015) found more asthma control was associated with higher self-efficacy. Ejebe et al. (2015) looked at differences in demographics of adult asthma patients with self-efficacy but the mean age was 45.8 and not considered older adults.

Five studies used self-efficacy as an independent variable. The combination of variables used in each study differed causing varied results. For example, Eilayyan et al. (2015) used the independent variables of self-efficacy, physical activity, symptom status, emotional status, and healthcare utilization as predictors of perceived asthma control in a secondary analysis of longitudinal data from the Medical Office of the Twenty First Century (MOXXI) project. Self-efficacy was found to be an important factor related to AQOL and the ability to maintain asthma control (Eilayyan et al., 2015). Perceived asthma control was found to be positively associated with fewer asthma symptoms, higher levels of physical activity and, higher self-efficacy (Eilayyan et al., 2015). In another study by Ngamvitroi and Kang (2007), the authors prospectively examined the effects of asthma self-efficacy, social support, and asthma adherence knowledge on PEFM self-monitoring and found that these variables positively affected asthma control. Apter et al. (2009) explored the relationship between self-efficacy, asthma numeracy, and asthma related quality of life. Self-efficacy was a significant mediator variable that explained the relationship of asthma numeracy and AQOL. Apter et al. (2009) also found that low medication numeracy and low AQOL were positively associated. Lavoie et al.

(2008), studied the relationship between asthma self-efficacy, AQOL, and asthma control. Low asthma self-efficacy was associated with low FEV1 and asthma severity as determined by the Global Initiative for Asthma (GINA) guidelines. Lavoie et al. (2008) concluded that higher self-efficacy and better asthma control were related to higher AQOL. Self-efficacy, knowledge, and attitude towards asthma were potential factors identified by Mancuso, et al. (2010) affecting AQOL. Mancuso, et al. (2010) found that self-efficacy was positively associated with AQOL. Self-efficacy may also have an impact on AQOL and healthcare utilization. In a prospective cohort study, Mancuso et al. (2001), studied the effects of self-efficacy, depressive symptoms, and unrealistic expectations on healthcare utilization and AQOL in asthma patients. Low self-efficacy, more depressive symptoms, and expecting to be cured of asthma predicted lower AQOL (Mancuso et al., 2001). Overall, lower asthma self-efficacy, a higher level of depressive symptoms, and greater unrealistic expectations were associated with worse asthma outcomes (Mancuso et al., 2001), (Table 4).

Another area of weakness in the literature is the lack of self-efficacy research in the older population. Participants in Eilayyan et al. (2015) had the highest mean age of 62.1 (+/- 14.4). The range of ages was not reported for this study. Ngamvitroj and Kang (2007) included an age range from 20-82 years that included older adults, but the mean was 45.5 (+/-12.5). None of the studies reviewed focused solely on older adults.

An important issue identified in the self-efficacy literature is the lack of research on older adults with asthma related to self-efficacy and that the variables studied are not consistent or founded through theory. Due to the lack of studies exploring the relationship

of self-efficacy and its effects on asthma outcomes, in the older adult population, there is a need for more evaluative studies to increase self-efficacy.

Asthma Quality of Life

Health-related quality of life is a concept explained by Wilson and Cleary (1995) as the happiness or wellbeing associated with one's life regarding a person's health. Specifically, AQOL is one's happiness or wellbeing regarding asthma control and management.

The variables of asthma self-efficacy, asthma knowledge, attitude, asthma control, asthma severity, asthma numeracy, and asthma self-management were included in different combinations as independent variables in the studies reviewed. Asthma control and asthma severity were not differentiated, and the other variables were not well defined leading to difficulty comparing variables across studies.

AQOL was most often the dependent variable in the studies reviewed (Lavoie et al., 2008; Mancuso et al., 2001; Mancuso et al., 2010; Juniper et al., 2004; Chen et al., 2007; Apter et al., 2009; Eilayyan, et al., 2015; Vollmer et al., 1999; Apter et al., 2006; Louis et al., 2020; and Briggs et al., 2021). Many authors found that higher AQOL was positively associated with self-efficacy (Apter et al., 2009; Lavoie et al., 2008; Mancuso et al., 2010; Mancuso et al., 2001; Eilayyan et al., 2015). Medication numeracy was found to influence AQOL through its impact on self-efficacy (Apter et al., 2009). Apter et al. (2006) and Apter et al. (2009) found that medication numeracy was associated with higher quality of life. Vollmer et al. (1999), Juniper et al. (2004), Chen et al. (2007), Lavoie et al. (2008), Louis et al., (2020), and Briggs et al. (2021) found that greater asthma control was related to higher AQOL. All the studies that link asthma control to

quality of life used different measurements for asthma control, such as, the ACQ, ATAQ, ACT and FEV1 (Table 4). The inconsistency in measures makes it difficult to compare findings across studies.

The review of literature found no studies specific to asthma in older adults. Lavoie at al. (2008) included participants with a mean age of 49.4 (+/- 14.3) with an age range from 18-75. Similarly, Mancuso, Sayles, and Allegrante (2010) reported a range of 18-62 for participants with a mean of 41 (+/-11). Chen at al. (2007) studied ages 20-89 with a mean of 52.8 and Apter et al. (2009) reported a mean age of 47 (+/-13). More research is need in this underserved and understudied older adult population.

Only one article reviewed specifically stated that their research was based on the Wilson and Cleary Theory of Health-Related Quality of Life. Eilayyan, et al. (2015) integrated Wilson and Cleary's HRQOL theory with the WHO's International Classification of Functioning, Disability and Health leading to the measurement of self-efficacy, quality of life and asthma control. Having only one study guided by theory leaves a gap in theory-based research in quality of life literature.

The literature revealed that many different measurement tools were used to measure each variable and the combination of variables studied was inconsistent (Table 4). This inconsistency makes it difficult to synthesize the literature. Since each measure differed slightly in its content it is difficult to determine which measure is most reliable and valid for the aims of this study. The combination of variables in each study was also inconsistent making it difficult to determine which concept had the most effect on the outcome variables.

The literature on factors affecting AQOL revealed little or no research on older adults, and lack of theory guided studies and inconsistency of the variables and measures used. The literature reviewed demonstrated that self-efficacy, asthma control, asthma self-management knowledge and medication numeracy influenced AQOL.

Conclusion

The aim of this review was to synthesize the literature related to asthma self-efficacy and AQOL and identify gaps that need to be addressed. The review found a lack of studies focused on older adults and a wide variety of combinations of independent and dependent variables. Using a theory helps to guide the selection of variables to be studied and brings consistency to the outcomes and conclusions. The age range of the participants was also problematic as there were no studies done specifically on adults over 65 year of age. This population is under-studied and under treated in asthma-related research.

The literature reviewed will guide the proposed study by providing a guiding theory to advise the selection of variables. Wilson and Cleary's HRQOL theory was used to develop the independent and dependent variables. Bandura's Social Cognitive theory was also used to explain the variable of self-efficacy which is a component of general health perceptions within the Wilson and Cleary theory.

The dependent variables for aim one will be Bandura's Social Cognitive Theory's concept of self-efficacy. The independent variables were chosen from the literature studying self-efficacy in asthma. There were several variables presented that were positively associated with asthma self-efficacy. The variables of self-management knowledge and medication numeracy were chosen for this study because they are also concepts associated with Wilson and Cleary's theory which is further explored in aim 2.

Through the second aim, Wilson and Cleary's theory of health-related quality of life's relationship with asthma is explored. There were variables identified in the literature that fit the concepts presented in the health-related quality of life theory. AQOL will be measured as the dependent variable and is a disease specific measure of the outcome of the Wilson and Cleary theory. The concepts that build the theory, biological and physiological variables, symptom status, functional status, and general health status will be used to explore quality of life related to asthma. Biological and physiological variables were explored through age, comorbidities, and asthma diagnosis. Symptoms status was explained by asthma control measures of ACT and self-management knowledge and medication numeracy measures helped identify functional status. The variable of self-efficacy explored general health perceptions (Figure 2).

The research aims addressed the age discrepancy identified in the literature and the lack of theory to guide the studies. The data for the research study were taken from a study that focused on patients with asthma that were 60 years of age or older. The research aims addressed the gaps in the literature and added to the body of knowledge for asthma in older adults.

RESEARCH DESIGN AND METHODS

Study Design

This cross-sectional study used secondary data to analyze factors affecting self-efficacy and quality of life in older adults with asthma. The primary study, R01AG047297

Asthma in Older Adults: Identifying Phenotypes and Factors Impacting Outcomes, was conducted at a university in the southeast region of the United States with older adults with asthma. The data were collected as part of the prospective cohort study that aims to develop a phenotyping algorithm for older adults with asthma. Additional aims for the primary study were to longitudinally investigate environmental triggers on asthma control and develop a predictive model of Asthma Quality of Life (AQOL) in this population. Data from the 18-month collection period from the primary study were analyzed in this study for factors affecting asthma quality of life and asthma self-efficacy in older adults with asthma. Independent variables of interest included asthma self-management knowledge, medication numeracy, asthma self-efficacy, asthma control, and asthma quality of life.

It is hypothesized, based on the current AQOL literature, that there is a positive correlation between the independent variables, asthma self-management knowledge, medication numeracy, and asthma control, and the dependent variables of AQOL and asthma self-efficacy. The proposed study analyzed these variables in the older adult population.

Primary Study

Sample. The primary study included 188 participants recruited in the southeastern United States. Participants in this study were >60 years old, have a diagnosis of asthma, positively answer at least one of six questions from the Global Initiative for Asthma guidelines, and demonstrated bronchodilator reversibility within the last five years or a positive Methacholine Challenge Test. Bronchodilator reversibility is defined as a 12% or greater increase in FEV1 or FVC and an increase of 200 mL following bronchodilator administration within the last 5 years and/or a methacholine challenge test result of PC20 ≤ 8 mg/dL. If initial eligibility criteria were met the participant was scheduled for a pulmonary function test (PFT) at the university's Clinical Trials Unit. Exclusion criteria included, a current diagnosis of other chronic pulmonary disease, residing in a skilled nursing facility, current smoker, smoking cessation less than 5 years ago, more than a 20-pack year smoking history, prognostic index score of greater than or equal to 10, inability to perform PFT, diagnosis of Myocardial Infarction (MI), stroke or major illness in the last 3 months at the time of data collection. The literature also showed that cognitive status is a component of HRQOL which is a common issue in the older adult population. Data from the primary study being used screened the participants for cognitive ability by using the Prognostic Index for Older Adults as part of the inclusion/exclusion criteria and addressed this potential confounder.

Recruitment. Participants in the primary study were recruited from clinician offices including asthma clinics, pulmonologist, and allergists, as well as residential and assisted living facilities, and within the community at churches and senior citizen centers

(Polivka et. al, 2018). Participants in the primary study that expressed interest were contacted by the research team. A script was used to provide information and answer questions about the study and if inclusion criteria were met, they were scheduled for baseline assessments and confirmatory PFTs at the Clinical Trials Unit.

Data Collection. Data were collected by interviewer-administered questionnaires and via biophysiologic measures. The questionnaires administered in the primary study included: Mini-AQLQ, Asthma Self-Efficacy Scale, Asthma Self-Management Knowledge, Medication Numeracy Questionnaire, Asthma Control Test. Questions were also asked regarding the home environment, healthcare use, medications, comorbidities, work history, education level, asthma action plan, cigarette smoking, and nutrition, as well as demographic data. The biophysiologic measures were PFTs, fractional exhaled nitric oxide (FeNO), atopic skin testing, vitamin D, immunoglobulin E (IgEs), and sputum analysis. Participants also self-reported their medications, healthcare use, and environmental exposures.

Measures

The measures that were used in this study are based on the review of literature, Wilson and Cleary's HRQOL, and Bandura's Social Cognitive theory. Table 5 presents the measures, instruments, reliability information, and statistical data.

Demographic Characteristics. Data on the following demographic characteristics were used as co-variates: (a) age, (b) gender, (c) race, (d) number of comorbidities, and (e) level of education. These variables served as controls for the outcome variables based on Wilson and Cleary's (1995), HRQOL model. Characteristics of the individual are presented at the pinnacle of the HRQOL model to demonstrate the

influence of demographic data on each construct in the model. In the HRQOL model, age, gender and race are characteristics that influence symptom amplification and personality motivation through cultural and generational preferences affecting symptom status and functional status as shown in Figure 1. Level of education is a characteristic that represents a value preference that affects General Health Perceptions and Overall Quality of Life. Comorbidities were included in this study as reflected in the Biophysiologic and Psychologic Factors construct in the HRQOL model and is a factor that can significantly affect AQOL (Wilson & Cleary, 1995).

Asthma Self-Efficacy. The outcome variable for Aim 1 was asthma self-efficacy. The Asthma Self-Efficacy Scale (ASES) (Tobin et al., 1987) was used to measure asthma self-efficacy. This scale has twelve items with possible answers being: very sure (one point), somewhat sure (two points) and not sure at all (three points). Scores can range from three to 36 with higher numbers indicating less self-efficacy. The Self-efficacy scale was reverse coded to match the direction of the other scales. The Cronbach's alpha was used to measure internal consistency and was 0.97 in the first and second administration (Tobin et al., 1987).

