THE CHARACTERISTICS THAT ASSOCIATE WITH HEALTH RELATED QUALITY OF LIFE IN PATIENTS WITH TYPE-2 DIABETES

by

Lichun (Rebecca) Chia, RN

BSN, Franciscan University of Steubenville, 1999

Submitted to the Graduate Faculty of

School of Nursing in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2007

UNIVERSITY OF PITTSBURGH

SCHOOL OF NURSING

This dissertation was presented

by

Lichun (Rebecca) Chia

It was defended on

April 24, 2007

and approved by

Jacqueline Dunbar-Jacob, PhD, RN, FAAN, Professor and Dean, School of Nursing

Susan M. Sereika, PhD, Associate Professor, School of Nursing

Eric Rodriguez, MD, UPMC

Dissertation Advisor: Sandra Engberg, PhD, RN, CRNP, Assistant Professor

and Chair, Department of Health Promotion & Development, School of Nursing

THE CHARACTERISTICS THAT ASSOCIATE WITH HEALTH RELATED QUALITY OF LIFE IN PATIENTS WITH TYPE-2 DIABETES

PURPOSE: The study examined characteristics (sociodemographic and number and types of study-focused comorbidities) associated with health related quality of life and the relationships between general health-related (MOS SF-36) and diabetes specific (Diabetes Quality of Life Measure - DQOL) quality of life, and tested the revised Wilson and Cleary model proposed by Ferrans et al. utilizing the Structure Equation Modeling (SEM) in individuals with type-2 diabetes and hypertension and/or hyperlipidemia. Type-2 diabetes impairs health and quality of life with potentially devastating consequences occurring as a result of diabetes-related comorbidities. Wilson and Cleary proposed a comprehensive conceptual model for HRQoL. The model had not been tested in diabetes.

METHODS: Three hundred twenty-one subjects with type-2 diabetes and hypertension and/or hyperlipidemia were included in this secondary data analysis. The parent study examined the impact of a problem-solving based, multi-component telephone intervention on adherence to multiple medications in subjects with type-2 diabetes and hypertension and/or hyperlipidemia. Baseline data from the parent study were utilized in the current study.

RESULTS: Characteristics significantly related ($p < .01$) to general health related and/or diabetes specific quality of life included gender, age, income, marital status, household size, the number of study-focused comorbidities, peripheral vascular disease, renal disease, history of

stroke/TIA, psychological problems and arthritis. Most correlations between SF-36 subscale and DQOL subscale/total scores were statistically significant ($p < .01$). Following considerable modifications to both the measurement and structural equation model (i.e., addition of correlated errors, omission of measured variables, and addition of new variables), the revised Wilson and Cleary model was valid for explaining the relationships between the selected observed variables and their relationship to overall quality of life ($\chi^2_M(98) = 203.986$, *CMIN/DF* = 2.081, CFI = 0.952, SRMR = 0.0549 and RMSEA = 0.058 with 90% CI = 0.047 - 0.069).

CONCLUSIONS: The SF-36 was more sensitive to sociodemographic variables and the presence of study-focused comorbidities than the DQOL. After data modifications, the revised Wilson and Cleary model provided a good fit to the data in these subjects with type-2 diabetes and hypertension and/or hyperlipidemia. These findings need to be confirmed in a larger independent study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

" *Man's main task in his life is to give birth to himself, to become what he potentially is, the most important product of his effort is his own personality."*

-Erich Fromm, Psychologist

This passage has had a profound influence on how I have been living my life, especially, my decision to come to the US to study nursing, and later, the decision of continuing to advance myself personally, academically, and professionally through pursuing a doctoral degree.

First of all, I would like to thank God for keeping my faith, with the trust I have in Him I have been able to believe in myself when I am not courageous enough… I am really blessed to have worked with incredible people, and to have been supported by them, from my undergraduate years until now. I have had amazing opportunities that have brought me closer to my goals and the place I would like to be in life, but at the same time, I am also so humbled by what I have learned throughout these years.

They are so many people who have touched and bettered my life in all different ways that I can never express my appreciation well enough with the words; however, I sincerely hope that the following passages can in some way convey my deepest gratitude to each one of them.

I would like to dedicate my dissertation to my family back in Taiwan, my parents, brother and his family, for all the support and sacrifices they have made so I was able to pursue the goals of my life here in the US. Above all, to my parents who have endured being thousands of miles

away from their only daughter and not being able to see her as often as they would like. Nothing can surpass what they have done for me.

I also would like to thank my committee members, my Dissertation Chair, Dr. Sandra Engberg, for her tireless support, encouragement, and understanding. In addition, she has undertaken the painstaking process of editing my dissertation documents. Dr. Jacqueline Dunbar-Jacob, who has been so gracious and generous by allowing me to use data from her research study, and has been so supportive in providing the information I needed to complete my dissertation. Dr. Susan Sereika, thank for her kindness and assistance; particularly, during the extensive processes of analyzing data and writing up results. I would like to thank Dr. Eric Rodriguez, for his expertise and valuable advice on gerontology and clinical practice. Furthermore, to Dr. Erlen, who has been my mentor since the very beginning of my time in this the program; she has seen me through different stages of my progression and been a consistent source of support.

There is one saying in Chinese beliefs that people who are fortunate are always able to have someone important, helpful, or influential present at the times of need throughout her/his life. In Chinese, we call it "貴人", meaning "precious person", similar to "guardian angel" in English translation. For me, one of these people is my husband, Teppituk Krinchai, to whom I would like not only to dedicate this dissertation, but also share every one of my accomplishments with. For the dissertation part, I thank him for all the technical support; he has perfected each table and figure that is in the document. For everything that I have accomplished during my doctoral program, I am grateful for his unconditional love, unwavering support, and most importantly, the strong faith he has in me, even when I have only little in myself. Besides the

most sincere thanks to him, I can only continue striving to live up my potential as he has always been helping me do.

Before closing, I would like to also thank the Diabetes Management research team, the project coordinator - Lisa Tamres, project nurse - Maura McCall, research specialist - Kathleen Kennedy, and Cameron Kramer. Furthermore, thank Rick Engberg, who had helped me with the data. I truly thank everyone for the effort and help while I was gathering the data together; it has been a tremendous team effort for me to have what I need in order to complete the dissertation.

Last but not the least; my appreciations go to the following people as well, Sister Mary Paul of Our Lady of China, who has been keeping me in her prayers all these times and made everything possible by assisting me with the journey coming to and studying in the US; Drs. Caroline Miller, Kevin Harris and Mary Kay Mortimer from my undergraduate years at Franciscan University of the Steubenville, Steubenville Ohio; my host parents Mr. and Mrs. Carson, who have been so kind to me, especially during the initial years of my staying in the US; Ms. Judith Tate who helped me with the admission into the program; Dr. Willa Doswell, whom I first worked for as a student worker; Dr. Elizabeth Schlenk, who gave me the opportunity to co-author a manuscript with her and taught me so much about the process; my fellow classmates, Beth Grabiak and Lorrain Reiser, we helped each other through challenging courses; and so many other people who have made my life here in the US so much more meaningful and joyful and whose name I have not addressed, I thank them from the bottom of my heart.

As I mark the end of this unforgettable journey and the start of the next exciting voyage, I am writing down all of the above as a way of remembering and being forever grateful to cherish the experiences for the rest of my life……

1.0 INTRODUCTION

This chapter presents detailed information on type-2 diabetes, general health related quality of life and diabetes-specific quality of life. It also presents the specific aims and research questions that are addressed in this study and provides operational definitions for key study terms.

1.1 TYPE-2 DIABETES

1.1.1 Prevalence of type-2 diabetes

Diabetes Mellitus is a metabolic disease characterized by increased blood glucose (hyperglycemia) resulting from deficiencies in insulin secretion, action or both (American Diabetes Association [ADA], 2004a). The chronic hyperglycemia of diabetes is associated with long term damage, dysfunction, and failure of various organs especially the eyes, kidneys, nerves, heart, and blood vessels (ADA, 2004a).

The Center for Disease Control and Prevention (CDC) reported that in 2005 that there were proximately 15 millions of people diagnosed with diabetes and that it was the sixth leading cause of death in the United States (CDC, 2005c, 2006a). The estimated prevalence of diagnosed diabetes is highest among people aged 65 - 74 years of age and lower among people age 45 and younger (CDC, 2005c). More than 200,000 people die of diabetes-related

complications annually, and 65% of those deaths are caused by diabetes-related heart disease and stroke (CDC, 2005c).

In 2002, the total cost of diabetes was 132 billion dollars in the US, including direct medical costs of $92 billion and indirect costs related to disability, job loss and premature death of $40 billion. In addition, the average health care cost for a person with diabetes was estimated at 13,000 dollars annually comparing to $2,500 for a person without diabetes (CDC, 2006a).

In type-2 diabetes, formerly referred to as non-insulin dependent diabetes mellitus (NIDDM) or adult-onset diabetes, persons develop gradual insulin resistance and deficiency. These patients do not, however, necessarily need insulin treatment to survive (ADA, 2004a). Type-2 diabetes accounts for 90 - 95% of diagnosed cases of diabetes, and the incidence of both type-2 diabetes and diabetes-related comorbidities are increasing (CDC, 2005a). The increase has been attributed to a variety of risk factors including the aging of the U.S. population, the sedentary life style of many Americans, and the high prevalence of obesity, which most often appears in people age 40 or older (CDC, 2006a). According to the CDC (2005a), more than 18% of adults aged 65 and older have diabetes. Many also have hypertension and a poor lipid profile. Furthermore, an estimated 41 million Americans are at high risk for developing type-2 diabetes (CDC, 2005c). This increasing incidence of type-2 diabetes may be related in part to changes in diagnostic criteria and more frequent screening. The modified diagnostic criteria was based on statistics that illustrated an increase in the prevalence and incidence of diabetic retinopathy occurring at about a Fasting Plasma Glucose (FPG) of 126 mg/dl in addition to the need to decrease the inconsistencies when a FPG cut point of 140 mg/dl and a 2-hour value in the Oral Glucose Tolerance Test of 200 mg/dl (11.1 mmol/l) are used for diagnosis (Genuth et al., 2003).

1.1.2 Comorbid conditions of type-2 diabetes

Type-2 diabetes can have a direct impact on patients' overall health and quality of life with potentially devastating consequences occurring as a result of diabetes-related comorbidities. When diabetes is not well managed glucose and fats remain in the blood and, over time, damages vital organs. Diabetes can cause heart disease, stroke, blindness, kidney failure, peripheral vascular disease with lower-extremity amputations, and increased risk of death secondary to influenza and pneumonia. These comorbid conditions contribute to impaired physical functioning among many people with diabetes (HP, 2000).

Heart disease is the leading cause of diabetes-related death, and mortality is about 2 - 4 times higher for adults with diabetes than for those without the disease (CDC, 2006a). Presently, coronary heart disease (CHD) is the most frequent and expensive cardiovascular complication of diabetes. The largest portion of the direct costs related to diabetes are attributed to hospitalizations for diabetes-associated cardiovascular disease (HP, 2000). Further information regarding comorbidities associated with type-2 diabetes will be discussed in the Chapter two Literature Review sections.

1.2 QUALITY OF LIFE

In 1946 the World Health Organization (WHO) defined the meaning of health, "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946, p. 1315). The defined state of physical, mental and social well-being is now known as "quality of life". In the past four decades, quality of life has been brought to the

attention of the patient care practice and research fields, and been increasingly considered as a critical endpoint in clinical research. Successful treatments should result in improvements in both patients' health status and quality of life.