Asthma Self-Management Knowledge. Asthma self-management is an independent variable in both aim 1 and 2. The Self-Management Knowledge Questionnaire (Schaffer & Yarandi, 2007), was used to measure asthma self-management knowledge. This instrument contains 24 true or false questions about asthma self-management knowledge. It is scored by summing the correct answers for a continuous score from 0-24. Higher scores indicate greater self-management knowledge. The tool has a demonstrated a Cronbach's alpha of 0.69. (Schaffer & Yarandi, 2007).

Medication Numeracy. Medication numeracy is an independent variable in Aims 1 and 2. The Asthma Numeracy Questionnaire (ANQ), (Apter et al., 2006) measured asthma medication numeracy. This tool has four questions: two multiple choice questions and two fill-in-the-blank questions. The number of correct answers is summed to create a score from 0 to 4, with higher scores equaling higher numeracy scores. The measure of internal consistency was 0.57. The authors argued that this is a satisfactory value for a test with less than ten items (Apter et al., 2006).

Asthma Quality of Life. The outcome measure for aim 2 is asthma Quality of Life (AQOL). The mini-Asthma Quality of Life Questionnaire (mini AQLQ), (Juniper et al., 1999) measured AQOL. The Asthma Quality of Life Questionnaire (AQLQ) measured symptoms, activity limitations, emotional function, and environmental stimuli of patients with asthma to determine asthma quality of life. The mini AQLQ includes 15 items, rather than the original instrument with 32 items, with each answer ranging from one to seven. The sum of these scores can range from 15 to 105 with higher scores indicating higher QOL. Intraclass correlation coefficients (ICC) were used to compare the original instrument to the shorter mini AQLQ and show that the reliability was still present. The ICC for the AQLQ was higher (0.95) than the mini AQLQ (0.83) but both were still considered good/excellent (Juniper et al., 1999).

Asthma Control. Asthma control was measured subjectively using the Asthma Control Test (ACT) and objectively via the Forced Expiratory Volume Percent Predicted (FEV%), obtained at baseline during pulmonary function testing. The ACT instrument is a self-report tool with five Likert-like questions assessing asthma symptoms. The scores were summed and can range from 5-25 on a continuous scale, with higher scores

indicating better asthma control. The Cronbach's alpha was found to be 0.85 at baseline and 0.79 at a follow up visit that was scheduled four to 12 weeks later. (Schatz et al., 2006; Schatz et al., 2007)

Spirometry was used as an objective measure of asthma control because it measures airflow rates on exhalation which are reduced in asthma. Forced Expiratory Volume (FEV1) is a widely accepted physiologic measure of asthma control. FEV1 measures the amount of air in a forced exhalation after a full inhalation in the first second of exhalation (Miller et al., 2005). FEV1% is a ratio of FEV1 and Forced Vital Capacity expressed as a percentage that compares values based on adults of the same gender, height, and age (Cline et al., 1994). FEV1% predicted is considered a better predictor of asthma control than FEV1 because it is compared to patients with similar physiological characteristics (Cline et al., 1994).

Throughout this study, asthma control will refer to both the biophysiologic measures obtained from spirometry and the self-report data of the ACT.

Data Management. The data were prepared and coded by the research team of the parent study. The data are stored in Research Electronic Data Capture (Redcap). Redcap is a secure data management program developed by Vanderbilt University that manages online surveys and databases. It is also capable of secure file sharing and exports directly to most statistical packages including SPSS. The data was deidentified and downloaded via secure internet connection from the file sharing option in RedCap and saved in an SPSS data file. Once downloaded the data was saved on a password-protected computer. The data were transferred to SPSS Statistics 28 for analysis and were cleaned and coded for use in this study.

Missing Data. Missing data was handled by using pairwise deletion. In this method the case with missing data was deleted, leaving the remaining data available for further analysis (Fox-Wasylyshyn & El-Masri, 2005).

Data Analysis

Descriptive Statistics. To assess demographic variables, means and standard deviations were analyzed for continuous variables and frequencies and percentages were analyzed for categorical variables. The demographic variables of the sample include age, gender, race, number of comorbidities, education level, healthcare usage, and medication use. The scores were calculated for each measurement of asthma self-management knowledge, medication numeracy, asthma self-efficacy, asthma control and AQOL as specified by the primary study.

Statistical Procedures. The statistical procedures were conducted in SPSS statistics. The alpha value for the analysis was 0.05. This significance level was used to make decisions on significance of the data. A Cronbach's alpha was performed to determine the internal reliability of the measures.

Pearson Correlation Coefficients were used to determine the strength and direction of the relationships between each independent variable with the dependent variable. Multiple regression was performed in both aims to determine the relationship between the independent and dependent variables. Multiple regression was used to predict a continuous dependent variable with more than one independent variable. Multiple regression explained the contribution each variable has on the total variance of the model and assess how well the statistical model fits the observations. (Munro, 2005). The multiple regression models were adjusted for of age, gender, race, education level,

and number of comorbidities. Interaction effects were evaluated to determine if correlation between the variables is present as this can cause bias. An interaction effect is present if the relationship between two variables changes the relationship of a third variable. If a significant interaction is present a centered variable will be created to eliminate this effect. (Cohen, 2003). Table 5 presents the statistical test that was used for each hypothesis.

Assumptions. Meeting the assumptions of multiple regression allowed the researcher to have information on the accuracy of predictions, test how well the regression model fits the data, and determine the variation in the dependent variable explained by the independent variable (Cohen, 2003). The assumptions of independence, linearity, homoscedasticity, multicollinearity, normality, and outliers was evaluated.

Assumptions for multiple regression state that the dependent variable must be continuous and have two or more independent variables and must demonstrate independence of observations. This was assessed by creating a scatterplot in SPSS. If the assumption of independence is not met another statistical test may be more appropriate such as a logistic regression after making the dependent variables dichotomous. (Cohen, 2003)

If the assumption of independence is met, then the assumptions of homoscedasticity and linearity were tested. Homoscedasticity should be present and represents that residuals are equal for every value of the dependent variable. Linearity is the assumption that there is a linear relationship between the independent variables and the dependent variable individually and as a group. To test these assumptions a scatterplot was created in SPSS. This allowed the evaluation of linearity by looking for

patterns in the scatterplot. There should not be a curve in the scatterplot data, but it should demonstrate the residuals in a pattern forming a line when assessing linearity. For the assumption of homoscedasticity, the spread of the residuals should not increase or decrease, causing a fan or funnel shape, but should be evenly spread. If the assumptions are not met the data may be statistically transformed to create linearity and homoscedasticity or another statistical method may be chosen. (Cohen, 2003)

Multicollinearity was examined next. Multicollinearity occurs when independent variables are highly correlated with each other; this should not be present. The assumption multicollinearity was tested with correlation coefficients and Tolerance/VIF values. If multicollinearity is not met the correlations between the variables will be high (>0.85) and the tolerance value will be less than 0.1 or a VIF greater than 10. If the assumption is met the data demonstrates that the variables are not highly correlated making it easier to determine which variable contributes to the variance explained. If multicollinearity is present, then one of the correlated variables will be dropped. The decision on which variable to drop will be made based on theory and previous research. (Cohen, 2003)

If the assumption of multicollinearity is met, the data can be checked for outliers. Outliers were assessed with case wise diagnostics. If any cases have a standardized residual of greater than +/-3 then it will be investigated further as an outlier. There are two options if outliers are present. The outlier can be removed or, if the outlier has a large influence on the data, it can be considered with the model. (Cohen, 2003)

Once outliers have been removed, if necessary, the assumption of normal distribution is assessed. In order to determine statistical significance, the data must be

normally distributed. Normal distribution can be determined with a histogram or P-P plot. A histogram with a normal distribution curve overlay can be used to ensure that most of the data falls under the bell curve. A P-P plot of standardized residuals can confirm normality by showing data points along a diagonal line. If the data does not demonstrate a normal distribution the data can be transformed to create normality, or an alternative statistical test can be considered. (Cohen, 2003)

When the data sufficiently met the assumptions, or adjusted, it was analyzed for statistical significance in SPSS Statistics 28 using multiple regression.

Aim 1 explored the relationship of asthma self-management knowledge and medication numeracy with asthma self-efficacy in older adults with asthma. To test the hypothesis that asthma self-management knowledge is positively related to asthma self-efficacy, asthma self-management knowledge was compared by Pearson Correlation Coefficient to asthma self-efficacy. Hypothesis two, in older adults, medication numeracy is positively related to asthma self-efficacy, Pearson Correlation Coefficient was used to assess the relationship between medication numeracy and asthma self-efficacy. This method was used to determine the strength and direction of the relationship between two continuous variables. Hypothesis three states that in older adults self-management knowledge and medication numeracy are collectively related to asthma self-efficacy. A multiple regression analysis was used to assess the variables of asthma self-management and medication numeracy with asthma self-efficacy while controlling for age, gender, race, number of comorbidities, and level of education.

Aim 2 explored the relationship between asthma self-efficacy, asthma self-management knowledge, medication numeracy, asthma control (this included both

subjective and objective data for asthma control), and AQOL in older adults with asthma. Hypotheses four through seven used Pearson Correlation Coefficients to individually assess the variables of asthma self-management knowledge, medication numeracy, asthma self-efficacy and asthma control with the outcome variable of AQOL. Hypothesis eight was analyzed with multiple regression to determine the strength of relationship of each variable on AQOL while controlling for age, gender, race, number of comorbidities, and level of education. Interaction effects were adjusted for as necessary.

Human Subject Approval

Human subjects approval was sought through the university's Institutional Review Board. This study is considered exempt and does not need a HIPPA waiver of research authorization since the data has been deidentified. This research is a secondary analysis of data from a larger study and did not collect primary data from human subjects. There is a small risk that participants may be identified by combining several characteristics (age, gender, ethnicity, comorbidities and level of education) due to the small sample size and setting. An effort was made to ensure the privacy of individual case information by interpreting data as a whole rather than an individual basis.

To protect integrity and anonymity, the data from the primary study is stored in a secure data management program as previously described. The data was transferred using a file sharing option over a secured network. After the data were retrieved from the data management site it was stored and analyzed from a password protected computer to ensure data security.

RESULTS

To achieve the specific aims for this study self-efficacy and quality of life data were correlated with factors that may affect their outcomes in older adults with asthma. Multiple regression was used to determine the strength of the correlation of asthma self-knowledge management and medication numeracy with asthma self-efficacy, and asthma self-knowledge management, medication numeracy, asthma self-efficacy and asthma control (Asthma Control Tests and FEV1%) were correlated with quality of life.

The primary study (N = 178) collected data at baseline, nine and 18 months. This secondary study analyzed baseline data to describe the sample and 18-month data to address the three study aims. Participant characteristics are initially described followed by analysis of the hypotheses.

Participant characteristics

The average age of the participants (N=173) was 69.4 (SD=5.6), ranging from 61.7 years to 90.1 years. Most participants were women (74.0%) and White/Caucasian (80.9%), had health insurance coverage (99.4%), and were retired (65.3%); 30.0% working for pay or self-employed and 48.6% had completed college (Table 7). The most common self-reported comorbidities were arthritis (64.5%) and hypertension (45.7%) with the average number of comorbidities reported at 2.2 (SD=1.72).

Less than a third (30.1%) of participants reported having a peak flow meter. Of these, 21.2% reported using their peak flow meter every day. Only 13.9% of participants reported reviewing an asthma action plan with their healthcare provider (Table 8). Less than half (43.9%) reported having a spacer to use with their inhalers. During the preceding 12 months, few participants (3.5%) reported having an overnight hospital stay and 8.1% reported having had an emergency room visit (Table 9). Fifty-seven percent of participants sought treatment from a healthcare provider for worsening asthma symptom in the past 12 months (Table 9).

The number of participants that took five or more medications specifically for asthma was 42 (24.3%) (Table 10). When counting all medications taken by prescription and over the counter 142 (89%) participants took five or more medications (Table 10).

Dependent Variables

ASE was the dependent variable for Aim 1 and was measured by the ASE scale. The average self-efficacy score was 31.3 (SD=3.9), with a low score of 16.0 and a high score of 36.0, with lower scores indicating better asthma self-efficacy. AQOL was the dependent variable for Aim 2 and was measured using the mini-asthma quality of life scale. Scores on the Mini-Asthma Quality of Life scale, when expressed as the total responses divided by 15 per the scoring instructions, had a low score of 1 and a high of 7 producing a mean of 5.5 (SD=1.2). For this instrument higher scores indicated higher quality of life (Table 11).

Independent Variables

The independent variables for Aim 1 were measured with the Asthma Self-Management Knowledge (ASMK) scale and the Medication Numeracy Scale. The mean score for the ASMK scale was 21.1 (SD=2.1) with a range of 15-24, with 24.0 indicating higher asthma self-management knowledge. The mean score for the Medication Numeracy Scale, with four items, was 3.1 (SD=0.9). The scores ranged from 0 and 4, with higher scores equaling higher medication numeracy (Table 11).

The independent variables for Aim 2 were ASMK, medication numeracy and ASE, as previously reported, with the addition of asthma control. Asthma control was measured subjectively by the Asthma Control Test (ACT) and had a mean of 20.2 (SD=4.0) a range of 16.0-36.0 with higher scores indicating better asthma control (Table 11). Asthma control was also measured objectively with an FEV1% predicted for which the mean was 82.3 (SD=18.44) and a range of 36 to 139. FEV1% is a ratio of FEV1 and Forced Vital Capacity expressed as a percentage that compares values based on adults of the same gender, height, and age and asthma was considered well controlled when the value is greater than or equal to 80 (Cline et al., 1994), therefore, this population demonstrates average FEV1%.

Bivariate Correlations

Pearson correlation coefficients were calculated for each variable to evaluate bivariate significance. The independent variables for Aim 1 were assessed for significant relationships to the dependent variable of asthma self-efficacy. ASMK was significantly related to asthma self-efficacy with an r (152)=0.22, p=0.007. Medication numeracy was

not significantly associated with asthma self-efficacy with an r (164)=0.07, p=0.381, (Table 12).

For Aim 2 the independent variables (ASMK, medication numeracy, ASE, asthma control) were assessed for significant relationships with the asthma quality of life as the dependent variable. All of the independent variables in this aim were significantly associated with asthma quality of life when compared independently: ASMK r (147)=0.19, p=0.018, medication numeracy r (158)=0.33, p<0.001, asthma control r(161)=.85, p<.001, and asthma self-efficacy r(160)=0.21, p=0.008, (Table 12).

Other relationships that were significant were the two independent variables of asthma control and ASE (r (167)=0.22, p=0.004) and asthma control and medication numeracy (r (170)=0.22, p=0.005), (Table 12). Possible interaction effects were analyzed with the multiple regression assumption of multicollinearity and interactions were not significant.

Multiple Regression

A multiple regression was performed for Aims 1 and 2. The assumptions of multiple regression were evaluated to ensure the correct statistical test was used. Assumptions one and two require that the study have one continuous dependent variable and two or more independent variables that are continuous or nominal level; this assumption is met. Assumption three requires independence of observations which was evaluated with the Durbin-Watson Statistic. In this study the Durban-Watson statistic was 1.96 for Aim 1 and 1.92 for Aim 2. This statistic ranges from 0-4 with a goal of approximately 2 to indicate no correlation between residuals. For assumption four,

linearity, a scatterplot was created with the studentized residuals and unstandardized predicted values to evaluate the dependent and independent variables (Appendix A). Also, a partial regression plot was created with each independent variable and the dependent variable. The scatterplots showed a linear relationship, meeting this assumption, by being scattered with no pattern present (Appendix). Assumption five, homoscedasticity, assessed via a scatterplot of the studentized residuals and unstandardized predicted values, was also met (Appendix A). Assumption six states that two or more independent variables should not be highly correlated. The VIF/Tol statistic was used to evaluate this assumption. If the VIF is less than 0.10 or the Tol is more than 10, multicollinearities would be present which is not the case for these data. Assumption seven evaluates for significant outliers. Case wise diagnostics was used to identify outliers greater or less than +/-3. There were two outliers of concern for Aim 1 which were evaluated and determined to be within the normal range for that variable and were retained for analysis. There were no outliers identified for Aim 2. Assumption eight evaluated if the residuals were approximately normally distributed with histograms for Aim 1 and Aim 2. All regression assumptions were met.

Aim1: Explore the relationship of asthma self-management knowledge and medication numeracy with asthma self-efficacy in older adults with asthma.

For the first Aim, multiple regression was used to explore the relationships between the independent variables of medication numeracy and asthma self-management knowledge with the dependent variable of asthma self-efficacy. The model was not significant when regressing medication numeracy and asthma-self-management with all covariates accounted for, $F(7, 141)=1.57$, $p=0.15$, Adjusted $R^2=0.03$. The independent

variables only accounted for 3% of the variance in the dependent variable. Only asthma self-management knowledge was significantly associated with asthma self-efficacy (p=0.03) while controlling for age, sex, level of education, race and number of comorbidities (Table 13).

Aim 2: Explore the relationship of asthma self-efficacy, asthma self-management knowledge, medication numeracy, and asthma control with AQOL in older adults with asthma.

For the second Aim, multiple regression was used to explore the relationships among the independent variables of medication numeracy, asthma-self management knowledge, asthma-self efficacy, asthma control and the covariates of age, gender, race, level of education, and number of comorbidities with the dependent variable of asthma quality of life. The model was statistically significant, F (10, 136)=45.30, p=<0.001, adjusted R^2=0.75. The variables collectively explain 75% of the variance in asthma quality of life, which is considered a large effect size (Cohen, 1988). Age (p=0.05), total comorbidities (p=0.01), medication numeracy (p=0.01), and asthma control (p=<0.001), had the highest association with asthma quality of life, while controlling for age, sex, level of education, race and number of comorbidities (Table 14).

DISCUSSION

This study aimed to improve asthma quality of life in older adults with asthma by identifying significant relationships among factors which may affect asthma outcomes. These factors include asthma self-management knowledge, medication numeracy, asthma control, and asthma self-efficacy. This was the first study that explores these variables in the older adult population that was guided by Wilson and Cleary's Health-Related Quality of Life Model (1995). Research among older adults has specific challenges due to factors such as multiple comorbidities, polypharmacy, and physiologic changes of aging creating need for research in this underserved population (Bowling et al., 2019).

Descriptive Statistics

Age, sex, race and level of education were treated as covariates included in the regression analysis because they have an impact on asthma quality of life. The mean age of the sample was 69.4 years old and was primarily White/Caucasian (74%), and female (80.9%). The sample was well educated with 82.1% of participants having completed at least some college or more. The number of co-morbidities was also treated as a co-variate. The sample of 188 participants in this study had a mean of 2.2 comorbidities per participant, the most common comorbidity being arthritis (64.5%), and high blood pressure (45.9%). While age, sex, race and education level were unremarkable, comorbidities were not as high as other studies such as Wardzynska, et al. (2015), that

showed 8.4 comorbidities (N=93), but similarly reported arthritis and high blood pressure as the most common diagnoses.

The nursing and medical literature has shown healthcare usage was increased in the older adult population but a not found to be related to asthma quality of life (Yanez et al, 2017 & Ross et al., 2013). Therefore, healthcare use was used as a descriptive variable and not an independent variable. The number of medications taken also helped to describe the sample. Polypharmacy was defined as using five or more medications at a time (Watt et al., 2017). In this sample 24.3% of participants used five or more medications specifically for asthma. The average total of all medication, prescribed and over the counter, were 11.4 medications with 89% of participants taking five or more at a time. Polypharmacy was not a variable included in the literature reviewed for this study which may indicate a gap in asthma research. In a study by Bohmer et al. (2016), polypharmacy was correlated with older age in asthma patients that were considered as part of general HRQOL. Also, Schenker et al. (2019), found that the mean number of non-statin medications in patients with life limiting illness was 11.6 and that polypharmacy with correlated with poorer health related quality of life.

Descriptive statistics of the independent variables of medication numeracy, asthma self-management knowledge, asthma self-efficacy, and asthma control were also obtained. Medication numeracy was high, with a mean of 3.1 out of 4, when compared with Apter et al. (2009), mean medication numeracy score of 2.3. The instrument of asthma self-management knowledge had a mean score of 21.1. When expressed as a percentage of correct answers the total score showed that asthma self-management knowledge was strong at 88%, which was consistent with the findings of Schafer and

Yanardi, (2007) at 83%. The Asthma Self-efficacy Scale (Tobin et al., 1987), had a mean score of 31.3 with a high score of 36 after being reverse coded. Higher numbers equal better asthma self-efficacy which has been shown to be positively related to asthma quality of life and asthma control (Lavoie et al., 2008). Objective asthma control was measured with FEV1% predicted. The mean FEV1% percent predicted in this study was average at 82.3 (SD=18.4). Subjective asthma control, as measured by a questionnaire produced a mean of 20.2 which was considered well controlled due to the score being greater than 19 and was positively correlated with objective asthma control and AQOL (Schatz et al., 2006). Asthma quality of life measured by the mini-AQOLQ (Juniper et al., 1999) had a mean of 5.5. Chen et al. (2007) reported similar mini-AQOLQ total mean score of 5.3. The results support the hypotheses that the independent variables of asthma self-management knowledge, medication numeracy, asthma self-efficacy and asthma control in this study are highly correlated with the dependent variables of asthma self-efficacy and asthma quality of life.

Specific Aim 1

In Aim 1, asthma self-efficacy was hypothesized to positively correlate in bivariate analysis with asthma self-management knowledge and medication numeracy. Asthma self-efficacy and asthma self-management knowledge were significantly related ($p=0.01$), but medication numeracy and asthma self-efficacy were not significantly related ($p=0.38$), leading to the acceptance of hypothesis one and rejection of hypothesis two. When asthma self-management knowledge, medication numeracy and the covariates were regressed together only asthma self-management knowledge was statistically

significant (F (7, 141)=1.57, p=0.15, Adjusted R^2=0.03 (Table 13). Thus, hypothesis three was also rejected.

In the literature, asthma self-efficacy was found to be positively related to asthma knowledge by Ngamvitroj and Kang (2007). These results are also consistent with Mancuso et al. (2001) and Mancuso et al.'s (2010) studies that showed increasing asthma knowledge was associated with higher asthma self-efficacy. Although the two of the hypotheses in aim 1 were rejected it was determined that asthma self-management knowledge was positively associated with asthma self-efficacy providing a variable of interest when creating interventions to improve asthma self-efficacy.

Specific Aim 2

Aim 2 included asthma self-management knowledge, medication numeracy, asthma self-efficacy and, subjective and objective asthma control and explored their relationship to asthma quality of life. In bivariate analysis the independent variables were all significantly related to the dependent variable of asthma quality of life individually (Table 14) leading to the acceptance of hypotheses 4-7. The total regression model was a good fit, F (10, 136)=45.30, p=<0.001, accounting for 75% of the variance in the dependent variable but still led to the rejection of hypothesis eight since not all variables predicted asthma quality of life. The variables that were statistically significant in Aim 2 were age (p=0.047), total comorbidities (p=0.007), medication numeracy (p=0.014) and subjective asthma control (p=<0.001). Apter et al., (2009) also found a significant relationship between medication numeracy and asthma quality of life. Asthma control was most often correlated with asthma quality of life in the literature (Vollmer et al. ,1999; Juniper et al. ,2004; Chen et al. ,2007; Lavoie et al. ,2008; and Louis et al., 2021).

Although hypothesis eight was rejected valuable information was gained about the factors that positively affect asthma quality of life allowing clinicians and researchers to focus on the concepts that could help predict asthma quality of life.

Theoretical Model Fit

Selection of the variables included in this study was guided by the literature and was based on Wilson and Cleary's Health-Related Quality of Life (HRQOL) Model (1995) shown in Figure 1. In Figure 2, the HRQOL model was adapted for this study. Subjective asthma control, measured with the ACT, was significant in bivariate correlation (p=<0.001) and in Aim 2 regression (p=<0.001) at predicting symptom status and was included in the model under "Symptom Status." Objective asthma control, measured with the FEV1% was not significant in bivariate analysis (p=0.74) or multivariate regression (p=0.488) and thus was not included in the revised model. The variables used to represent "Functional Status" in the model were asthma self-management knowledge and medication numeracy. In this study, medication numeracy was significantly correlated with asthma quality of life in bivariate correlation (p =<0.001) and in the multivariate regression (p=0.014), and self-management knowledge was correlated with asthma quality of life in bivariate analysis (p = 0.02) but not in the multivariate analysis (p=0.611), therefore, it was not included in the final proposed model (Figure 3). Self- efficacy was proposed to measure "general health perceptions" in Wilson and Cleary's HRQOL model. Self-efficacy was not a good measure of general health perceptions and was not significantly correlated in multivariate regression (p =0.486), with asthma quality of life.

The importance of polypharmacy and its association with asthma quality of life was not fully appreciated. Schenker et al., (2019), found that polypharmacy was related to worsening symptom burden and QOL in the older adult population. A systematic review of pharmacy interventions to increase quality of life by Mahdavi and Esmaily (2021), found that pharmacist-led educational interventions positively affected asthma outcomes. In the current study, Asthma Quality of Life was significantly correlated in bivariate analysis with the total number of asthma medications $r(171)=-.019$, $p=0.04$, but the total number of all medications was not correlated with AQOL, $r(161)=-0.12$, $p=0.14$. Since Schneker et al. (2019), found a relationship with symptom burden and polypharmacy, a Pearson correlation coefficient was evaluated to compare polypharmacy with ACT representing symptom burden in the HRQOL model. This comparison was also significant, $r (171)=-0.26$, $p=<0.001$. From this information it is recommended that in future research a measure to evaluate general health perception in Wilson and Cleary's framework should be explored and polypharmacy variables should be included in the analysis of asthma quality of life in older adults with asthma. A newly proposed HRQOL model for older adults with asthma was created based on the findings of this study and warrants further evaluation. (Figure 3)

Limitations

The limitations in this study are inherent to the study design; secondary data analysis limits to what was collected in the original data set. Another limitation in this study is the homogeneity of the sample. The characteristics and socioeconomic factors in this analysis likely are not truly representative of all older adults with asthma. In addition, participants were also recruited in a relatively small geographic area.