Quality of life is generally viewed as a multidimensional concept including domains of physical health, role functioning, satisfaction with medical treatment, concerns about the future and general well-being, as well as non-medical elements, such as jobs, family, friends, and other environmental conditions (Bowling, 1997; Schipper, Clinch, & Olweny, 1996; Shumaker & Naughton, 1995). Later, the term "health-related quality of life" or HRQoL emerged in the literature and focused on quality of life related to health status and healthcare (Barr, 1995; Shumaker & Naughton, 1995; Watkins & Connell, 2004). HRQoL is not merely a description of patient's health status, but a distinctively personal view based on individual patients' perceptions of their health status as well as other aspects of their lives. It is used as a general label for a variety of physical functioning and psychosocial variables (Smith, Avis, & Assmann, 1999). When the goal of interventions is to improve patients' well-being rather than to cure their underlying disease, perceived quality of life is seen as an essential outcome of clinical research (Anonymous, 1995; Gill & Feinstein, 1994; Smith et al., 1999).

It is important to understand the difference between overall quality of life and HRQoL for data interpretation and conclusion purposes. Many studies have mistakenly assumed that health status (HRQoL) and overall quality of life, often referred to as "quality of life", are interchangeable terms, but excellent health does not infer excellent overall quality of life (Speight, 2002). In fact, efforts to achieve excellent health can sometimes impair overall quality of life, particularly in the management of chronic illnesses (Bradley, 2001).

HRQoL is often utilized in clinical settings and/or randomized clinical trials evaluating therapeutic interventions and treatment effectiveness (Testa & Simonson, 1996; Wilson & Cleary, 1995). Maciejewski (2006) defined HRQoL as consisting of seven measurable domains: (1) physical functioning, (2) social functioning, (3) emotional functioning, (4) cognitive functioning, (5) pain, (6) vitality, and (7) overall well-being. Each of these domains can be measured in two dimensions: (1) objective assessments of functioning or health status, and (2) subjective perceptions of health (Testa & Simonson, 1996).

The implication for investigators and healthcare providers administering HRQoL instruments in clinical and research settings is to establish a testable conceptual framework that explains the expected relationships among the varied constructs and domains of HRQL (Gill & Feinstein, 1994; Patrick & Bergner, 1990). A logical, quantitative understanding of the determinants of HRQoL can help develop rational and cost-effective strategies that target HRQoL problems. Designing intervention strategies requires that we not only identify the key factors that influence patients' perceived HRQoL, but also understand their relative significance and the degree to which they can be changed or modified. If we can succeed in this effort, the measurement of HRQoL will likely become an increasingly useful clinical tool (Wilson & Cleary, 1995).

In addition, the demand for specific quality of life measures to supplement general HRQoL assessment is rising. Rapid advances are being made in the development and application of measures specific to different diseases, conditions, functions, and populations (Guyatt, Feeny, & Patrick, 1993; Patrick & Bergner, 1990). General HRQoL instruments permit comparisons across various disease conditions which provide useful information for examining the efficacy of policy making and health care deliver systems. Conversely, administering these

instruments to patients with various medical conditions may result in limited sensitivity, specificity and effectiveness within a particular disease (R. M. Anderson, Fitzgerald, Wisdom, Davis, & Hiss, 1997).

There are several proposed conceptual models explaining the relationships among the components of HRQoL (Bergner, 1985; Johnson & Wolinsky, 1993; Nagi, 1965; Patrick & Bergner, 1990; Read, Quinn, & Hoefer, 1987; Verbrugge, 1991; Wilson & Cleary, 1995). One of the most popular, proposed by Wilson and Cleary (1995), integrates biological and psychological aspects of health status. It identifies and links five levels of dimensions related to HRQoL: (1) biological and physiological factors, (2) symptom status, (3) functional status, (4) general health perception, (5) overall quality of life.

The growing attention to quality of life in clinical studies is related to the increased prevalence of chronic illness as well as the aging of society (vanden Bos & Limburg, 1995). This phenomenon is evident in an increased number of articles retrieved when using the search term, "quality of life". There has been an exponential increase in the utilization of HRQoL measures in clinical research since 1973 (Testa & Simonson, 1996). Literature searches in Medline revealed that there were approximate 28,000 published articles related to this term between 1990 and 1999, and that the number nearly doubled to 45,248 publications between 2000 and 2006.

1.3 DIABETES QUALITY OF LIFE

It has been well established that diabetes is a disease that impacts HRQoL (Eiser & Tooke, 1993). Diabetes requires patients to self-manage their disease and they often experience a

lifetime struggle in maintaining their quality of life (Shen et al., 1999). People with diabetes have a worse quality of life than people without this chronic disease (Rubin & Peyrot, 1999). Since the disease is primarily self-managed and self-management regimens affect virtually all aspects of daily life while patients often experience no diabetes-related symptoms for many years, the major burden is often the treatment, not the disease. Over time, diabetes is often associated to a high prevalence of comorbid health problems. Woodcock and colleagues (2001) found that older age and co-existing health problems influenced patients' perceived health status and quality of life more than diabetes.

One of the ultimate goals in the treatment for patients with diabetes is to enhance their HRQoL, which may in turn also improve their disease status (Jacobson, de Groot, & Samson, 1995). The extensive self-management requirements in diabetes and the broad range of devastating complications make the assessment of quality of life and its response to interventions particularly challenging in this population (R. M. Anderson et al., 1997).

Although a universal definition of HRQoL does not exist, most people agree that it is comprised of varied domains including physical function, psychological function, social function, perceptions of well being and health, impairments, opportunities, and duration of life (Patrick & Erickson, 1993; Rubin & Peyrot, 1999). These domains are measured in terms of individuals' subjective perception of their health status (Barr, 1995; Watkins & Connell, 2004).

During the past three decades, there have been many diabetes-related quality of life measure developed (Bradley et al., 1999; DCCT Research Group, 1988; De Leon, 1995; Fitzgerald et al., 1996; K. A. Meadows, Abrams, & Sandbaek, 2000; Shen et al., 1999) and there has been much discussion in the literature regarding the use, validity and reliability of the diabetes-related quality of life measures (Bott, Muhlhauser, Overmann, & Berger, 1996, 1998;

DCCT Research Group, 1988; Kolawole, Abodunde, Ikem, & Fabiyi, 2004; Watkins & Connell, 2004). While general HRQoL instruments can adequately access diabetic patients' general perceptions of their health-related quality of life (Gill & Feinstein, 1994), the relationship between subjective HRQoL and objective measurements such as variables of metabolic control may be more difficult to detect, particularly when favorable metabolic outcomes such as low HbA1c levels are accompanied by high incidents of events such as hypoglycemia. Diabetes-specific quality of life measures are more responsive and sensitive to treatment effects and lifestyle issues than global measures because they contain more items assessing those areas (Bott et al., 1998; DCCT Research Group, 1996; Weinberger, Kirkman, Samsa, Cowper, & et al., 1994). They can reveal striking negative effects of the intensive treatment of diabetes and of the presence of complications (Bradley, 2001).

The impact that non-diabetic comorbidities have on SF-36 scores demonstrate the limitations of using only the general HRQoL measurement to evaluate diabetes interventions. The negative effects of another health condition may surpass any reductions in diabetes treatment burden and diabetes related symptoms or complications. A diabetes-specific measure, such as the Diabetes Quality of Life Instrument (DQOL), will provide additional information about the impact of this disease (Woodcock et al., 2001). Depending on the purposes of studies, it is important to include a multidimensional assessment of the quality of life (Patrick & Deyo, 1994). Use of both general and disease-specific measures of quality of life provides insight into the unique aspects of particular illnesses, as well as facilitating comparisons of findings across studies and disease treatments. There are relatively few studies comparing global and disease-specific measures in the same population of diabetic patients.

1.4 SPECIFIC AIMS AND RESEARCH QUESTIONS

The aims and research questions of this study are:

I. *To examine the relationships between demographic characteristics and both general health related and diabetes specific quality of life in individuals with type-2 diabetes and hypertension and/or hyperlipidemia.*

    1) *What are the relationships between both general and disease specific quality of life and sociodemographic characteristics among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?*

II. *To evaluate the relationships between general health related and diabetes specific quality of life in individuals with type-2 diabetes and hypertension and/or hyperlipidemia.*

    2) *What is the relationship between general health-related quality of life and diabetes specific quality of Life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?*

III. *To examine the associations between the number and types of comorbidities and general health related and diabetes specific quality of life in individuals with type-2 diabetes and hypertension and/or hyperlipidemia.*

    3) *Is there a relationship between study-specific comorbidities and general health related and diabetes specific quality of life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?*

4) *Is there a relationship between the number of study-specific comorbidities and general health related and diabetes specific quality of life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?*

IV. *To test the revised Wilson and Cleary conceptual model in the type-2 diabetes population.*

5) *Does the seven-factor measurement model fit the data?*

6) *To what extent is the revised Wilson and Cleary conceptual model of health-related quality of life consistent with data collected from individuals with type-2 diabetes and hypertension and/or hyperlipidemia?*

7) *Is there a significant relationship between the Characteristics of the Individual and Characteristics of the Environment?*

1.5 DEFINITIONS OF THE TERMS

Type-2 diabetes is a metabolic disorder characterized by impaired insulin utilization or production and is based on the diagnostic criteria of the parent study.

Study-specific comorbidities are co-existing conditions that are commonly seen in patients with type-2 diabetes including (1) heart attack or coronary artery disease (CAD), (2) peripheral vascular disease (PVD), (3) stroke or mini stroke (TIA), (4) renal or kidney disease, (5) psychological problem (anxiety and/or depression and/or other mental problems), (6) hypertension or high blood pressure, and (7) arthritis or rheumatic disease,

as measured by the Center for Research in Chronic Disorders (CRCD) Comorbidity Questionnaire.

Health related quality of life (HRQoL) is a person' or group's perceived physical and mental health over time. The current study assessed both general health related and diabetes specific HRQoL.

General health related quality of life is individuals' perceptions of their general health status as measured by the Medical Outcome Study Short Form-36 (MOS SF-36).

Diabetes specific quality of life is persons' perceptions of the effects that diabetes and its treatment have on their daily lives as measured by Diabetes Quality of Life Measure (DQOL).

Overall quality of life or quality of life is a composite assessment of the quality of the social, economic, and physical environments as well as health and well-being. The current study assessed overall quality of life using item #9A of the Medical Outcomes Study Short Form-36 (MOS SF-36) and item #15A of the DQOL.

General health perceptions are subjective judgments of one's general health as measured by General Health subscale of the Medical Outcomes Study Short Form-36 (MOS SF-36) and Impact subscale of the DQOL.

Functional status is the ability of the individual to perform particular tasks, such as walking, running and lifting. The MOS SF-36 Physical Functioning, Role Functioning (a combination of Role-Physical and Role–Emotional) and Social Functioning subscales

were used to assess patients' perceptions about their functional status, and the six-minute walk distance was used as an objective measure of functional performance.

Symptom status is an individual's perception of an abnormal physical, emotional or cognitive state as measured by the symptom checklist in the CRCD Comorbidity Questionnaire, Beck Depression Inventory (BDI-II) and Spielberger State-Trait Anxiety Questionnaire.

Biological and physiological factors are functions of cells, organs, and/or organ systems whose change may affect the individual's health. The current study used HBA1c, HDL to total cholesterol ratio and fasting insulin levels as proxy variables for biological and physiological factors.

Characteristics of the individual are personal factors that influence health outcomes, such as demographic, developmental, psychological, and biological factors. In the current study, ages, years of formal education and years since diabetes was diagnosed were used as proxy variables for characteristics of the individual.

Characteristics of the environment are environmental factors that influence health outcomes, such as the influence of family, friends, and healthcare providers. Household income and the number of adults living in the household were used as indicators of characteristics of the environment in addition to the tangible subscale of the Interpersonal Support Evaluation List (ISEL).