Clinical Implications

The treatment and control of asthma and its symptoms can be improved by providing education in the specific areas that affect asthma quality of life the most. This study examined which related variables have a significant effect on asthma quality of life. Medication numeracy was found to be correlated with asthma quality of life and future patient education can be targeted for gaining specific knowledge. Subjective asthma control is also related to asthma quality of life and clinical interventions to improve asthma control can be developed and strengthened. The variables that did not affect asthma quality of life was surprising as objective asthma control, like spirometry, and asthma self-management knowledge were not significant in predicting asthma quality of life but may still have a profound effect on asthma outcomes.

Nursing Implications

By studying the factors that affect asthma quality of life we are better able to focus on what areas need improvement in our patients care. Too often nursing care is heavy on clinical interpretation and treatments and the meanings and associations of concepts that patients experience gets lost. Research based on theory clarifies relationships between concepts so that nurses and medical clinicians can develop and improve treatment and outcomes.

Future Research

The implications that these results have for the profession of nursing demonstrates the importance of including specific groups of older adults in nursing research to capture data of this underserved and under-researched population as described in peer-reviewed articles by Bowling et al., 2019 and Enright, 2002. The older adult population has more

barriers to research than that of the general adult population, yet older adults experience the highest burden of disease (Yanez et al., 2014 & Ross et al., 2013). Additional research is needed to further validate the use of the proposed adaption of asthma quality of life model among older adults with asthma. Further research is also needed to operationalize the concept of general health perception in the adapted model. Moreover, research is needed to further explore the effect of polypharmacy and its relation to the model. Finally, future studies, with larger sample sizes, are also recommended to be conducted in a more diverse sample of older adults with asthma.

Conclusion

The results of this study are important for the nursing profession and future research to identify factors that affect asthma in older adults and to design interventions to improve the factors related to asthma quality of life. The use of theory to identify relationships between concepts that affect asthma outcomes adds to the body of nursing and medical knowledge and should be used to guide future research.

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Table 1

Commonly used abbreviations

HRQOL	Health-Related Quality of Life
AQOL	Asthma-Quality of Life
ANQ	Asthma Numeracy Questionnaire
AQLQ/mini-AQLQ	Asthma-Quality of Life/mini- Asthma-Quality of Life
ACT	Asthma Control Test
PEFM	Peak Expiratory Flow Meter
KASE-AQ	Knowledge, Attitude and Self-Efficacy-Asthma Questionnaire
FEV1	Forced Expiratory Volume

Table 2

Key search terms used for literature review in Pub Med and CINHAL

Concept	**Terms searched**
Self-efficacy	Self-efficacy Self-efficacy AND older adults Asthma Self-efficacy Asthma Self-efficacy AND older adults Albert Bandura Social Cognitive theory
Quality of Life	Quality of life Quality of life AND older adults Health-related quality of life Health-related quality of life AND older adults Asthma quality of life Asthma quality of life AND older adults Wilson and Cleary HRQOL model
Asthma self-management knowledge	Asthma self-management Asthma self-management knowledge Asthma self-management knowledge AND older adults
Medication Numeracy	Medication numeracy Medication numeracy AND older adults
Asthma Control	Asthma control Asthma control AND older adults Spirometry FEV1 FEV1 % predicted Asthma control measurement

Table 3

Conceptual operational definitions of asthma self-management, asthma knowledge, and asthma self-management knowledge

Variable	Conceptual Definition	Operational Definition
Asthma self-management knowledge	Specific asthma knowledge that one may use to maintain asthma control (Schaffer & Yarandi, 2007)	Factors including environmental control, inhaler technique, knowledge of steroid medication, knowledge of asthma management, and knowledge of asthma symptoms from subjects (Schaffer & Yarandi, 2007)
Asthma self-management	Self-treatment or seeking medical help Self-adjustment of medication regimen by the patient (Palen, Klein & Seydel, 1997)	Avoidance of triggers, use of inhalers, and self-monitoring of asthma control to determine self-management. (Federman, 2014)
Asthma knowledge	Understanding of the basic pathophysiology of asthma, be aware of common asthma symptoms and triggers, know appropriate steps to manage asthma episodes (Wigal et al., 1993)	A person's ability to identify triggers, understand how and when to use rescue and maintenance inhalers, and have a plan to manage exacerbations (Mancuso et al.)

Table 4

Relationships and measurements of variables

Studies	Variables, Relationships and Measures	
	Independent Variable	Dependent Variable
Eilayyan, et al., (2015)	↑Self-efficacy (KASE) ↑Asthma control (ACT)	↑AQOL (AQLQ) and Asthma control (ACT) ↑Self-efficacy (KASE)
Ozturk et al. (2015)	Knowledge (author developed scale)	Asthma control (ACT) *No association identified
Mancuso, Sayles, and Allegrante, (2010)	↑Self-efficacy (KASE) and Knowledge (KASE) ↑Knowledge (KASE)	↑AQOL (AQLQ) ↑Self-efficacy (KASE)
Apter et al. (2009)	↓Numeracy (ANQ) ↓Self-efficacy (Self-efficacy & situational barrier)	↓AQOL (AQLQ)
Huang and Wang (2008)	PEFM use with education	↑FEV1
Lavoie at al. (2008)	↓Self-efficacy (ASES) ↑Self-efficacy and ↑Asthma control (ACQ)	↓FEV1 ↑AQOL (AQLQ)
Chen et al. (2007)	↓Asthma Control (ATAQ) ↓ FEV1	↓AQOL (mini-AQLQ)
Ngamvitroi and Kang (2007)	↑Self-efficacy ↑Asthma knowledge ↑FEV1	↑PEFM
Apter et al. (2006)	↓ Medication Numeracy (ANQ)	↓AQOL (AQLQ)
Juniper et al. (2004)	↓Asthma control (ACQ) ↓FEV1	↓AQOL (AQLQ)
Mancuso, Rincon, McCulloch, and Charlson (2001)	↑Self-efficacy (KASE) ↑Knowledge (KASE)	↑AQOL (AQLQ) ↑Self-efficacy (KASE)
Vollmer et al. (1999)	↑Asthma control (ATAQ)	↑AQOL (AQLQ)

Briggs et al. (2021)	↓Asthma control (ACQ) ↓FEV1	↓AQOL (AQLQ & ↓EuroQol-5)
Louis et al. (2021)	↑ FEV1 ↑Asthma control (ACT)	↑AQOL (mini AQLQ)

Table 5

Measures and instruments

Aim	Measure	Instrument	Items	Cronbach's alpha	Data
	Age				Continuous
	Gender				Categorical
	Race				Categorical
	Number of comorbidities				Continuous
	Level of education				Categorical
1 & 2	Asthma Self-Management Knowledge	Self-management knowledge questionnaire	24 items (True/False)	0.67	Continuous
1 & 2	Medication Numeracy	Asthma medication numeracy questionnaire	4 items	0.57	Continuous
1 & 2	Asthma Self-Efficacy	Asthma self-efficacy scale	12 items	0.97	Continuous
2	Asthma Control	Asthma control test, FEV1	5 items	0.85 0.79	Continuous
2	Asthma Quality of life	Mini Asthma quality of life questionnaire	15 items	0.95 0.83	Continuous

Table 6

Statistical tests for hypotheses

Aim	Hypothesis	Independent variable	Dependent variable	Confounders	Statistical test
1	1	Asthma Self-management knowledge	Asthma Self-Efficacy		Pearson correlation coefficient
	2	Medication Numeracy	Asthma Self-Efficacy		Pearson correlation coefficient
	3	Asthma Self-management knowledge, Medication Numeracy	Asthma Self-Efficacy	Age, race, gender, number of comorbidities, and level of education	Multiple regression
2	4	Asthma Self-management knowledge	Asthma Quality of Life		Pearson correlation coefficient
	5	Medication Numeracy	Asthma Quality of Life		Pearson correlation coefficient
	6	Asthma Self-Efficacy	Asthma Quality of Life		Pearson correlation coefficient
	7	Asthma Control	Asthma Quality of Life		Pearson correlation coefficient
	8	Asthma Self-management knowledge, Medication Numeracy, Asthma Self-Efficacy, Asthma Control	Asthma Quality of Life	Age, race, gender, number of comorbidities, and level of education	Multiple Regression

Table 7

Descriptive statistics of Covariates (N=173)

Variable	n (%)
Age (M, SD)	69.4 (5.6)
Gender	
Male	45.0 (26.0)
Female	128.0 (74.0)
Race	
White/Caucasian	140.0 (80.9)
African American	31.0 (17.9)
Native American/Alaskan Native	7.0 (4.0)
Asian	1.0 (0.6)
Mixed	1.0 (0.6)
Other	2.0 (1.2)
Level of Education	
Grade 9-11 (Some High School)	7.0 (4.0)
Grade 12/GED (High School Graduate)	24.0 (13.8)
College 1-3 years (Some College)	58.0 (33.5)
College 4 years or more (College Graduate)	84.0 (48.6)
Employment	
Retired	113.0 (65.3)
Employed/Self-employed	42.0 (30.0)
Unemployed/Homemaker	8.0 (4.7)
Comorbidities	
Arthritis/joint condition	111.0 (64.5)
High blood pressure	79.0 (45.9)
Recent eye surgery	48.0 (30.4)
Hay fever	43.0 (23.9)
Chronic bronchitis, emphysema, or COPD	31.0 (18.3)
Heart condition	30.0 (17.3)
Skin condition	27.0 (15.6)
Diabetes	26.0 (15)
Other	23.0 (13.4)
Cancer	15.0 (8.7)
Ulcer	8.0 (4.7)
Stroke	7.0 (4.1)
Liver condition	5.0 (2.9)
tal Comorbidities (M,SD)	2.2 (1.7)
Covered by health insurance	99.4 (0.1)

Table 8

Descriptive Statistics of Asthma Management (N=173)

Variable	n (%)
Have a working peak flow meter? (Yes)	52.0 (30.1)
Use a peak flow meter to check on your asthma?	
All the time or most of the time	11.0 (21.2)
Some of the time/A little of the time	23.0 (44.2)
Never, don't know/not sure	18.0 (34.6)
In the past 12 months has your doctor given you a written action plan and reviewed it with you?	
Yes	24.0 (13.9)
No, don't know/not sure	149.0 (86.1)
Do you have a spacer to use with each of your inhalers?	
Yes	76.0 (43.9)
No, Lost/can't find	86.0 (49.7)
Don't use an inhaler	10.0 (5.8)

Table 9

Descriptive statistics of Healthcare Use (N=173)

Variable	n (%)
During the last 12 months, did you have to stay overnight at the hospital because of your asthma? (Yes)	6.0 (3.5)
Not counting hospitalizations, during the past 12 months, did you go to the emergency room because of your asthma?	
Yes	14.0 (8.1)
How many times? Mean (SD)	1.9 (1.0)
Not counting hospitalizations or ER visits, during the past 12 months, did you see a healthcare provider for your asthma?	
Yes	98.0 (57)
How many visits?	1.9 (1.1)
How many were unscheduled because your asthma got worse?	0.31 (.73)

Table 10

Descriptive Statistics of Medications Use (N=173)

	n (%)	Range
Total number of asthma medications	173 (3.3)	0-8
=>5 asthma medications	42 (24.3)	
Total number of all medications	11.4 (5.2)	1-24
=>5 all medications	142 (89.0)	

Table 11

Means and SD for independent and dependent variables (N=173)

Dependent Variables	N	Mean (SD)	Min-Max
Asthma Self Efficacy Scale	169	31.3 (3.9)	16-36
MAQOL - total	163	5.5 (1.2)	1-7
Independent variables			
ACT total	173	20.2 (4.0)	6-25
FEV1% predicted	167	82.3	18.4
Asthma self-management knowledge scale	154	21.1 (2.1)	15-24
Medication Numeracy	170	3.1 (0.9)	0-4

Table 12

Pearson Correlations coefficients and significance for Independent and Dependent Variables (N=173)

	ASMK	MN	ACT	ASE	MAQOL	FEV1%
ASMK Pearson correlation	1	-0.38	0.15	0.22	0.19	0.08
Sig		<0.001	0 .06	0.01	0.02	0.37
N	154	152	154	152	147	149
MN Pearson correlation		1	0.22	0.07	0.33	-0.04
Sig			0.01	0.38	0.00	0.66
N			170	166	160	164
ACT Pearson correlation			1	0.22	0.85	0.03
Sig				0.00	0.00	0.71
N				169	163	167
ASE Pearson correlation				1	0.20	-0.06
Sig					0.01	0.44
N					160	163
MAQOL Pearson correlation					1	-0.03
Sig						0.74
N					163	157
FEV1% (% predicted) Pearson correlation						1
Sig						
N						167

Correlation is significant at =<0.05 level.

Note: ASMK = Asthma Self-Management Knowledge
MN= Medication Numeracy Scale
ACT= Asthma Control Test
ASE= Asthma Self-Efficacy Scale
MAQOL = Mini-Asthma Quality of Life Scale

Table 13

Multiple Regression of Age, Sex, Level of Education, Race, Number of Comorbidities, ASMK, and Medication Numeracy on the Dependent variable of Asthma Self-Efficacy (N=173)

	B	95% CI for B LL UL		SE B	β	p	R^2	Adj R^2
Constant	31.48	19.89	43.06	5.86			0.07	0.03
Age	-0.11	-0.23	0.01	0.06	-0.15	0.071		
Sex	0.07	-1.40	1.55	0.75	0.01	0.924		
Level of Education	-0.19	-0.84	0.46	0.33	-0.06	0.570		
Race	0.73	-1.81	2.64	0.97	0.07	0.452		
Number of Comorbidities	0.07	-0.33	0.46	0.20	0.03	0.74		
ASMK	0.38	0.03	0.72	0.17	0.20	0.032		
Medication Numeracy	-0.09	-0.89	0.70	0.40	-0.02	0.820		

Note: Model =" Enter" method in SPSS; B=unstandardized regression coefficient; CI=confidence interval; LL=Lower limit; UL=Upper limit; SE B=standard error of the coefficient; β=standardized coefficient; R^2=coefficient of determination; ASMK=Asthma Self-management knowledge.
*p=<0.05.

Table 14

Multiple Regression of Age, Sex, Level of Education, Race, Number of Comorbidities, FEV1%, ASMK, Medication Numeracy, Asthma Self-Efficacy, and ACT on the Dependent variable Asthma Quality of Life (N=173)

	B	95% CI for B LL UL		SE B	β	p	R^2	Adj R^2
Constant	-0.89	-2.87	1.09	1.00			0.77	0.75
Age	0.02	0.00	0.04	0.01	0.9	0.047		
Sex	0.03	-0.20	0.26	0.12	0.02	0.808		
Level of Education	-0.06	-0.16	0.04	0.05	-0.06	0.205		
Race	0.24	-0.52	0.53	0.15	0.09	0.107		
Number of Comorbidities	-0.08	-0.14	-0.02	0.03	-0.12	0.007		
FEV 1%	-0.01	-0.01	0.00	0.00	-0.03	0.488		
ASMK	0.01	-0.04	0.07	0.03	0.02	0.611		
Medication Numeracy	0.15	0.03	0.27	0.06	0.13	0.014		
Asthma Self-Efficacy	0.01	-0.02	0.04	0.01	0.03	0.486		
ACT	0.23	0.20	0.25	0.01	0.78	<0.001		

Note: Model =”Enter” method in SPSS; B=unstandardized regression coefficient; CI=confidence interval; LL=Lower limit; UL=Upper limit; SE B=standard error of the coefficient; β=standardized coefficient; R^2=coefficient of determination; ASMK=Asthma Self-management knowledge; ACT= Asthma Control Test.
*p=<0.05.

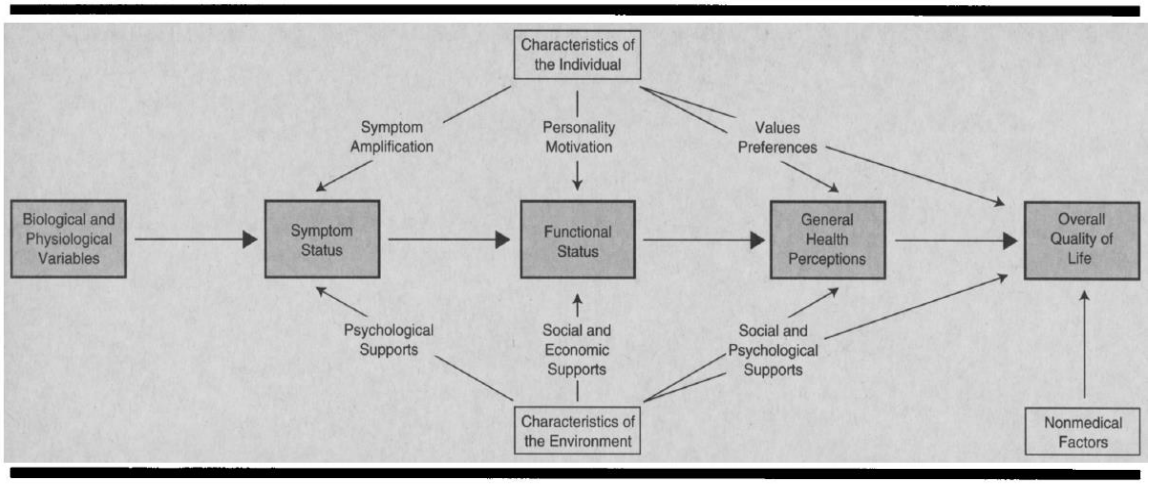
Table 15.

Acceptance or rejection of hypotheses

Hypothesis number	Hypothesis	Result
Aim 1		
1	Self-management knowledge is positively related to asthma self-efficacy.	Accepted
2	Medication numeracy is positively related to asthma self-efficacy.	Rejected
3	Self-management knowledge and medication numeracy positively effect Self-efficacy.	Rejected
Aim 2		
4	Medication numeracy is positively related to AQOL.	Accepted
5	Asthma self-management knowledge is positively related to AQOL.	Accepted
6	Self-efficacy is positively related to AQOL.	Accepted
7	Asthma control is positively related to AQOL.	Accepted
8	Self-management knowledge, medication numeracy, asthma self-efficacy, and subjective asthma control positively affect AQOL	Accepted (Number of Comorbidities, Medication Numeracy, ACT- subjective)

Figure 1

Wilson and Cleary's Health Related Quality of Life Model



Relationships among measures of patient outcome in a health-related quality of life conceptual model.

Note. From "Linking clinical variables with health-related quality of life," by I. Wilson and P. Cleary, 1995, JAMA, 273 (1), 59-65.

Figure 2

Proposed model of Health-Related Quality of Life in Older Adults with Asthma prior to analysis

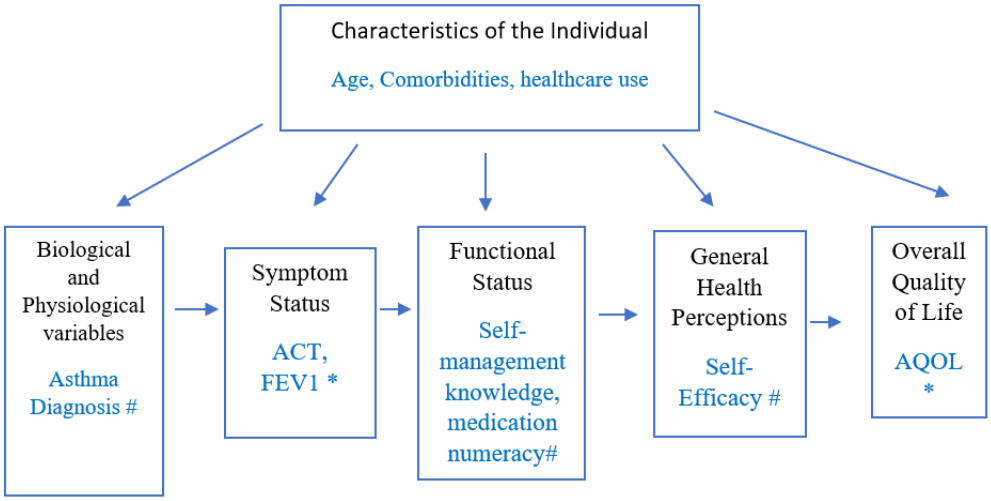
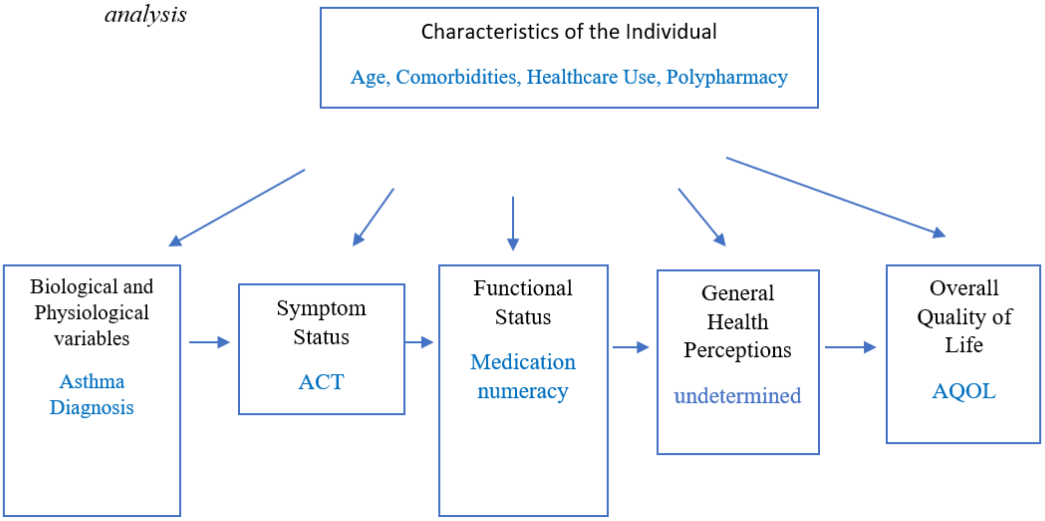


Figure 3

Newly proposed health-related quality of life model for older adults with asthma after analysis



Appendix
SPSS Scatterplots and Histograms

Figure 1

Scatter plot of Regression Studentized Residuals and unstandardized predicted values to evaluate the assumption of Linearity for Aim 1

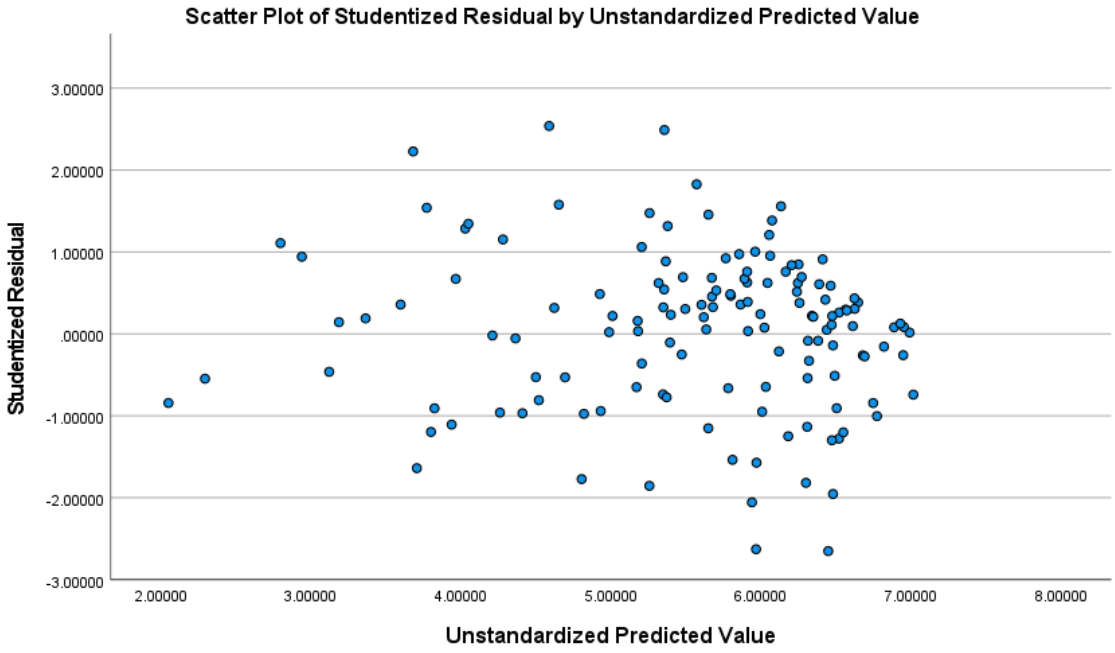


Figure 2

Partial Regression Plot for Age and Asthma Self-Efficacy for Aim 1

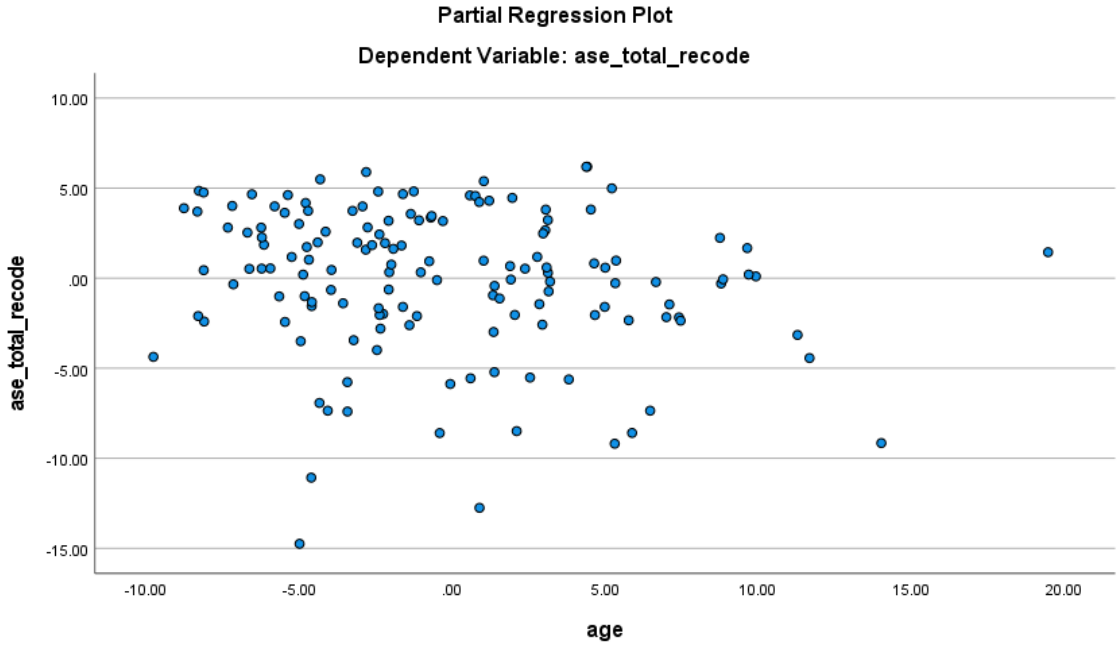


Figure 3

Partial Regression Plot for Level of Education and Asthma Self-Efficacy for Aim 1