2.0 THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter outlines the theoretical framework guiding the research study. Following the description of the theoretical framework is a review of the literature. The review includes published studies focusing on the relationships between sociodemographic characteristics and comorbidities and health- related quality of life (HRQoL) in patients with type-2 diabetes.

2.1 THEORETICAL FRAMEWORK

Wilson and Cleary have challenged the field of HRQoL, moving it from descriptive models to an explanatory model where the causal relationships among the components of HRQoL are explained. While HRQoL is often an outcome in clinical trials, there continues to be limited understanding of its determinants. If its underlying causes are identified, interventions to improve patients' perceived HRQoL can be targeted to those causes (Sullivan, Kempen, Van Sonderen, & Ormel, 2000; Wilson & Cleary, 1995).

Wilson and Cleary (1995) propose a comprehensive conceptual model for HRQoL that could be used to merge the biomedical and social science paradigms. It maps out specific causal relationships between health concepts (Sousa & Kwok, 2006). The model includes a full range of variables that are typically included in HRQoL assessments in addition to the integration of two different paradigms of health, one of which is held by clinicians and basic science

researchers, and the other by social scientists. The models of these two academic traditions differ in purpose, methods, and intellectual history, but it is useful to be able to compare them. In the clinical paradigm, or the "biomedical" model, the focus is on etiologic agents, pathological processes, and biological, physiological and clinical outcomes. The social science paradigm, or the "quality-of-life" model, focuses on dimensions of functioning and individuals' overall perceptions of well-being. Wilson and Cleary (1995) filled the gap between these two paradigms by defining the links between biological and other types of measures. The model is comprised of five primary levels of patient characteristics including (1) biological-physiological factors, (2) symptom status, (3) functional status, (4) general health perceptions and (5) overall quality of life. In addition, characteristics of the individual as well as the environmental factors are included in the model as nonspecific predictive variables of symptom status, functional status, general health perceptions and overall quality of life (Ferrans, Zerwic, Wilbur, & Larson, 2005; Wilson & Cleary, 1995).

Prior to the development of this model, the majority of HRQoL studies had a very limited or no theoretical basis (Sousa & Kwok, 2006). Measuring HRQoL without reference to a conceptual model stalled the expansion of HRQoL knowledge for many years. Wilson and Cleary model placed the concepts in a context and guided the development of new understandings about the relationships among the them (Fawcett, 1999) and consequently helped health providers to identify and measure appropriate patient outcomes that reflect quality patient care (Sousa & Kwok, 2006).

While the model proposes a linear progression across the five concepts, Wilson and Cleary state that the unidirectional arrows between concepts do not imply that there are no reciprocal relationships. Additionally, the unidirectional arrows between nonadjacent levels do

not imply the absence of reciprocal relationships between the levels. The arrows do, however, depict the proposed dominant causal associations between concepts (Wilson & Cleary, 1995). Wilson and Cleary also suggest that the components of the model exist on a continuum of increasing biological, social, and psychological complexity. At one end of the continuum are biological measures such as serum lipid levels and glycoslylated hemoglobin, and at the other are more complex and integrated measures such as physical functioning and general health perceptions. Wilson and Cleary HRQoL model is illustrated in Figure 2-1. The following sections will describe each construct of the model in greater details.

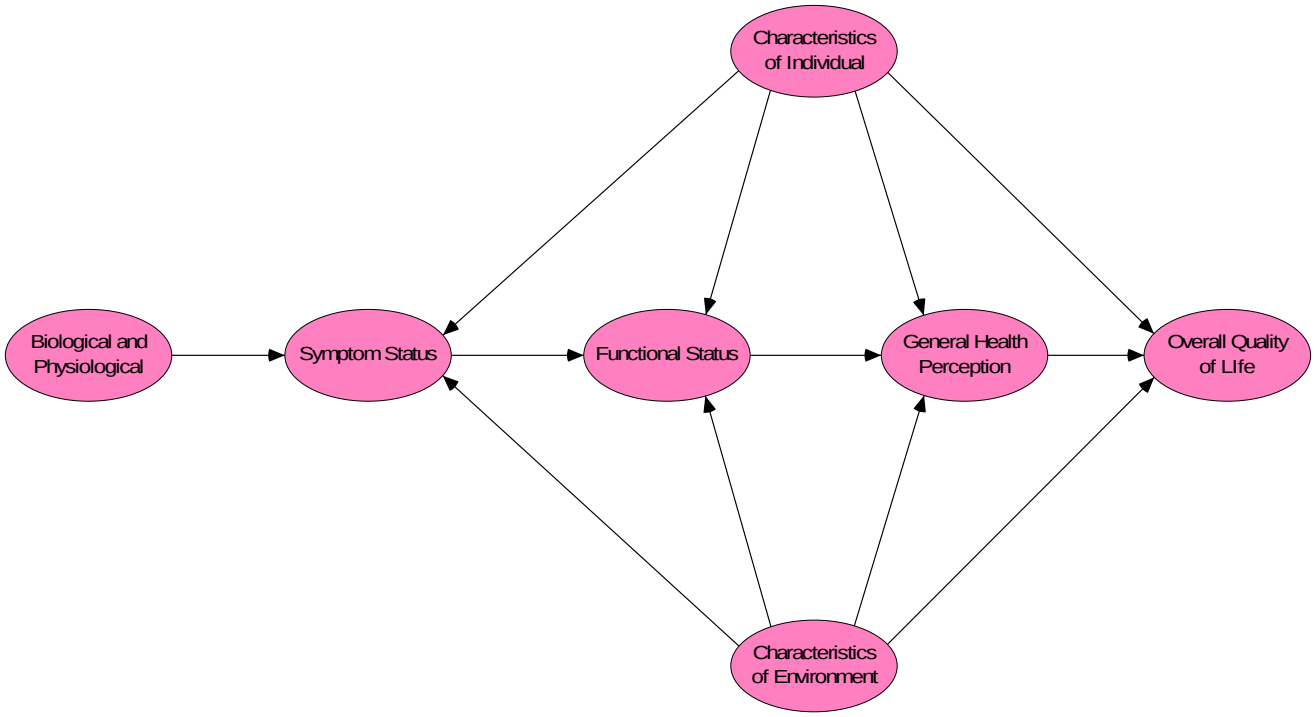

Figure 2-1: Wilson & Cleary Model of Health-Related Quality of Life (1995)

2.1.1 Biological and Physiological Factors

The first construct, biological and physiological factors, focuses on the function of cells, organs, and organ systems. Examples include the following: diagnosis-related laboratory values for type-2 diabetes such as HbA1c and physical examination findings such as a systolic and diastolic blood pressure. The health effects of characteristics that are mainly mediated by changes in cell, organ, or organ system function are included at this level in the model (Wilson & Cleary, 1995).

This study used HbA1c, HDL to total cholesterol ratio and years since diabetes was diagnosed as proxy variables for the biological and physiological factors. HbA1c was used instead of fasting glucose values because it is a better diabetes-management indicator than fasting glucose. HbA1c values reflects how well the patient has managed his/her diabetes for the past three months, while fasting glucose represents the amount of glucose in the blood right at the time of sample collection. Thus, HbA1c is a better overall measure of glucose control.

2.1.2 Symptom Status

Wilson and Cleary (1995) define symptom status as “a patient's perception of an abnormal physical, emotional, or cognitive state”, and classified symptoms into (1) physical symptoms, (2) psychological symptoms, and (3) symptoms that are not clearly physical or psychological in origin such as emotional distress, fear, worry, and frustration. The model suggests that symptom status is influenced by biological and physiological factors as well as characteristics of the individual and environment, although the effects of biological and physiological variables on symptom are ambiguous (Wilson & Cleary, 1995). Several diabetes-related studies reported that

many patients have profoundly abnormal HbA1c levels for quite sometimes without having any symptom (Hiltunen, Keinanen-Kiukaanniemi, Laara, & Kivela, 1996; O'Connor et al., 2006).

In addition to depression and anxiety which were measured by the Beck Depression Index-II and Spielberger State-Trait Anxiety Inventory respectively, this study focused on five of the most common symptoms among patients with type-2 diabetes according to ADA (2006b; 2006c). They were (1) fatigue, (2) diarrhea, (3) vision problems, (4) dizziness or light-headedness (with standing), and (5) frequent urination. The reported symptoms were weighted by the patients' perception of the symptoms' impact on their quality of life. These self-report symptoms are subjective experiences that are influenced by a number of demographic and cultural factors (Angel & Cleary, 1984; Barsky, Cleary, & Klerman, 1992; Barsky, Cleary, Sarnie, & Klerman, 1993).

2.1.3 Functional Status

The next level in the model is functional status which, similar to symptom status, is an essential point of integration. In this model, functional status is characterized as the ability of the individual to perform defined tasks and adjust to his/her environment and it can be measured either subjectively or objectively over a given time frame (Lipkin, 1990; Wilson & Cleary, 1995). While symptom status is a vital determinant of functioning, other aspects of an individual's personal and social environment may also have important effects on functioning. Personal and environmental factors such as perceived self-efficacy, family relationships and access to health care or medical treatment can impact the individual's functioning status.

Physical, social, role, and psychological function are the four domains that are commonly used to assess the functional status. While it is known that these are not the only domains of

functioning that may be of interest to patients, health care providers and researchers, they are the minimum areas of functioning that should be evaluated (Cleary, Greenfield, & McNeil, 1991; A. M. Jette et al., 1986; Ware, 1987; Ware, Brook, Davies, & Lohr, 1981).

The current study examined subjects' functional status by evaluating self-reported functional perceptions using the Physical Functioning, Social Functioning, Role-Physical and Role-Emotional subscales of MOS SF-36. In addition, the six-minute walk distance was utilized as an objective measure of physical performance (ATS, 2002). While the Physical Functioning subscale measures individuals' abilities to perform activities varying from basic to more vigorous without restrictions due to health, the Social Functioning Subscale assesses their capabilities to perform normal social activities without frequent interference because of physical or emotional problems. In the current study, the Role-Physical and Role-Emotional SF-36 subscales were combined to form a single Role Functioning subscale to assess physical or emotional limitations related to subjects' performance of their work or other daily activities (Ware & Sherbourne, 1992).

2.1.4 General Health Perceptions

The next concept in the Wilson and Cleary model is general health perceptions, a subjective self-rating of one's overall general health. According to the model, general health perceptions are directly related to functional status and indirectly related to symptom status and biological and physiological factors (Wilson & Cleary, 1995). These associations were supported by several studies (Barsky et al., 1992; Idler & Kasl, 1991; Wan, 1976). In addition, the model suggests that the general health perceptions are also influenced by characteristics of the individual and environment.

Although general health perceptions are affected by the preceding elements of the model, they are different from the other components of the model. Consequently, applying measures of other components, such as of symptom or of functional status, to evaluate general health perceptions is not suitable. General health perceptions are often measured by a single question that asks people to rate their health on a scale ranging from poor to excellent although it can also be measured by a battery of items (Ferrans et al., 2005; Ware & Sherbourne, 1992).

The current study used the MOS SF-36 General Health and the DQOL Impact subscales as measures of the general health perceptions factor. The SF-36 General Health subscale evaluates individuals' perceptions of how good their health is. The DQOL Impact subscale represents the impacts of diabetes and its treatment regimen on an individual's well-being.

2.1.5 Overall Quality of Life

The final concept in the Wilson and Cleary model is overall quality of life. Overall quality of life refers to how happy and/or content an individual is with his/her life as a whole. Overall quality of life should be related to HRQoL, but is also determined by other salient life circumstance and experiences (Wilson & Cleary, 1995). However, general measures of life satisfaction or happiness are not as strongly related to objective life situations as might be expected (Diener, 1984). Lower functioning is not inevitably related to lower levels of satisfaction (Patrick, Danis, Southerland, & Hong, 1988). One explanation for this counterintuitive finding is that people change their outlooks and expectations as their circumstances change (Patrick & Erickson, 1993).