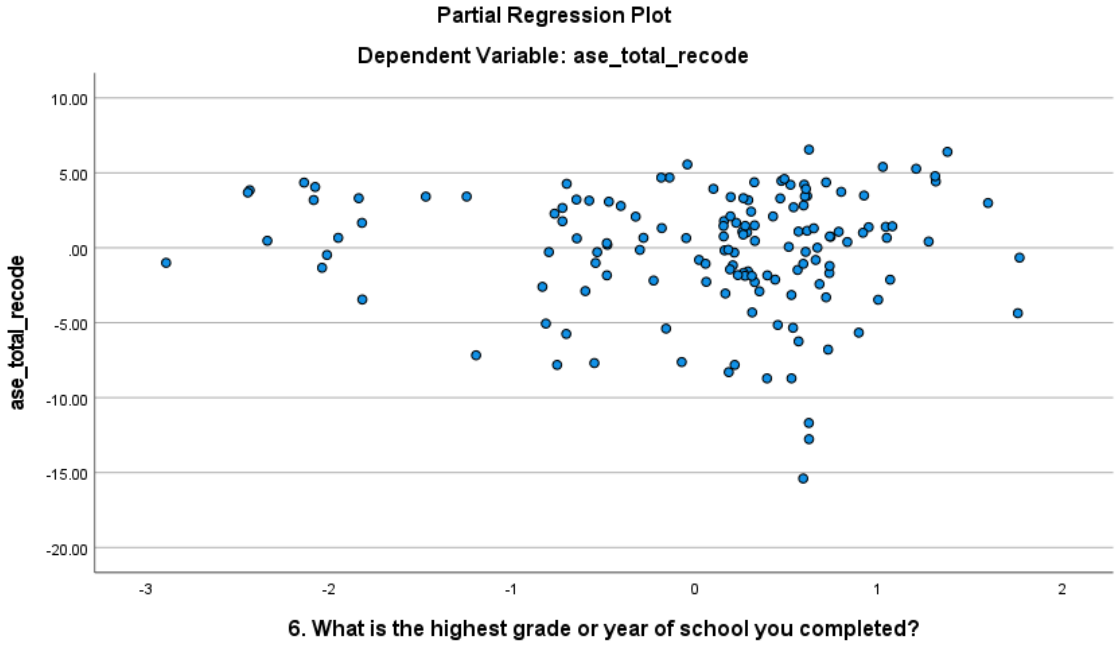


Figure 4

Partial Regression Plot for Race and Asthma Self-Efficacy for Aim 1

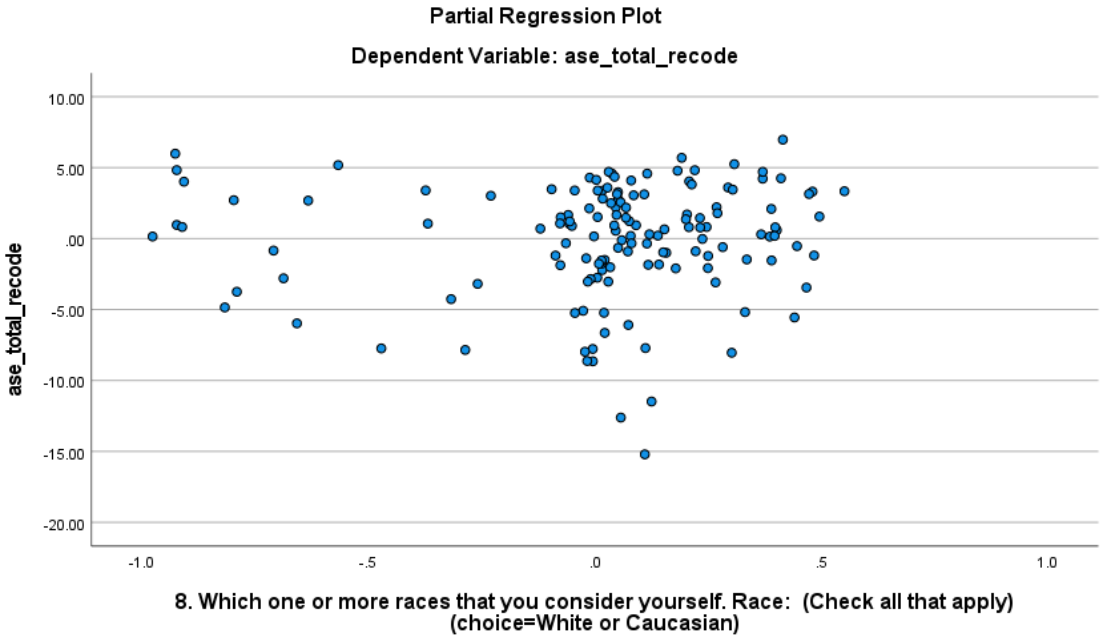


Figure 5

Partial Regression Plot for Total Comorbidities and Asthma Self-Efficacy for Aim 1

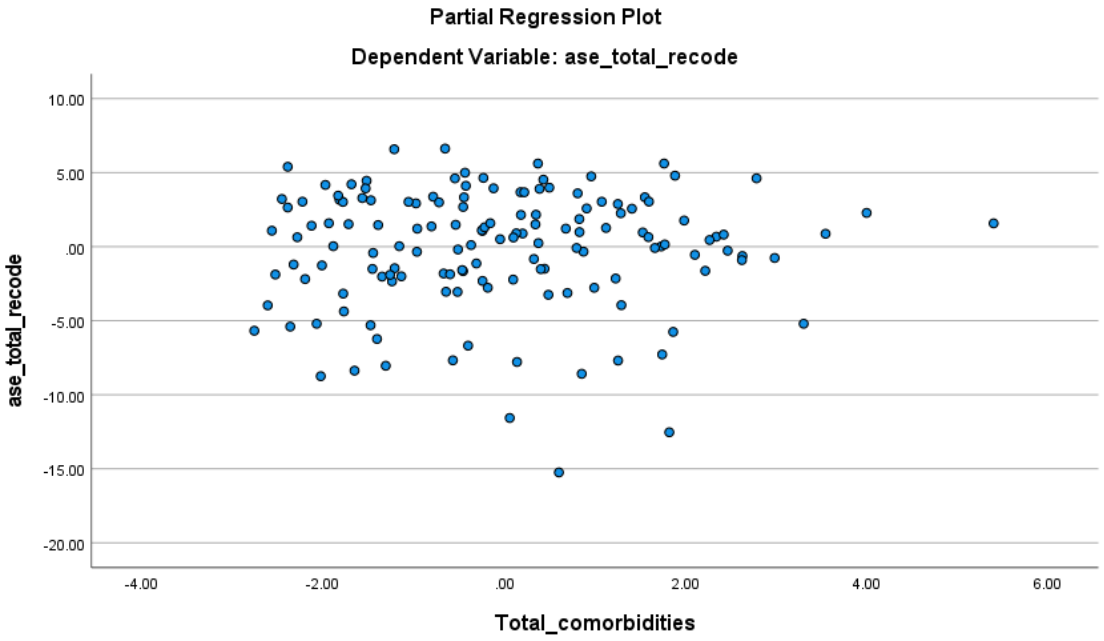


Figure 6

Partial Regression Plot for Asthma Self-Management Knowledge and Asthma Self-Efficacy for Aim 1

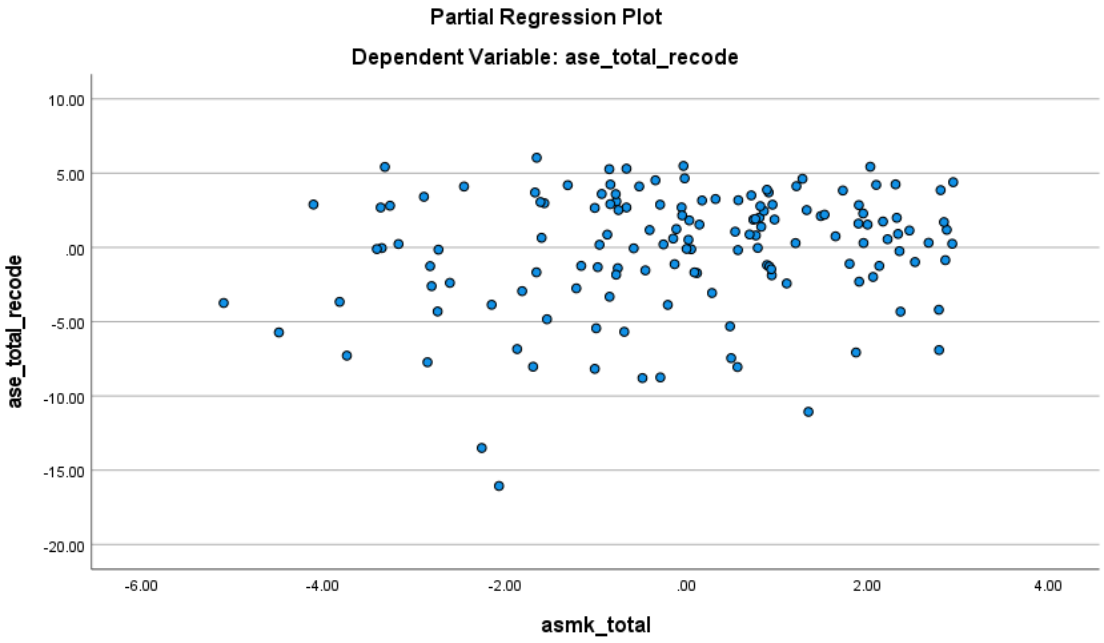


Figure 7

Partial Regression Plot for Medication Numeracy and Asthma Self-Efficacy for Aim 1

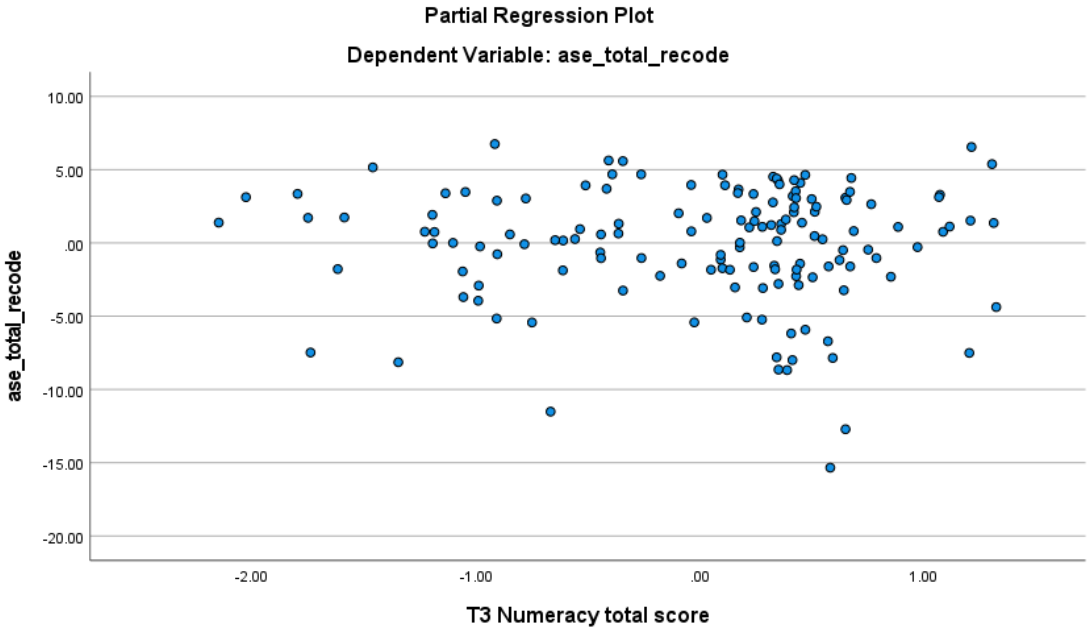


Figure 8

Histogram with Asthma Self-Efficacy as the dependent variable for Aim 1

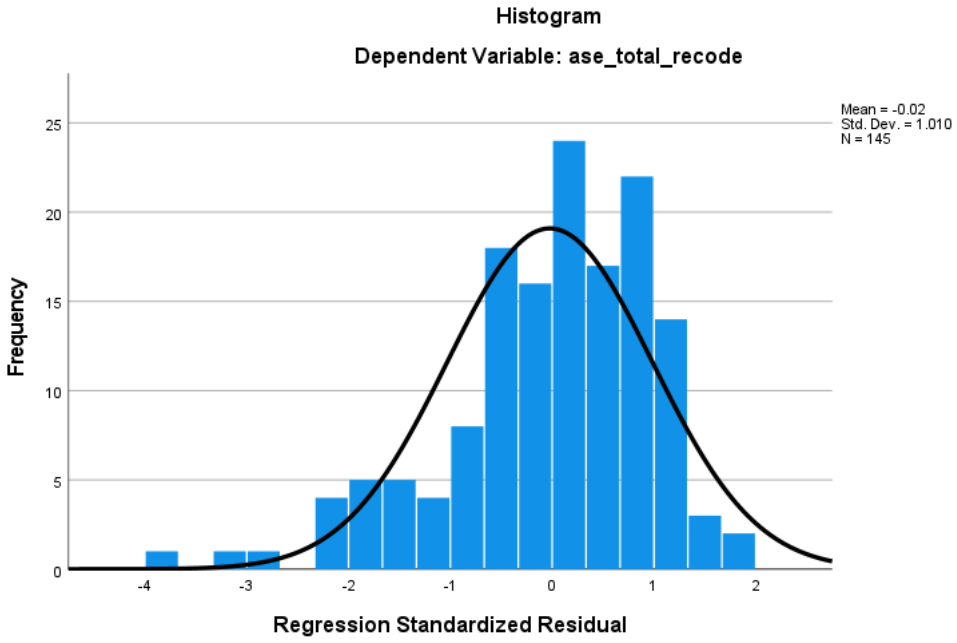


Figure 9

Scatter plot of Regression Studentized Residuals and unstandardized predicted values to evaluate the assumption of Linearity for Aim 2

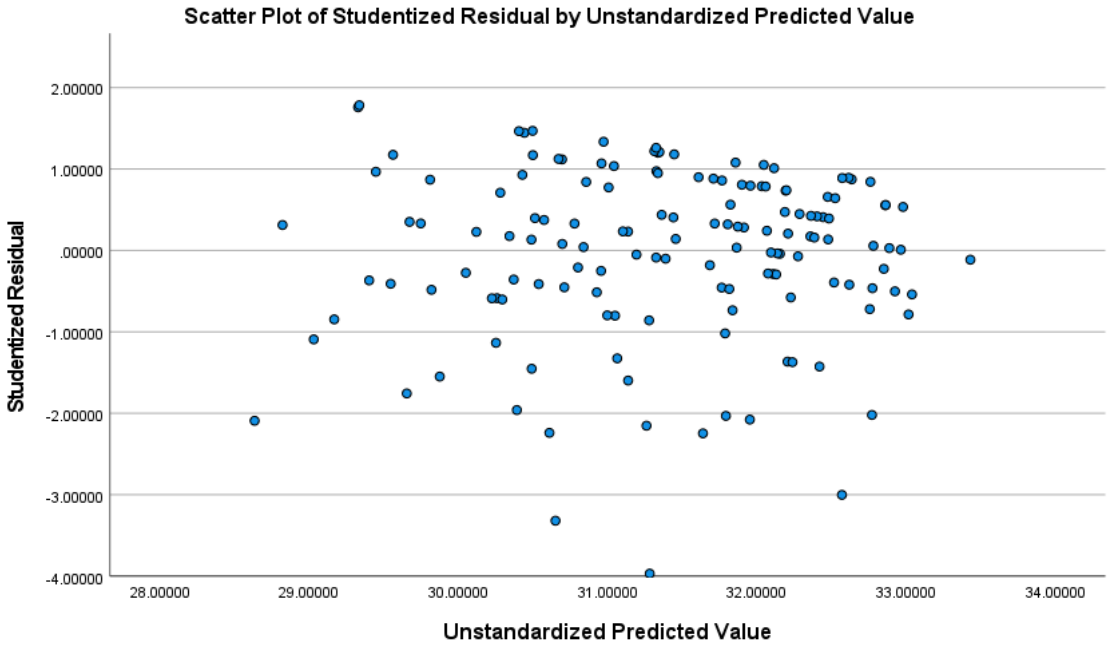


Figure 10

Partial Regression Plot for Age and Asthma Quality of Life for Aim 2

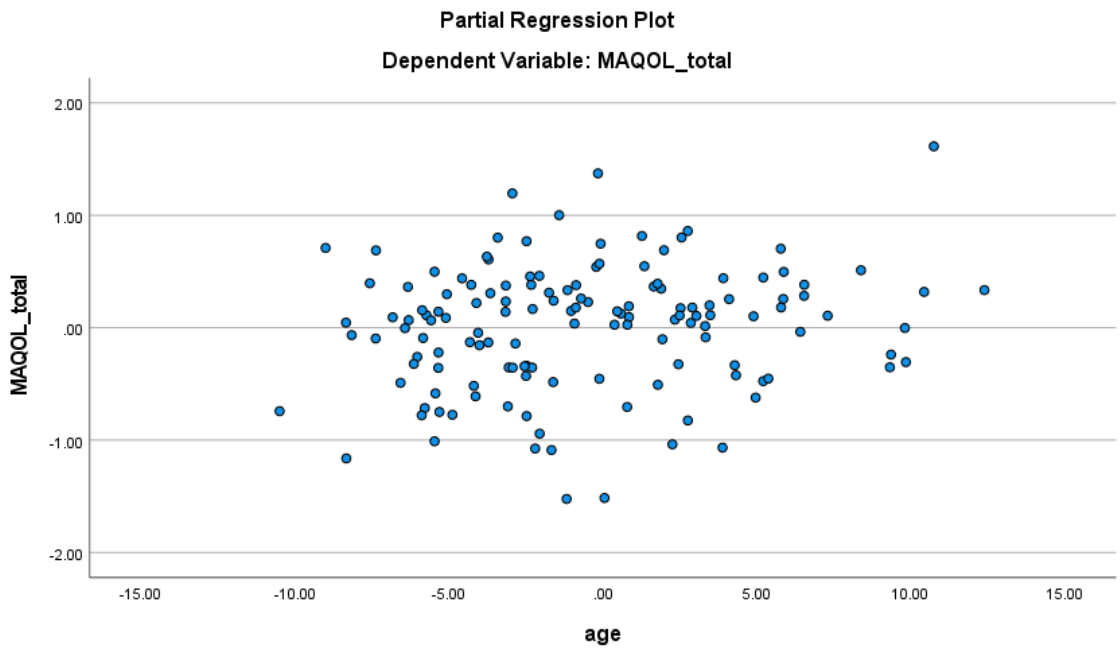


Figure 11

Partial Regression Plot for Level of Education and Asthma Quality of Life for Aim 2

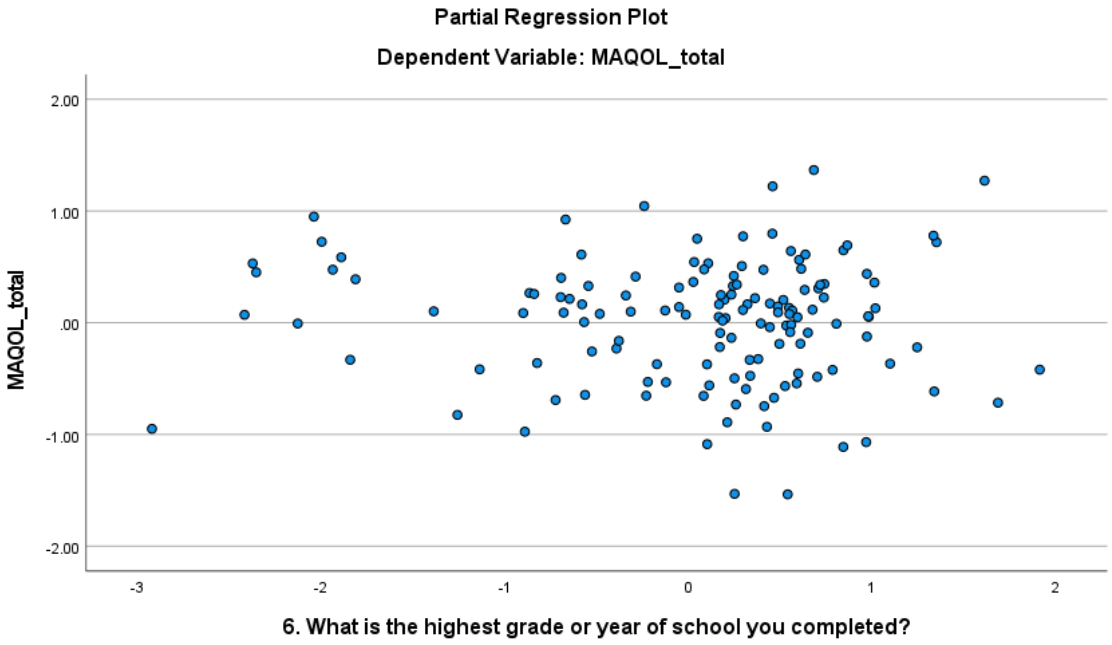


Figure 12

Partial Regression Plot for Race and Asthma Quality of Life for Aim 2

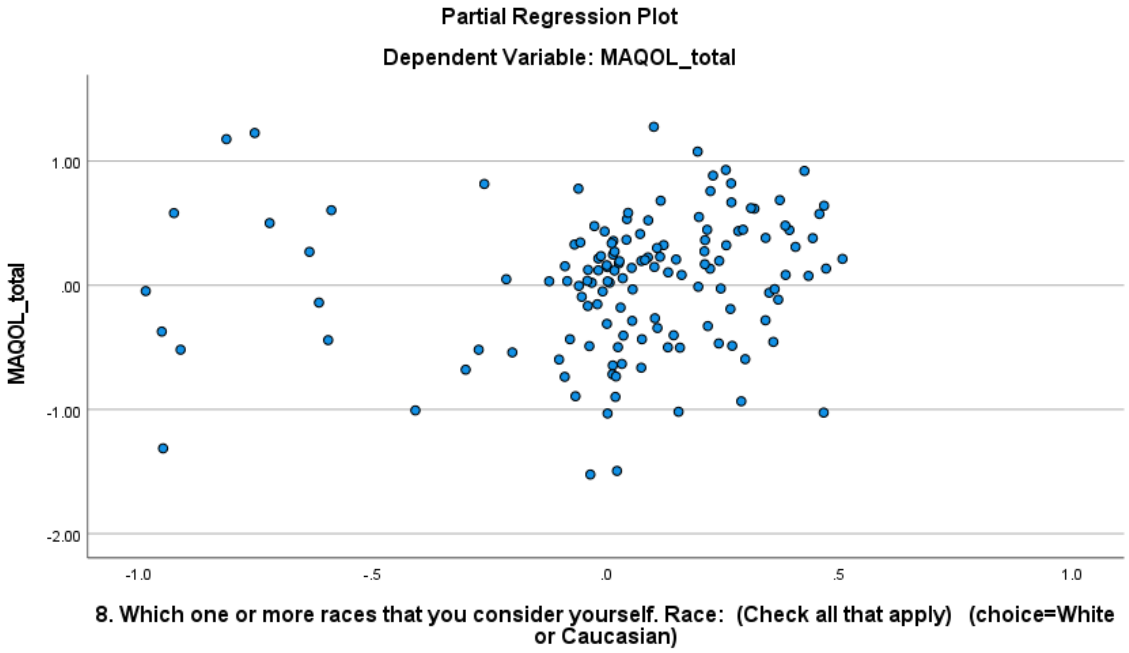


Figure 13

Partial Regression Plot for Total Comorbidities and Asthma Quality of Life for Aim 2

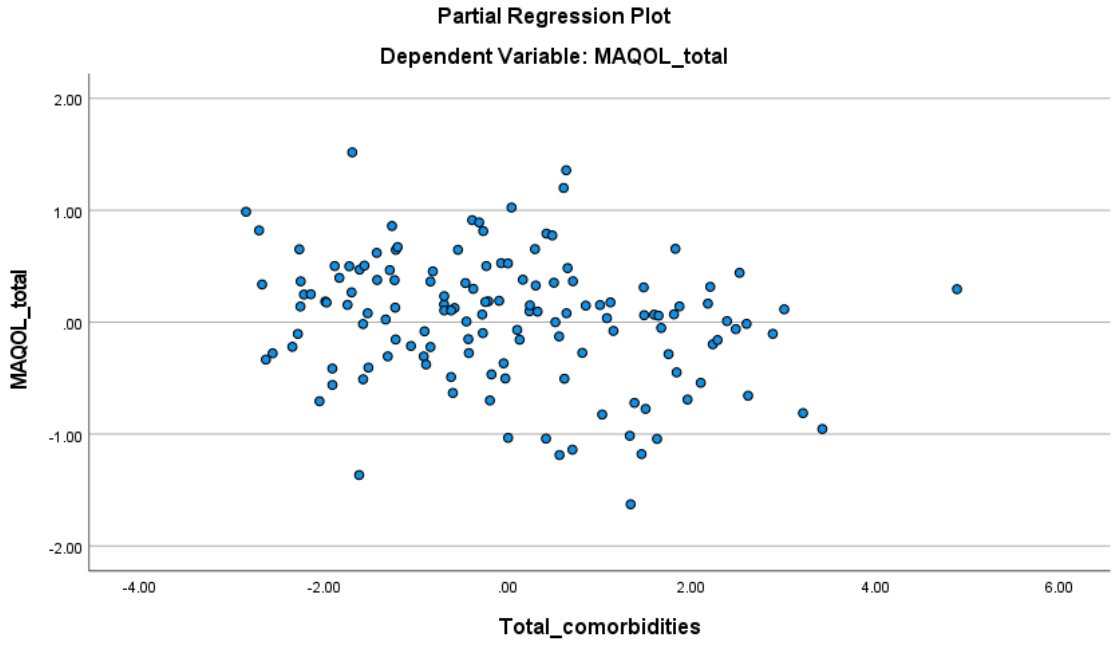


Figure 14

Partial Regression Plot for Asthma Self-Management Knowledge and Asthma Quality of Life for Aim 2