The current study used two items from the SF-36 and DQOL to assess overall quality of life. Item 9A of the SF-36 asks subjects how much time during the past 4 weeks they felt full of life and the item 15A of DQOL asks subjects how satisfied they are with their life in general.

2.1.6 Characteristics of the Individual and Environment

Characteristics of the individual (for example, values and patient preferences) as well as the environment (for example, social, economic, and psychological support) are recognized as contributing to symptom status, functional status, general health perceptions and overall quality of life (Ferrans et al., 2005; Wilson & Cleary, 1995).

In this study, age, years of formal education and years since diabetes was diagnosed were used as proxy variables for characteristics of the individual. The Tangible subscale of the Interpersonal Support Evaluation List (ISEL) which assesses an individual's perceptions of availabilities of material aid was used as an indicator of characteristics of the environment along with gross household income and the number of adults living in the household.

Ferrans and colleagues (2005) revised the Wilson and Cleary Model to add pathways between (1) characteristics of the individual and (2) characteristics of the environment and biological and physiological factors. Individual characteristics such as genetic make-up are known to influence biological functions such as vulnerability to disease and response to treatments. Environmental characteristics can also influence susceptibility to disease or disease severity. In type-2 diabetes, for example, limited financial resources or access to shopping could influence dietary intake and, secondarily blood sugar control and, thus, HbA1c. Likewise, living in an unsafe area could limit opportunities to exercise and, again, negatively impacting glucose control. Ferrans also suggested that there are interactions between characteristics of the

individual and the environment although these were not shown in her illustration of the model. Knowledge from the emerging field of genomics has demonstrated these interactions in a number of diseases (Guttmacher & Collins, 2002). These relationships are also plausible in type-2 diabetes. Figure 2-2 shows the revised Wilson and Cleary Model which was tested in this study.

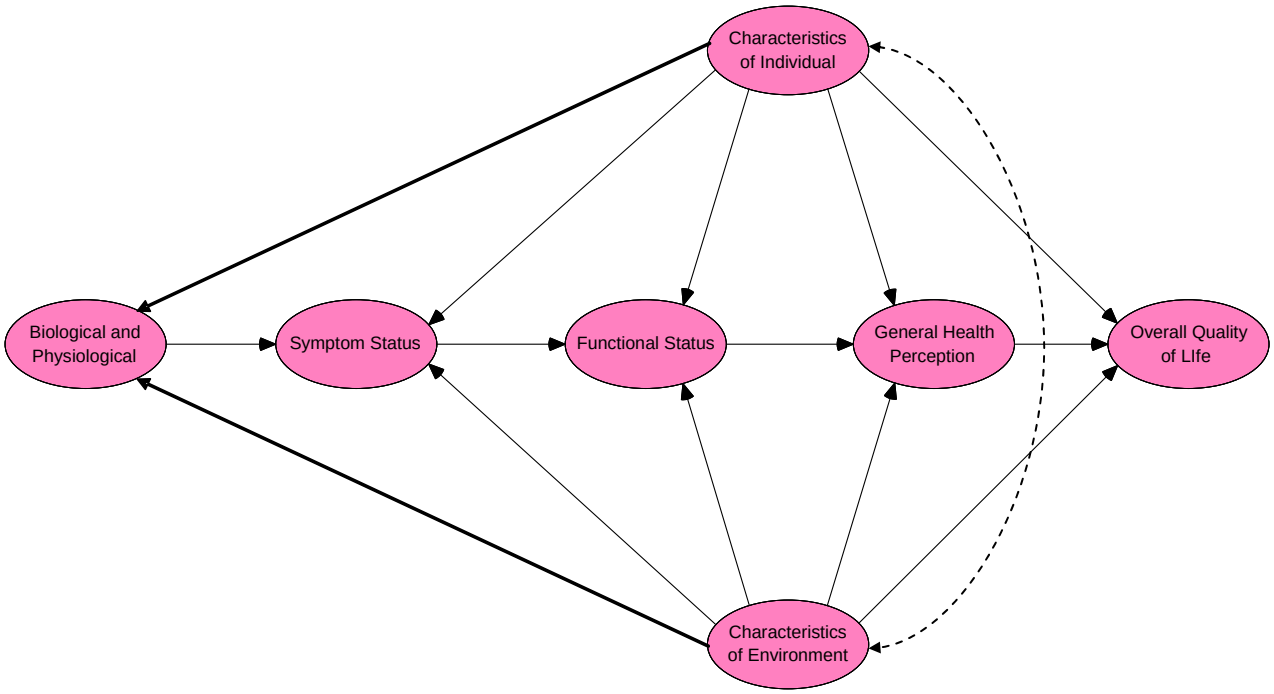

Figure 2-2: Revised Wilson & Cleary Health-Related Quality of Life Model

2.1.7 Application of the revised Wilson and Cleary Model

This study utilized the revised Wilson and Cleary model to examine the relationships between biological-physiological factors, symptom status, functional status, and general health

perceptions as well as characteristics of the individual and environment in individuals with type-2 diabetes mellitus and hypertension and/or hyperlipidemia. The model hypothesizes that the overall quality of life is directly related to general health perceptions and characteristics of the individual and environment. Functional status indirectly affects overall quality of life through general health perceptions. Similarly, symptom status also affects overall quality of life indirectly through both functional status and general health perceptions. Symptom status is influenced directly by biological and physiological factors. Hence, those factors also affect overall quality of life. Finally, general health perceptions, functional status, symptom status and biological and physiological factors are affected by characteristics of the individual and environment. Therefore, these characteristics have both direct and indirect (through symptom status, functional status and general health perceptions) effects on overall quality of life (Wilson & Cleary, 1995). Table 2-1 summarizes the model concepts with corresponding study variables and sources.

Table 2-1: Summary of Latent Variables, Measured Variables and Instruments

Model Concepts	Study Variables	Sources
Overall Quality of Life	Full of Life	SF-36: Item# 9A
	Satisfied with Life	DQOL: Item# 15A
General Health Perceptions	General Health	SF-36: General Health subscale
	Diabetes-related Health	DQOL: Impact subscale
Functional Status	Physical Function	SF-36: Physical Function subscale
		6-Minute Walk Distance
	Role Function	SF-36: Role-Physical & Role-Emotional subscale
	Social Function	SF-36: Social Function subscale
Symptom Status	Weighted Physical Symptoms	CRCD Comorbidity Questionnaire: Symptom check list
	Depression	Beck Depression Inventory-II
	Anxiety	Spielberger State-Trait Anxiety Inventory: State anxiety
Biological & Physiological	Diabetes Management	Lab Values: HbA1c
		Lab Values: Insulin level
		Lab Values: HDL ratio
Characteristics of the Individual	Age	SDM: Calculated age
	Duration of Diabetes	SDQ: Item# 11
	Years of Education	SDM: Item# 23
Characteristics of the Environment	Perception in availability of material aid	ISEL: Tangible subscale
	Number of Adults Living in Household	SDM: Item# 16
	Gross Household Income	SDM: Item# 23

Note: SDM = CRCD Sociodemographic Questionnaire
DSQ = Diabetes Study Questionnaire

2.2 LITERATURE REVIEW

Search strategies for this review included the use of Medline and PsychInfo using keywords relevant to each of following sections. The searches were restricted to the years after 1990. The findings of the studies that assessed the health related quality of life in diabetes population are summarized in Table 2-2, and the findings of the studies that used the Wilson and Cleary Conceptual Model are summarized in Table 2-3.

2.2.1 General and Diabetes-Specific Quality of Life and Type-2 Diabetes

Since early 1980, health outcomes research on chronic illness including diabetes has become increasingly concerned with patients' evaluations of the clinical effectiveness of care and treatment, with quality of life being one of the most important indicators (Cox & Gonder-Frederick, 1992). Diabetes is a highly prevalent illness among older adults, and one of the chronic diseases that can impact patients' perceived quality of life as a result of the burdensome nature of the interventions needed to adequately manage the condition and the devastating and sometimes life-threatening complications that commonly occur (Jacobson, de Groot, & Samson, 1994). Although the Diabetes Control and Complications Trial (DCCT, 1993) found that lowering blood glucose through intensive treatment can prevent or delay the diabetes-related complications, the impact of intensive blood glucose control regimens on the patients' quality of life should not be ignored. The control of high blood sugar imposes restrictions on patients' quality of life as it often involves frequent self-monitoring of blood glucose levels and self-medication, dietary restrictions and routine exercise (Hanestad & Albrektsen, 1991). Most studies examining quality of life in diabetic patients report that they experience a lower quality

of life compared to the healthy population (Graue, Wentzel-Larsen, Hanestad, Batsvik, & Sovik, 2003; Mayou, Bryant, & Turner, 1990), and that their sense of well-being diminishes when complications become more severe and the diabetic regimen becomes more rigorous (Jacobson, 1994; Nerenz, Repasky, Whitehouse, & Kahkonen, 1992). Thus, it is important for clinicians and researchers to include a quality of life assessment in the outcomes they measure.

Diabetes mellitus (DM) is a group of metabolic illnesses that are characterized by elevated blood glucose levels resulting from deficits in insulin secretion (Insulin-Dependent Diabetes Mellitus [IDDM] or type-1 diabetes), insulin utilization (Non-Insulin-Dependent Diabetes Mellitus [NIDDM] or type-2 diabetes), or a combination of both (ADA, 2004b; CDC, 2005b; Kaholokula, Haynes, Grandinetti, & Chang, 2006). Over time, high glucose levels damage nerves and blood vessels, leading to complications such as heart disease, stroke and kidney problem, the leading causes of death among people with diabetes. DM has hit epidemic proportions in many parts of the world, and has increasingly become one of the most important public health concerns (Wee, Cheung, Li, Fong, & Thumboo, 2005). The current study focused on type-2 diabetes. Type-2 diabetes is not characterized by an absolute insulin deficiency, but insulin resistance is increased and/or the pancreas does not secrete enough insulin in response to glucose stimulation (Kaholokula et al., 2006).

In health care research, quality of life is usually measured as the patient's perceived health status focusing on his/her illness and treatment experience. Hence, in health care research, it is referred to as Health-Related Quality of Life (HRQoL). HRQoL measures are classified into two major categories: the general health-related and disease-specific quality of life measures.

General health-related measures are used to compare outcomes across different populations and interventions in order to examine the effectiveness of policies and health care programs for the purpose of resource allocation (Patrick & Deyo, 1989). These measures are particularly useful for broad-based policy decision making but the tradeoff may be diminished sensitivity and specificity within a particular disease entity (R. M. Anderson et al., 1997). Examples of general HRQoL measures used in diabetes studies include the Medical Outcome Study Short Form 36-item Health Survey (MOS SF-36 or SF-36: Ware & Sherbourne, 1992), Nottingham Health Profile (NHP: Hunt, McKenna, McEwen, Williams, & Papp, 1981), Sickness Impact Profile (SIP: Bergner, Bobbitt, Carter, & Gilson, 1981), Duke Health Profile (DUKE: Parkerson, Broadhead, & Tse, 1991) and General Health Perceptions Questionnaire (GHP: Ware, 1976).