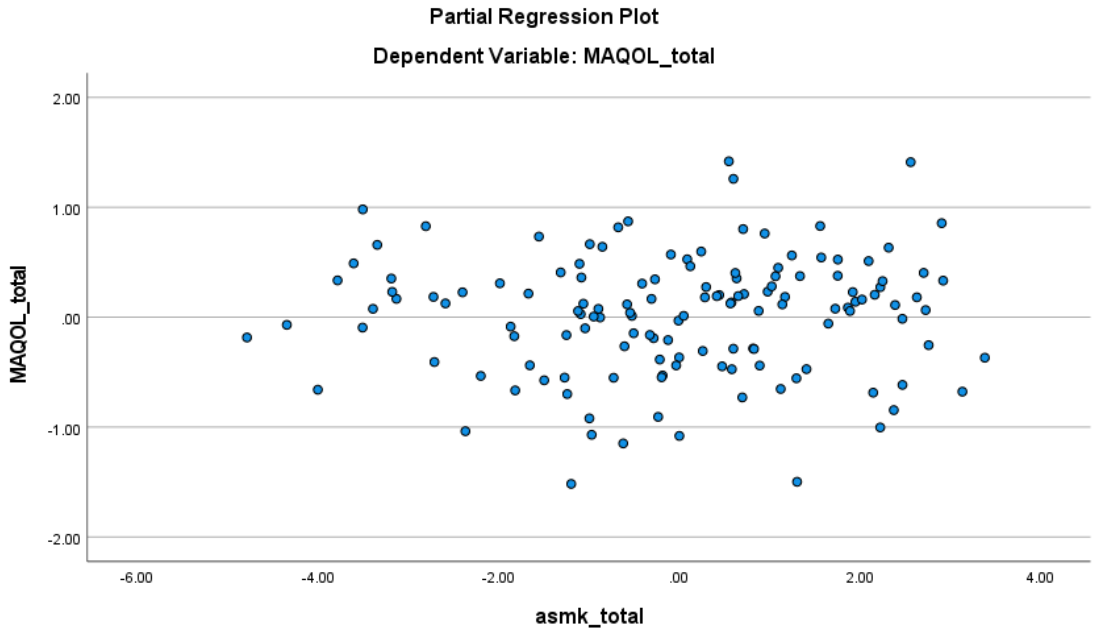


Figure 15

Partial Regression Plot for Medication Numeracy and Asthma Quality of Life for Aim 2

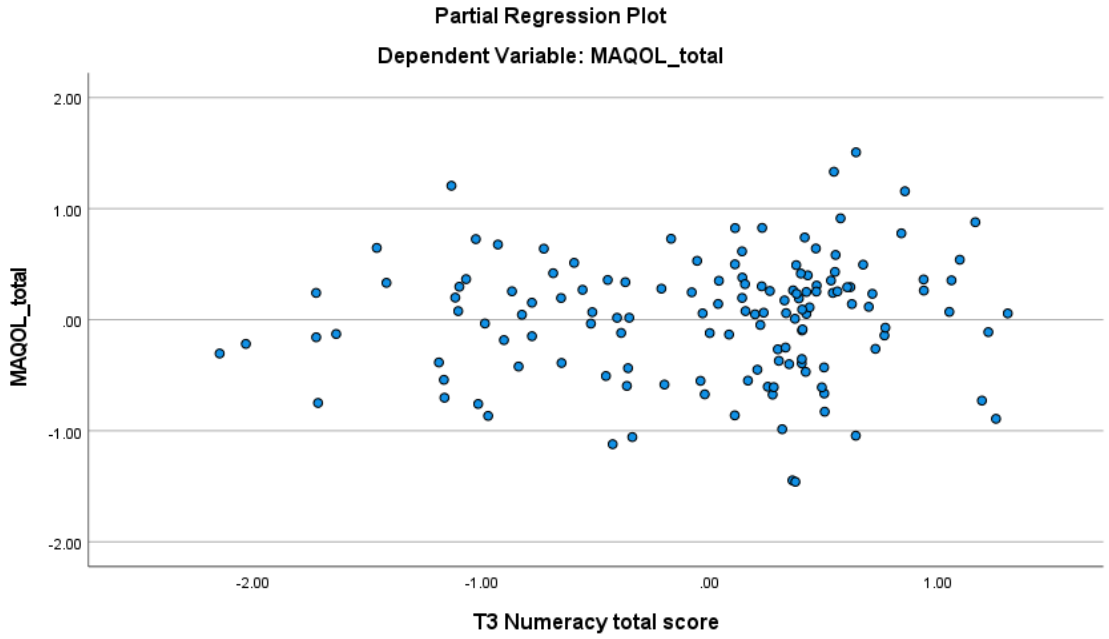


Figure 16

Partial Regression Plot for Asthma Self-Efficacy and Asthma Quality of Life for Aim 2

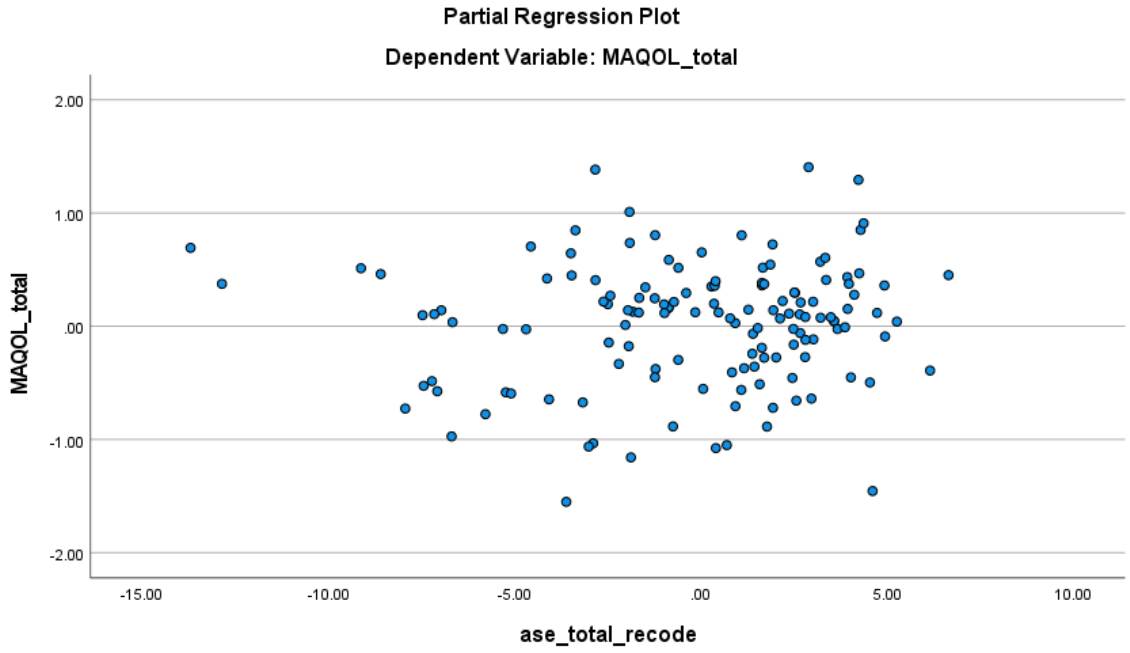


Figure 17

Partial Regression Plot for Asthma Control and Asthma Quality of Life for Aim 2

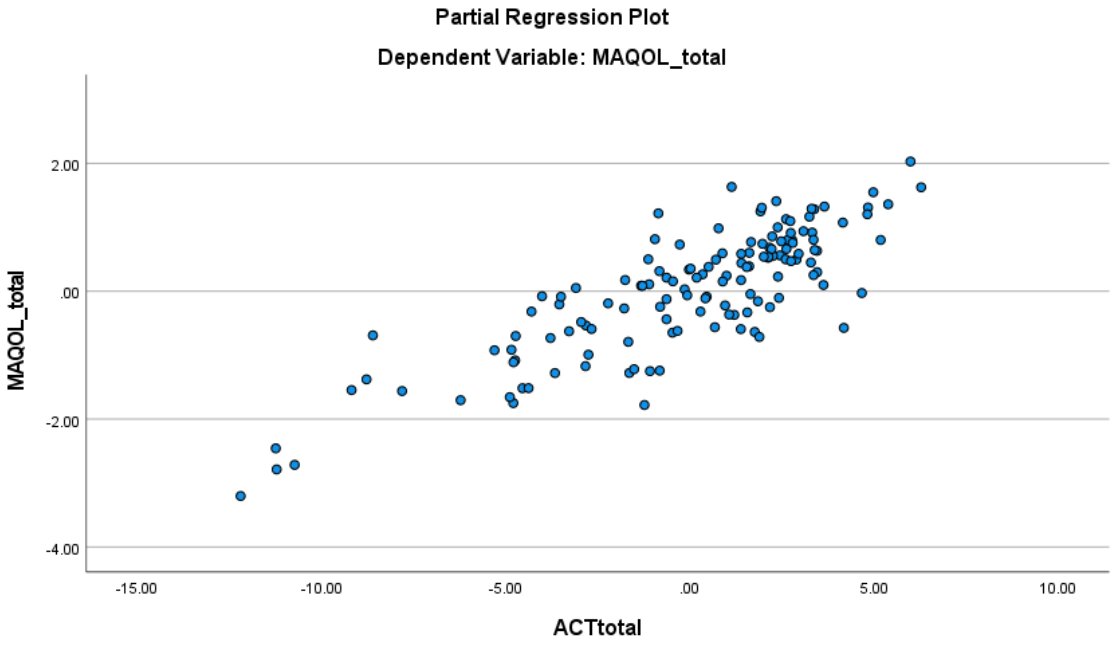
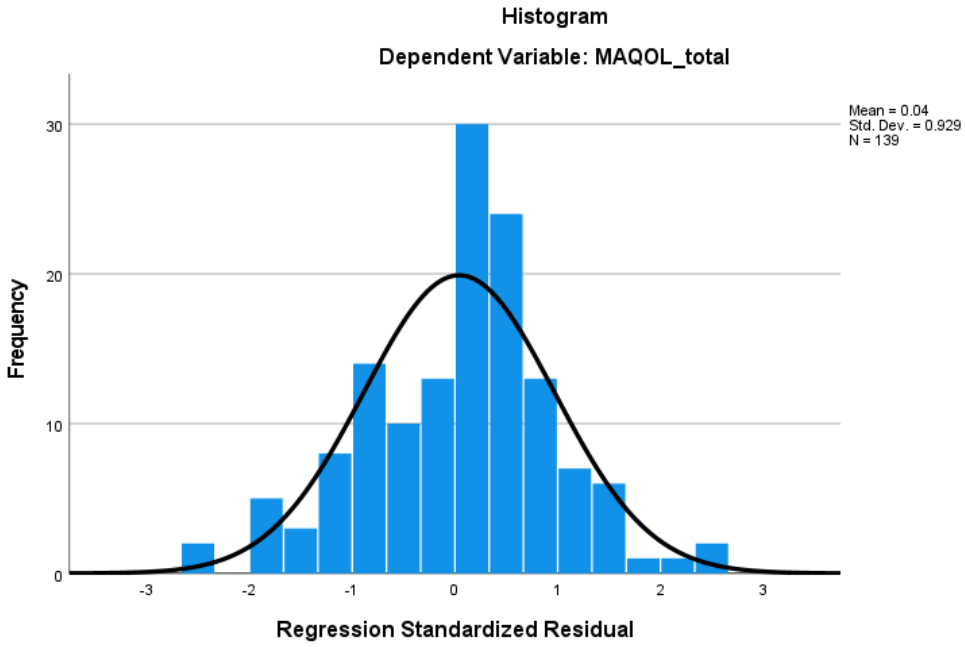


Figure 18

Histogram with Asthma Quality of Life as the dependent variable for Aim 2



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Boone, Karen; Mainous R.O.; Kang, Kyung; Jin, Hanzhu (2006) Use of Near Infrared Spectroscopy for brain tissue oxygenation in the preterm infant, International Society of Oxygen to Tissue Transport, Louisville, KY

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Boone, Karen; Mainous R.O.; Kang, Kyung; Jin, Hanzhu (2006) Use of Near Infrared Spectroscopy for brain tissue oxygenation in the preterm infant, International Society of Oxygen to Tissue Transport, Louisville, KY