Unlike general health-related quality of life measures, disease-specific measures are designed to address specific domains that are related to a particular disease, such as knowledge, attitudes, beliefs, treatment satisfaction and impact, and self-care behaviors (DCCT Research Group, 1988; Garratt, Schmidt, & Fitzpatrick, 2002; K. Meadows, Steen, McColl, Eccles, & et al., 1996; Watkins & Connell, 2004). This study focused on measures that are designed specifically for diabetes, diabetes-specific quality of life measures. Over the past decades, many diabetes-specific quality of life measures have been developed in an attempt to understand the effects of intensive treatments and complications of diabetes on quality of life (R. M. Anderson et al., 1997; Bott et al., 1998; Bradley et al., 1999; DCCT Research Group, 1996; Jacobson, 1994; Parkerson et al., 1993; Patrick & Deyo, 1989; Shen et al., 1999). Examples of diabetes-specific measures are the Diabetes Quality of Life Measure (DQOL: DCCT Research Group, 1988), Diabetes Care Profile (DCP: Fitzgerald et al., 1996), Diabetes Health Profile (DHP: K.

Meadows et al., 1996), Diabetes-39 (D-39: Boyer & Earp, 1997), Audit of Diabetes Dependent QoL (ADDQoL: Bradley et al., 1999) and Diabetes Quality of Life Clinical Trial Questionnaire (DQLCTQ: Shen et al., 1999). Garratt and colleagues (2002) reported that better diabetes-related quality of life was associated with better glycemic control, fewer diabetic complications, being male, younger age, being married and higher socioeconomic status.

Despite the fact that some studies have concluded that the general measures provided as much or more information about HRQoL than disease-specific instruments (Parkerson et al., 1993), several studies showed that the general HRQoL measures had poor discriminant validity (R. M. Anderson et al., 1997; Sureshkumar et al., 2002), and were able to detect the differences in treatments and disease groups only when serious health problems had already developed (Jacobson et al., 1994). General health-related and disease-specific measures of HRQoL examine quality of life from different but complimentary perspectives (Jacobson et al., 1994). Thus, the combined use of both general and diabetes-specific measures for the quality of life evaluation is recommended (Beaser, Garbus, & Jacobson, 1996; Garratt et al., 2002; Jacobson, 1997; Woodcock et al., 2001).

The current study used the most recent version of the SF-36 (SF-36v2) and DQOL to assess the patients' perceptions on their HRQoL. Most studies using the SF-36 health survey as a general health-related measure reported that type-2 diabetes had a negative impact on almost every dimension of HRQoL (Jacobson et al., 1994; Thommasen & Zhang, 2006a; Wee et al., 2005). The literature search revealed that although many studies used the SF-36 to evaluate subjects' HRQoL, there were only a few studies utilizing the DQOL measure, and even fewer studies that used both measures (Jacobson et al., 1994; Jacobson, de Groot, & Samson, 1997; Trief, Wade, Pine, & Weinstock, 2003).

2.2.2 Demographic Characteristics, Quality of Life and Type-2 Diabetes

Better understanding of the relationship between HRQoL and its determinants, such as age, gender and marital status, is necessary to develop treatment strategies designed to improve quality of life. Theoretically, demographic characteristics should have a greater impact on general health-related quality of life measures than on disease-specific measures. This was confirmed by a study of 227 individuals with type-2 diabetes that used the Psychological Well-being scale as a general health-related quality of life measure and the Psychological Integration Scale (ATT 39) as a diabetes specific measure. The diabetes specific measure did not show significant gender differences, while the general health-related measure did show gender differences with men scoring better in all the areas of psychological well-being than women (Shobhana et al., 2003).

Older age is often associated with lower HRQoL due to limitations in physical and leisure time activities (Mayou et al., 1990). A study of a general population in the Bella Coola Valley indicated that only age and race were significant predictors of general HRQoL as measured by SF-36 (Thommasen & Zhang, 2006b). This pattern also applied to the diabetes subjects in the study (Thommasen & Zhang, 2006b).

A diabetes self-management survey of 2,056 adults reported that older age was related to lower quality of life as measured by the physical, social and mental subscales of the SF-20 (Glasgow, Ruggiero, Eakin, Dryfoos, & Chobanian, 1997). This finding was consistent with recent studies that also reported significant negative relationships between age and SF-36 scores (Camacho et al., 2002; Rejeski et al., 2006). Among 310 under-served low-income patients with diabetes mellitus in North Carolina, older age was associated with lower SF-36 Physical Functioning scores but higher SF-36 Mental Health scores (Camacho et al., 2002). Paschalides

and colleagues (2004) conducted a study of general health-related quality of life among 184 patients with type-2 diabetes. They found similar negative association between age and SF-36 Physical Component subscale scores (Paschalides et al., 2004).

At least three studies reported that the DQOL was capable of detecting age differences. Jacobson and colleagues (1994) used both the SF-36 and DQOL to assess HRQoL in 134 adults with diabetes, and reported that the Physical Functioning subscale of the SF-36 and overall DQOL scores were negatively related to age. There were no significant relationships between age and any of the other SF-36 subscales or the DQOL subscales (Jacobson et al., 1994). Trief and colleagues (2003) also used both the SF-36 and DQOL to assess the HRQoL among diabetic patients along with two diabetes specific questionnaires (the Problem Areas in Diabetes Scale [PAID] and Appraisal of Diabetes Scale [ADS]). They reported that older subjects had significant lower scores on the Role-Physical and Role-Emotional subscales of SF-36 and on the PAID and ADS, but higher SF-36 Social Functioning and DQOL Satisfaction subscale scores than younger subjects. Parkerson and colleagues (1993) conducted their study using the DQOL and different general health-related quality of life measures (general health perceptions Questionnaire [GHP] and Duke Health Profile [DUKE]). They reported that older age was associated with less social worry as assessed by DQOL (Parkerson et al., 1993).

Orfila and colleagues (2006) examined gender differences in general health-related quality of life among older adults. They found that women showed worse HRQoL than men which they attributed to a higher prevalence of disability and chronic conditions. They also suggested that older women are considerably more likely than men to experience functional impairments in mobility and personal self-care, which may contribute to their lower HRQoL (Orfila et al., 2006). A similar finding was reported in the diabetes population where being

female was associated to lower general health-related quality of life as measured by the Physical Functioning, Social Functioning and Mental Health subscales of the SF-20 (Glasgow et al., 1997). Among 5,145 obese adults with type-2 diabetes, men had significantly higher Physical and Mental Health component scores on the SF-36 than women (Rejeski et al., 2006). The DQOL developers reported that among 134 type-1 diabetic adults, there was a significant association between DQOL scores and gender with males reporting less of impact of diabetes and fewer diabetes-related worries than females (DCCT Research Group, 1988).

The reported association between gender and HRQoL has, however, been inconsistent as measured by both general health related and diabetes specific measures. A number of studies reported that there were no associations between gender and HRQoL (Camacho et al., 2002; Jacobson et al., 1994; Shobhana et al., 2003; Thommasen & Zhang, 2006b).

Jacobson and colleagues (1994) reported that marital status was the only sociodemographic characteristics that was significantly related to SF-36 and DQOL scores in their study of subjects with both type-1 and type-2 diabetes. Separated or divorced individuals generally experienced worse quality of life comparing to those who were single or married (Jacobson et al., 1994). Parkerson and colleagues (1993) also reported that being married was associated with less social and diabetes related worry.

Jacobson and colleagues (1994) reported that neither SF-36 nor DQOL scores were influenced by subjects' level of education. This finding was consistent with a previous study that reported there were no significant relationship between educational level and DQOL subscale or total scores (Parkerson et al., 1993). In contrast, Rejeski and colleagues (2006) reported that higher education was associated with higher HRQoL as measured by the Physical Component

subscale of the SF-36. In a survey of 2,056 adults with diabetes, less education was associated with lower general health-related quality of life (Glasgow et al., 1997).

Glasgow and colleagues (1997) examined the relationship between socio-economic status and general health related quality of life in subjects with diabetes. The subjects who had household incomes less than $15,000 reported significantly lower physical, social and mental scores on the SF-20 than those who had higher household incomes (Glasgow et al., 1997).

Although research on quality of life in diabetic patients has been increasing, there is limited research examining the relationships between demographic characteristics and HRQoL in individuals with type-2 diabetes. The studies presented suggest that among individuals with diabetes lower HRQoL can be expected in older females, when individuals are separated or divorced, when their education is less than high school, and when their household income is low. Additional research is needed to confirm these findings. No published studies examining the association between the number of adults in the household and HRQoL were found.

2.2.3 Comorbidities in Type-2 Diabetes and Quality of Life

Diabetes is associated with a number of long-term complications including heart disease, peripheral vascular disease, neuropathy, retinopathy, and renal disease. Diabetes complications are a major cause of morbidity, mortality, and high health-care costs in the US and around the world. Without complications or comorbidities, diabetes has remarkably little or no effect on patients (ADA, 2006b; O'Connor et al., 2006).

In general, diabetic patients with co-existing chronic medical conditions had lower HRQoL than those who only had diabetes (Lloyd, Sawyer, & Hopkinson, 2001; Maddigan, Feeny, & Johnson, 2005). The greater the number of the coexisting chronic conditions the worse

the HRQoL (Glasgow et al., 1997; Thommasen & Zhang, 2006b). There is evidence that even the presence of mild complications in patients with type-2 diabetes can have a profound effect on HRQoL (Lloyd et al., 2001). Wee and colleagues (2005) reported that individuals with diabetes had lower general HRQoL than those without diabetes and that it was even lower when there was a co-existing condition such as hypertension or heart disease. This is consistent with the findings of a recent study that reported that the number of comorbidities was associated with lower HRQoL as measured by the SF-36 (Thommasen & Zhang, 2006b).

Jacobson and colleagues (1994) found that the SF-36 was more sensitive to changes in the number and severity of diabetes complications than the DQOL. An increase in the number and severity of diabetes complications was associated with significantly worse quality of life, as measured by the SF-36 (all subscales) and DQOL (satisfaction, impact and total scores) among subjects with type-1 diabetes. Among those with type-2 diabetes, the number of complications was a weak predictor of quality of life. It had significant negative associations only with SF-36 Role-Physical and DQOL Satisfaction subscale scores. However, the investigators noted that subjects with type-2 had fewer complications (only one had three complications) than subjects with type-1 diabetes (Jacobson et al., 1994).

The diagnosis of diabetes is often delayed (Cathelineau, de Champvallins, Bouallouche, & Lesobre, 1997; Singh, Jackson, Wills, Davies, & Wise, 1992) and made by chance during the evaluation of other health problems or when the patient develops complications (Hiltunen et al., 1996). A recent study of 504 newly diagnosed diabetic patients showed that 7% had symptoms of complications of diabetes, and 61% did not have any diabetes-related symptoms (O'Connor et al., 2006). Since the symptoms are one of the strongest HRQoL indicators, the ultimate goal of

diabetes treatment is to obtain a symptom-free state and to retain a quality of life that is as good as possible (Hiltunen et al., 1996).

The following sections of the literature reviews focus on the comorbid conditions of interest in the current study: (1) hypertension; (2) heart disease and stroke; (3) peripheral vascular disease; (4) renal disease; (5) mental health problem including depression, anxiety or other psychiatric problems; and (6) arthritis. Findings related to their prevalence, symptoms and impact on HRQoL are presented.

2.2.3.1 High Blood Pressure

Normal blood pressure is less than 120/80 mm Hg and the pressure above 140/90 mm Hg indicate hypertension (HTN) (AHA, 2006). HTN is a very common condition in diabetes, and is generally asymptomatic. About 73% of adults with diabetes have HTN (CDC, 2005b). The prevalence rate of HTN in diabetes is about twice as higher as among those without diabetes (Moore et al., 1998). Most people find out about the condition when their blood pressure is checked during routine medical care for other health problems or when they develop one of the comorbid conditions associated with hypertension.

Although HTN is one of the most common comorbid conditions associated with diabetes, it has very little impact on HRQoL as measured by the SF-36 (Alonso et al., 2004). Rejeski and colleagues (2006) reported that the presence of HTN in obese adults with type-2 diabetes was associated with significantly lower Physical Component scores (47.5 vs. 49.7, $p < .01$) but significantly higher Mental Component scores (54.2 vs. 53.4, $p < .01$) on the SF-36. Wee and colleagues (2005) found that subjects with diabetes who had HTN experienced significantly lower scores (2.3 points, $p < .05$) only on the Physical Functioning subscale of the SF-36 than those without HTN.

2.2.3.2 Heart Diseases and Stroke

Hyperglycemic conditions overtimes result in increased deposits of fatty materials on the inside of blood vessel walls increasing the prevalence of arteriosclerosis, and eventually leading to cardiovascular diseases (NIDDK, 2005a). About 65% of deaths in adults with diabetes are caused by heart disease and stroke with the death rates from these conditions being two to four times higher in persons with diabetes than people without diabetes (CDC, 2005b; NIDDK, 2005b).

Two major types of cardiovascular disease among individuals with diabetes are coronary artery disease and cerebral vascular disease (NIDDK, 2005a). Individuals with diabetes are at a greater risk of having a stroke or heart disease than those without diabetes (Bell, 1994; NIDDK, 2005a). The CDC reported that during 1999-2001, the age-adjusted prevalence of heart disease (24.5% versus 6.6%) and stroke (9.3% versus 2.6%) among adults with diabetes was approximately two to three times greater than among adults without diabetes (CDC, 2003). The 1989 National Health Interview Survey (NHIS) Diabetes Supplement reported that 12.7% of individuals with diabetes aged 65 years or older reported a history of stroke (Kuller, 1995).

Heart disease and stroke have a major impact on an individual's quality of life. They can contribute to chronic pain or discomfort, activity restriction, social limitations, disability, and unemployment. Several studies have reported that stroke and heart disease are strongly correlated with impaired physical function, causing disability (Haan & Weldon, 1996; Kuller, 1995; Maddigan et al., 2005; Worley, Lalonde, Kerr, Benavente, & Hart, 1998). Otiniano and colleagues (2003) reported that the coexistence of stroke and diabetes was strongly associated with disability and poor HRQoL, and that the effects became stronger with additional comorbid conditions.

2.2.3.3 Peripheral Vascular Disease

PVD is also known as lower extremity arterial disease (LEAD or LED). PVD is more common in diabetic than non diabetic patients (Palumbo & Melton III, 1995). Due to differences in the definition of PVD, type of diabetes studied, age group of interest, and the study methods used, the prevalence of PVD varied in studies of subjects with diabetes (EDIC Research Group, 1999; Palumbo & Melton III, 1995).

The prevalence of PVD is approximately twice as high among patients with diabetes mellitus as in the overall population (Gregg et al., 2004). Among those with type-2 diabetes, the prevalence of PVD was greater than 4% (Kanta Barman et al., 2004) with higher rates in men than in women (Criqui et al., 1985). Lloyd et al. (2001) reported that 7% of 1233 type-2 diabetic patients had PVD. These subjects reported significantly lower scores in physical and social functioning than those without PVD.

2.2.3.4 Renal Disease

Each year more than 100,000 people are diagnosed with kidney failure, the end-stage of renal disease (NIDDK, 2006). The major causes of chronic kidney failure (CKD) are diabetes (44.2%) and hypertension (27.6%). Most people with diabetes, however, do not develop diabetic nephropathy severe enough to cause end stage renal failure (ESRD). Although about 10% to 15% of individuals with diabetes in the U.S. have nephropathy (ADA, 2006a), less than 1% of those are living with ESRD as a result of diabetes (NIDDK, 2006). Rocco et al. reported a statistically significant negative relationship between HRQoL and glomerular filtration rates in subjects with CKD (1997). The impaired HRQoL of the patients with CKD has been attributed to limitations in physical function and the effects of treatment (Merkus et al., 1997; Merkus et al., 1999; Walters, Hays, Spritzer, Fridman, & Carter, 2002).

The Renal Research Institute-CKD (RRI-CKD) conducted a study on 634 patients who had significantly impaired renal function (38% had diabetes), and reported that patients with CKD had higher HRQoL scores on every SF-36 subscale than dialysis patients, but lower scores on all subscales except the Mental Health subscale than the general U.S. adult population (Perlman et al., 2005). A study of 186 African Americans with type-2 diabetes indicated that people with impaired renal function had significantly lower Physical Functioning and General Health SF-36 scores than those without impaired renal function (Hill-Briggs, Gary, Hill, Bone, & Brancati, 2002).

2.2.3.5 Mental Problems (Depression/Anxiety and others)

Diabetes is considered to be one of the most psychologically and behaviorally demanding chronic medical illnesses due to the unique demands of its treatment regimen (Fisher, Delamater, Bertelson, & Kirkley, 1982). Following the diagnosis, many patients experience several unique behavioral and psychological problems including social withdrawal, depression and anxiety caused by the demands of the diabetes treatment regimen and the awareness of the almost inevitable onset of diabetic complications (Cox & Gonder-Frederick, 1992). These psychological problems and their symptoms are known to influence HRQoL (Jacobson et al., 1997; McHorney, Ware, & Raczek, 1993; Wells et al., 1989). As the condition progresses, psychosocial problems often occur secondary to the development of complications. One study suggested that patients typically return to pre-diagnosis levels of functioning after the adjustment to the disease (Holmes, 1986). but that is not always the case (Kovacs et al., 1990).

Depression is common in the diabetes population, affecting between 9% and 33% of patients (about two to six times higher than the prevalence in the general population), depending on the population studied and the method used to diagnose depression (R. J. Anderson,

Freedland, Clouse, & Lustman, 2001; Gavard, Lustman, & Clouse, 1993; Kopp, 1988; Peyrot & Rubin, 1997). A recent study reported that the prevalence of depression in the diabetic population was 24% compared with 17% in the non-diabetic population (Goldney, Phillips, Fisher, & Wilson, 2004). A review of 42 studies examining the prevalence of comorbid depression in the patients with diabetes concluded that the prevalence rate differed by gender (28% for female vs. 18% for male), study design (21% in controlled studies vs. 30% in uncontrolled studies), subject source (32% in clinical studies vs. 20% in community studies), and the assessment method (31% by self-report questionnaires vs. 11% by standardized diagnostic interviews) but did not differ by the type of diabetes (diagnostic interview: 13.6% for type-1 vs. 10.9% for type-2) or the self-report scale used to measure depressive symptoms (29.1% versus 32.9%) (R. J. Anderson et al., 2001).

Two studies compared general HRQoL in type-2 diabetic patients with and without co-existing depression. Those with depression reported lower HRQoL than those without depression (Hanninen, Takala, & Keinanen-Kiukaanniemi, 1999; Viinamaki, Niskanen, & Uusitupa, 1995). Approximately one in every three individuals with diabetes has depression at the level severe enough to impair functioning and quality of life (R. J. Anderson et al., 2001; Jacobson et al., 1997; Koenig, George, Peterson, & Pieper, 1997; Lyness, King, Cox, Yoediono, & Caine, 1999).

Jacobson and colleagues (1997) conducted a study of diabetic patients of whom 70% scored 63 or higher on the global severity index of the Psychiatric Symptoms Checklist (SCL-90-R) and 30% below this cutoff. They reported that both type-1 and type-2 diabetic subjects with a life time history of a psychiatric disorder had significant lower DQOL total scores than those without a history of the condition. Almost all aspects of both general health and diabetes-related

quality of life as measured by SF-36 and DQOL, were adversely influenced by the presence of psychiatric symptoms and illnesses as well as the severity of diabetes, and the associations were very strong, even after the effect of diabetes complications were taken into account (Jacobson et al., 1997).

2.2.3.6 Arthritis

Arthritis is the leading cause of disability in the US. Each year between 2003 and 2005, almost 19 million American adults reported activity limitations due to arthritis. An estimated 46 million American adults reported physician-diagnosed arthritis from 2003 to 2005, and the number is projected to increase to 67 millions in 2030 (CDC, 2007). Arthritis was selected as one of the study focused comorbidities in the current study due to the high prevalence of the condition among adults aged 45 years and older, which is similar to the age inclusion criteria in the current study. According to "Mobility and Mortality Weekly Report", 50% of persons 65 years of age and older and 29.3% of persons aged 45–64 years have the condition compared to 7.9% of younger age groups (18–44 years) (CDC, 2006b).

Rheumatic conditions are typically characterized by pain and stiffness in and around one or more joints. Although arthritis is not a major factor affecting the mortality, it can have a negative impact on HRQoL (Stewart et al., 1989). A recent study of HRQoL in obese adults with type-2 diabetes reported that the prevalence of arthritis among the subjects was 40.9%. Those with arthritis had significantly lower Physical Component SF-36 scores (45.0 vs. 50.0, $p < .01$) but higher Mental Component scores (54.3 vs. 53.8, $p < .01$) compared to those without arthritis (Rejeski et al., 2006). Two other studies reported similar finding (Maddigan et al., 2005; Thommasen & Zhang, 2006b).

2.2.4 Wilson and Cleary HRQoL Conceptual Model

A search of Ovid using key word "Wilson and Cleary" resulted in 14 published research studies utilizing Wilson and Cleary model of HRQoL as a conceptual framework. The majority of the studies focused on the HIV population, and two of them were conducted in Spain and South Africa. Although to date, few studies have tested the entire model, it has been cited more than 300 times (Hofer et al., 2005).

Wilson and Cleary (1997) conducted an 8-month longitudinal cohort study designed to establish clinical characteristics associated with declining physical functioning in people with AIDS. Data were used to test part of the model (from biological and physiological factors to functional status). The selected independent predictors of declining physical function included symptoms, laboratory test results, comorbid conditions, medications, the number of new acute infections and weight loss. Sociodemographic information such as age, race, gender, and educational level were also included in the analysis. Younger participants (the mean age was 36) had an average 9.6 point (on a 100-point scale) decline in physical functioning, greater than the decline seen in older subjects. Two symptom complexes (fatigue and neurologic symptoms; p =.0002 & .001 respectively), four comorbidities (hypertension, depression, GI disease and weight loss; p = .0005, .004, .018 and .0001 respectively) were significant independent predictors of 8-month Intermediate Activities of Daily Living (IADLs) scores after statistically controlling for baseline IADL scores and sociodemographic variables. Take together, these variables explained 56% of the variance in 8-month physical functioning (Wilson & Cleary, 1997).

Nokes and colleagues (2000) investigated variables predicting health-related quality of life as conceptualized by Wilson and Cleary Model for people with HIV/AIDS. Participants

were either age 50 or older (n = 73) or younger than age 50 (n = 640). Complete information was available to fit every concept of the model but the analysis was limited to describing the bivariate relationships between model factors. SEM was not implemented for the analysis. The descriptive analyses showed that older subjects reported significantly more medical conditions such as diabetes or hypertension (p = < 0.001) and more limitations in physical functioning (p = .006), and disclosed their HIV status to fewer people (p = <.001) than younger subjects. The last finding (less disclosure of HIV) could have been related to older individuals having fewer people in their social networks than younger people (Nokes et al., 2000).

Phaladze et al. (2005) examined the meaning of quality of life for people living with HIV/AIDS in four countries in sub-Saharan Africa. They utilized a descriptive, cross-sectional design with a convenience sample (n = 743). Wilson and Cleary model was implemented as a framework for categorizing variables, such as demographic characteristics and measures of severity of illness and examining their relationship to quality of life. Hierarchical multiple-regression was performed with quality of life (defined as life satisfaction) as the dependent variable. They found that subjects with higher life satisfaction scores were less educated, had not been diagnosed with AIDS or other comorbidities, and had lower symptom intensity, greater functioning and fewer health worries. The combination of variables in the model explained more than 50% of the variance in life satisfaction. Participants' self-reported overall functioning explained the greatest variance of in life satisfaction, with a distinctive R^2 of approximate 30% (Phaladze et al., 2005).

Orfila et al. (2006) evaluating the associations between (1) gender, (2) performance-based functional ability, (3) chronic diseases, and (4) other socio-demographic variables (e.g., age and social class) and HRQoL (measured by the Nottingham Health Profile questionnaire) in

older adults. They performed sequential multiple linear regression analysis to test the Wilson and Cleary model (1995), although they combined biological and physiological factors with symptom status), to estimate the magnitude of the association between gender and quality of life, and to assess to what extent sociodemographic and lifestyle variables, performance-based functional capacity, and chronic conditions affected that relationship. Their findings were consistent with the model. Functional capacity, arthritis, back pain, diabetes, and depression were significantly related to the general HRQoL.

Penckofer and colleagues (2005) compared HRQoL in 61 women before and three months following Coronary Artery Bypass Graft (GABG) surgery, guided by Wilson and Cleary model. The results revealed that older age, more comorbidities, (e.g., hypertension and diabetes), and smaller coronary arteries were associated with poorer HRQoL in women after CABG surgery. Women reported better psychological well being at three months after surgery ($F_{[1,55]} = 16.40$, $p < .001$) than pre-operatively. Further analyses indicated that women had less anxiety ($F_{[1,55]} = 24.00$, $p < .001$), improved well-being ($F_{[1,55]} = 5.67$, $p = .021$), and improved health ($F_{[1,55]} = 26.00$, $p < .001$) after surgery. There were also significant improvements on the measures of well-being after the surgery ($\chi^2_{[2]} = 6.26$, $p = .043$)) with the proportion of women reporting (1) a sense of positive well being increasing from 37% to 61%, (2) moderate distress decreasing from 27% to 14% and (3) severe distress decreasing from 36% to 25%. Significant improvements in HRQoL were found after surgery. According to the Wilson and Cleary model, these changes would be expected since there were improvements in symptoms and functional status (Penckofer et al., 2005).

Hofer et al. (2005) used structural equation modeling to test Wilson' and Cleary model in patients with coronary artery disease ($n = 465$) at three different points of time (at the baseline

evaluation of chest pain and 1-month and 3-months later). The study's objective was to find out whether the model was applicable to coronary artery disease patients and stable in this particular group of patients over time. Satisfactory fits of the models were obtained at both baseline and over time. The final model linked clinical variables, such as the number of diseased vessels and the number of risk factors, to general HRQoL through the mediating effects of the experience of actual symptoms (i.e., symptom status), physical functioning, and general health perceptions. Depression and anxiety symptoms had the most significant impact on HRQoL. The findings provided empirical evidence for Wilson and Cleary theoretically derived HRQoL model. Although the five factors were significantly related in the theorized direction, there was also a significant direct influence of physical functioning on global HRQoL. Furthermore, individual and environmental characteristics were significantly related to the central variables (endogenous variables): symptom status, physical functioning status, general health perception and general HRQoL. The overall model explained approximately 49% of the variance in overall HRQoL. This study's finding also support the application of structural equation modeling in the investigation of the HRQoL (Hofer et al., 2005).

Structural Equation Modeling (SEM) is a powerful method that allows researchers to simultaneously test the underlying relationships between several variables within the framework of a model. The advantage of using this approach for model testing in HRQoL research is its capability to allow simultaneous investigation of a set of measurement paths and a structural path proposed by the model. In the measurement paths, latent or unobserved variables, such as functional status or global HRQoL, are defined by a single variable or combination of two or more observed variables (Kline, 2005). The latent variables are then connected to form the structural path of the model. The relationships between two latent variables or between a single

predictor and a latent variable are specified as path coefficients or regression coefficients (Hofer et al., 2005; Smith et al., 1999).

As presented above, there are a limited number of studies that utilized this method to examine Wilson and Cleary Model of HRQoL. The only diseases the model has only been tested in are HIV/AIDS and coronary artery disease. The findings from several studies also suggested that the relationships among the factors proposed by Wilson and Cleary Model may be applicable in other diseases. Therefore, there is a need for more rigorous well design analytical methods to test the model in different population such as the type-2 diabetes population. The current study tested the revised Wilson and Cleary model with pre-existing data collected from subjects with type-2 diabetes.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
Rejeski et al., (2006)	5,145 Obese adults aged 45 to 74 with type-2 diabetes, 80.6% HTN, 40.9% arthritis, 14.1% CAD, and 8.4% retinopathy	SF-36	None	To describe and examine conceptually relevant correlates of HRQoL in obese adults with type-2 diabetes	n/a	HRQoL varied significantly by age, gender, marital status, income, years of education ($p < .0001$).	Number of physical complaints, type of comorbidities: having arthritis, HTN, CAD or depression was associated with lower HRQoL (SF-36 PCS).
Thommasen and Zhang, (2006b)	675 survey responders, 72 of whom had DM. Among diabetes, 50% had HTN, 13% had CAD, 24% had depression and/or anxiety and 6% had rheumatoid arthritis (RA)	SF-36	None	To assess HRQoL in adults suffering chronic disease and living in the rural, remote community of Bella Coola	n/a	Only age and race were significant predictors of HRQoL, not gender ($p < .05$).	Number of comorbidities was associated with lower HRQoL. CAD and renal disease were associated with significantly lower scores in almost every subscale ($p < .05$).
Maddigan et al., (2005)	n = 53,137 control group, 1,193 diabetes only, 1,087 diabetes with other comorbidities	Health Utilities Index Mark 3 (HUI3)	None	To assess the impact of comorbid heart disease, stroke and arthritis on HRQoL in people with diabetes in the general Canadian	n/a	Not reported	Overall HUI3 scores for respondents with diabetes alone were lower than controls (0.88 versus 0.92, $p < .001$). The scores for diabetes combined with heart disease (0.77), RA (0.78) or

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
				population			stroke/TIA (0.79) were significantly lower than diabetes alone ($p < .05$). Triplets of comorbidities were associated with overall HRQoL deficits of approx. 0.26–0.30, relative to controls.
Wee et al., (2005)	5,224 multinational patients with diabetes	SF-36 and SF-6D	None	To evaluate the impact of DM and co-existing chronic medical conditions on HRQoL	n/a	Not reported	Diabetic patients with HTN, heart or musculoskeletal disease had lower SF-36 scores ($p < .05$) than patients with only diabetes
Paschalides et al., (2004)	184 patients with type-2 diabetes	SF-36, Illness Perception Questionnaire (IPQ) and Well-Being Questionnaire (WBQ)	None	To examine the interrelationships of anxiety, depression and personal illness representations with glycaemic control and HRQoL in Type-2 diabetic adults.	n/a	Older age was significantly associated with lower HRQoL ($p = .02$).	Depression and anxiety were associated with significantly worse physical and mental functioning relative to subjects without depression and anxiety ($p < .0005$)
Otiniano et al., (2003)	A total of 3050 subjects of age 65 years or	Self-rated health status (excellent,	None	To examine how diabetes in combination with	n/a	Not reported	Diabetes and stroke in combination is strongly associated

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
	older, of which 23% had diabetes and 6% had a stroke.	good, fair, and poor).		stroke affects functional activities of daily living (ADLs) and instrumental activities of daily living (IADLs), self-rated health, and 5-year mortality in elderly Mexican Americans with or without other comorbidities.			with a poor self-rated health (odds ratio [OR] = 3.5; 95% CI, 1.4–8.6). The risk of disability was further increased if the subject had another comorbid condition (hypertension, heart attack, cancer, hip fracture, arthritis), ORs of 27.02 ; 95% CI, 13.53–53.98 for ADL and of 23.03; 95% CI, 8.59–61.74 for IADL disability
Shobhana et al., (2003)	227 type-2 diabetic patients	Psychological Well-being scale	Psychological Integration Scale (ATT 39)	To assess the role of diabetes integration and psychological factors in patients with type-2 diabetes.	The psychological well-being subscales and total scores were significantly correlated with the diabetes integration scale (all *p* values were < 0.0001).	Diabetes specific measure did not show significant gender differences, while the generic measure did show gender differences with men scored better in all the areas of psychological well-being than women subjects ($p <$ .05).	n/a
Trief et al., (2003)	191 patients with diabetes (DM) treated	SF-36	DQOL, Problem areas in	To compare and contrast the HRQoL of 91	SF-36 summary scores did not detect the difference	HRQoL scores are influenced by age. Elderly reported sig.	Not reported

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
	with insulin; 63% had type-2 DM, aged > 30 years old.		diabetes scale (PAID), and Appraisal of diabetes scale (ADS)	elderly (≥ 65) and 100 younger (30-64) individuals with diabetes.	between two age groups, but three diabetes-specific measures did ($p <$ .05)	lower SF-36 RP ($p <$ .006) and RE ($p <$ .03) subscale, PAID ($p <$ .001) and ADS ($p <$ .03)scores but higher SF-36 SF subscale ($p <$ .03) and DQOL Satisfaction scores ($p =$ .008).	
Camacho et al., (2002)	310 patients with Diabetes: 69% were female and 84% had type-2 DM.	SF-36	Diabetes-39 (D-39)	To describe correlates of HRQoL among under-served low-income patients with diabetes mellitus	Not reported	Older age was associated with lower SF-36 PF score and higher SF-36 MH score ($p <$ .01). No gender-related differences.	Not reported
Lloyd et al., (2001)	1,233 patients with type-2 DM, not using insulin, 35 years and older, 46% also had HTN, 12% peripheral neuropathy, 8% CAD and 7% PVD.	SF-36	None	To assess the effects of diabetic complications on HRQoL	n/a	Not reported	CAD was associated with significant reductions of all SF-36 subscales except RE and MH at $p <$ .05; PVD was associated with significantly lower SF-36 PF and SF ($p <$ .05); HTN did not have an effect on HRQoL.
Anderson et	255 patients with type-2	SF-36	Diabetes Care Profile	To compare the SF-36 and DCP in	The DCP had predictive validity	Not reported	1) Patients using insulin: 6 of SF-36

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
al., (1997)	diabetes, 36% using insulin, ≥22 years or older		(DCP)	patients with type-2 diabetes (NIDDM)	regarding glycemic control ($p < .03$), whereas the SF-36 did not		subscales (PF, RP, BP, GH, VT, and SF) are negatively correlated with number of type-2 diabetes related complications (coronary artery disease, stroke, nephropathy, neuropathy, retinopathy, and diabetes related foot infections). Two DCP subscales (a. Social and Personal Factors, b. Positive Attitudes) are also negatively correlated with number of complications (both $p < .001$). 2) Patients not using insulin: only GH of SF-36 was negatively correlated with number of complications ($p < .01$). No correlations were found between DCP subscales and number of

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
							complications.
Boyer et al., (1997)	427 patients with DM, 33% type-1, 45% female, 42% also had HTN, 38% arthritis, 35% circulatory problems	SF-36	Diabetes-39 (D-39)	To develop an instrument (D-39) specifically designed to assess the quality of life of people with diabetes	Since D-39 scores were reversed comparing to SF-36. Strong negative correlations were identified between many subscales. (*r* varied from -0.71 to -0.15)	As measured by D-39, not being married was associated with lower QoL. Women perceived greater impact of diabetes on their QoL than men did. Aged older than 75 years was associated with a lower QoL than younger age (p-values not reported).	D-39 scores were influenced by the number of comorbidity: Subjects with 7 or more had worse HRQoL. Depressive patients had lower HRQoL as measured by D-39 than those who were not depressed (p-values not reported).
Glasgow et al., (1997)	2,056 adults with DM, avg. age of 59 years	SF-20: social, physical, and mental health subscales.	None	To investigate HRQoL and the demographic, medical-history, and self-management characteristics associated with it.	n/a	Characteristics related to lower QoL were: less education, lower income, living alone, older age, being female ($p <$ .01) and lower levels of physical activity ($p <$ .01).	The number of complications and comorbidities were related to lower QoL ($p =$ <.001).
Jacobson et al., (1997)	240 patients with type-1 and type-2 diabetes, 49% were men.	SF-36	Diabetes Quality of Life (DQOL)	To evaluate the influence of psychiatric symptoms and illness status on the HRQoL of outpatients with	Not reported	Not reported	After controlling for complications frequency and diabetic type, psychiatric disorders (such as depression) were associated with worse scores in all

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
				diabetes mellitus.			SF-36 and DQOL scales except SF-36 PF ($p < .005$)
Jacobson et al., (1994)	111 patients with type-1 DM and 129 patients with type-2 DM	SF-36	DQOL	To examine the effects of diabetes on patients' perceptions on their QoL and compare the psychometric properties of a SF-36 versus DQOL measures	Correlations: -0.003 to 0.60 indicating that the areas of functioning addressed by the DQOL and SF-36 overlapped only to a modest degree.	Both measures were not influenced by age, gender or educational level, except SF-36 PF and overall diabetes-specific QoL deteriorated with age ($p < .05$). They were affected by marital status: separated or divorced individuals experienced lower levels of QoL.	The number and severity of complications (proliferative retinopathy, symptomatic neuropathy, and nephropathy requiring treatment) was a significant negative predictor of general HRQoL measured by all SF-36 subscales ($p < .01$ to $p < .005$), as well as DQOL total ($p < .01$) and subscale scores ($p < .05$ to $p < .005$).
Parkerson et al., (1993)	170 patients with type-1 diabetes aged 17 to 59 yrs, 53.5% were women, 63.9% were married, and 60.3% of subjects had 13 to 16 yrs of	General Health Perceptions Questionnaire (GHP) and Duke Health Profile (DUKE)	DQOL	To compare a disease-specific (DQOL) with two generic QoL (GHP and DUKE) instruments	Both generic and disease-specific results were the same.	Being married was significantly related to less social and diabetes related worry ($p < .05$), and older age was associated with less social worry of DQOL ($p < .05$). There was no	Nephropathy was not significantly related to any of DQOL scores.

Note: The detailed footnotes are listed at the end of the table.

Table 2-2: Overviews of Studies Assessing the Health Related Quality of Life in Diabetes Population (continued)

Authors	Primary Disease and Population	HRQoL Measures		Study's Objective	Relationship between		
		General	*Diabetes-specific*		*HRQoL Measures*	*Demographic Factors and HRQoL*	*Comorbidity and HRQoL*
	education.					significant relationship between educational level and DQOL subscale and total score.	

DQOL DRW = diabetes related worry subscale; **DQOL IMP** = impact subscale; **DQOL SAT** = satisfaction subscale; **DQOL SVW** = social/ vocation worry subscale; **DQOL TOT** = total score; **SF-36 BP** = bodily pain subscale; **SF-36 GH** = general health subscale; **SF-36 MCS** = mental component summary; **SF-36 MH** = mental health subscale; **SF-36 PF** = physical functioning subscale; **SF-36 PCS** = physical component summary; **SF-36 RE** = role-emotional subscale; **SF-36 RP** = role-physical subscale; **SF-36 SF** = social functioning subscale; **SF-36 VT** = vitality subscale

Note: The detailed footnotes are listed at the end of the table.

Table 2-3: Overviews of Studies Using Wilson and Cleary Conceptual Model

Authors	Primary Disease and Population	Study's Objective	Variables	Analytical Methods	Findings
Orfila et al., (2006)	544 elderly patients with various chronic conditions, 65% women, mean age of 78.4 for women and 78.8 for men	To assess whether performance-based functional capacity, and reported chronic health conditions explain HRQoL differences by gender	The Nottingham Health Profile (NHP) as GHP; Established Populations for the Epidemiological Study of the Elderly (EPESE) for FS; Self-reported chronic conditions for BPF & SS; recorded sociodemographic information and Spanish version of the British Registrar General's classification were used for COI & COE	MR and PA	Women (65.4%) showed worse results than men on HRQL ($p < .001$), functional capacity $p < .001$). The final regression model explained 42% of the variance in GHP as measured by NHP. The final good-fit model was obtained by allowing an error term correlation between COI and COE, and direct links from BPF to FS and SS to GHP.
Sousa and Kwok, (2006)	917 patients with HIV/ AIDS	To validate Wilson and Cleary model using SEM in patients living with HIV from the AIDS Time-Oriented Health Outcomes Study (ATHOS)	CD4 count as BPF; AIDS-specific symptom checklist from ATHOS database as SS; Health Assessment Questionnaire-Disability Index (HAQ-DI) as FS; A double-anchored, 100 mm visual analogue scale from 0 (poor health) to 100 and an ordinal scale rating from 1 (excellent) to 5 as GHP; General health status scale as OQL	SEM	Wilson and Cleary model was valid in patients living with HIV/AIDS. The relationships between the five constructs were significant at $p < .05$ level after allowing direct links from SS to GHP and SS to OQL.
Arnold et al., (2005)	95 patients with chronic obstructive pulmonary disease (COPD, avg. aged 65 years) and 90 patients with chronic heart failure (CHF,	To investigate whether the relationship between objective health parameters and general health perceptions was mediated by symptoms of dyspnea and physical functioning in patients	Objective health parameters (FEV1 or LVEF) as BPF; Symptoms of dyspnea as SS; The physical functioning subscale (10 items) of the Rand 36-item Health Survey as FS; The general health perceptions subscale (5 items) of the Rand 36-item Health Survey as GHP; and the Perceived Health Competence Scale, Socio-demographic variables (Age, gender, marital status and educational level) were used for descriptive analysis.	SEM	The relationship between BPF (FEV1 or LVEF) and FS was not mediated by SS as assessed by symptoms of dyspnea. BPF and SS were independently related to FS (BPF: $B = .20$ for COPD; $B = .17$ for CHF, SS: $B = -.63$ for COPD; $B = -.67$ for CHF), which was directly related to GHP ($B = .39$ for COPD; $B = .52$ for CHF)

Note: The detailed footnotes are listed at the end of the table.

Table 2-3: Overviews of Studies Using Wilson and Cleary's Conceptual Model (continued)

Authors	Primary Disease and Population	Study's Objective	Variables	Analytical Methods	Findings
	avg. aged 60 years)	with COPD and CHF.			Perceived health competence was related to SS and GHP in patients with either COPD or CHF (SS: B = -.41, p < .001 for COPD; B = -.30, p < .01 for CHF, GHP: B = .17, p < .05 for COPD; B = .34, p < .001 for CHF). Although patients with COPD reported lower levels on all self-reported health parameters in the model than the patients with CHF, the relations between the health parameters (BPF) in the model were comparable for COPD and CHF patients.
Hofer et al., (2005)	465 patients with coronary artery disease were evaluated at baseline, 1 and 3 month follow-ups	To test Wilson and Cleary conceptual model of HRQL in coronary artery disease	Number of diseased coronary arteries and risk factors were used for BPF; Canadian Cardiovascular Society classification for SS; SF-36 physical function scale for FF; SF-36 general health perception score for GHP; physical, social, and emotional. HRQoLs from the MacNew Heart Disease Quality of Life Questionnaire were used for OQL; German short form of the Social Support Questionnaire, Competence and Control Orientations Questionnaire, State-Trait Anxiety Inventory and Hospital Anxiety and Depression Scale were used for COI & COE	SEM	After modifications, a satisfactory fit model was obtained. Increased number of involved vessels (*beta* = 0.15) and risk factors (*beta* = 0.08) associated with the worse SS. The worse SS related to poor performance of physical activities (*beta* = -0.09). Limitation in FS led to a worse GHP (*beta* = 0.25). GHP predicted significant directional influence on global HRQoL (*beta* = 0.24)
Penckofer	61 women	To determine the	Age, cardiac History, and number of	Descriptive statistics,	Subjects had significantly

Note: The detailed footnotes are listed at the end of the table.

Table 2-3: Overviews of Studies Using Wilson and Cleary's Conceptual Model (continued)

Authors	Primary Disease and Population	Study's Objective	Variables	Analytical Methods	Findings
et al., (2005)	aged 39 to 83 years who had coronary artery bypass graft (CABG) surgery	effect of coronary artery bypass graft surgery on the quality of life of women	bypasses were used for BPF; presence of angina, shortness of breath, tiredness or fatigue and Psychological General Well Being Index (PGWBI) for SS; Specific Activity Scale, a measure of a person's functional ability based on the metabolic equivalents (METS) and physical activity related questions for FS; Jalowiec Coping Scale and The Powers and Miller Support Scale for COI & COE; a single, 10-point Likert scale item asking, "How is your overall health at the present time" was used for GHP; The Ferrans and Powers Quality of Life Index (QLI, Cardiac Version) was used for OQL	chi-square, and ANOVA were used describing and comparing differences over time. MANOVA was used for comparing differences over time in multiple scales	improved quality of life (p = .004) due to increased satisfaction with health and functioning (p < .001) at three months following CABG surgery.
Phaladze et al., (2005)	743 persons with HIV/ AIDS aged average 34.05 years, 61.2% were women	To understand the subjective meaning of quality of life for AIDS patients in Africa.	Age, sex, years of education, adequacy of income, number of children, and other variables were used for COI & COE; AIDS diagnosis and comorbidities included in the survey also used for BPF; the Revised Sign and Symptoms Checklist for Persons with HIV Disease including calculated number of symptoms and mean intensity of symptoms for SS; HIV/AIDS-Targeted Quality of Life (HAT-QoL) for FS and OQL	Hierarchical multiple regression	61.6% participants had an AIDS diagnosis, 32.0% reported having other chronic comorbidities. Mean level of education was 7.70 years. 59.5% participants reported not having an adequate income, 82.1% reported not having health insurance. The overall model explained 53.2% of the variance in QoL as measured by life satisfaction
Janz et al., (2001)	570 women aged more than 60 years	To describe the impact of clinical and psychosocial factors on the QOL of older	Number of heart diagnoses, comorbidities, heart medications and no-heart medications as BPF; Number of symptoms, Impact of symptoms and CES-D Depression Scale as	Multiple regressions using OQL as dependent variable	At baseline, GHP and SS accounted for 38% and 26% of the variation in OQL. Using logistic regression models, 7

Note: The detailed footnotes are listed at the end of the table.

Table 2-3: Overviews of Studies Using Wilson and Cleary's Conceptual Model (continued)

Authors	Primary Disease and Population	Study's Objective	Variables	Analytical Methods	Findings
		women with heart disease.	SS; 6-minute walk and the physical, psychosocial and total score of Sickness Impact Profile (SIP) as FS; Level of stress, Rates of present health, physical satisfaction, mental satisfaction and social satisfaction as GHP; Overall QoL rating as OQL; MOS Social Support Scale as COE; Characteristics of the person (age, race, marital status and level of education) as COI.		measures were significant predictors (p <.05) of maintenance/improvement versus decline in OQL over 12 months. For women who maintained or improved their satisfaction with social activities, the odds for also maintaining or improving OQL were 4.5 times the odds for women whose satisfaction with social activities deteriorated.
Cosby et al., (2000)	146 patients hospitalized with AIDS	To determine the relationships among anemia, neutropenia and thrombocytopenia and characteristics of the individual, physiological markers, symptoms, functional status, general health perceptions, and well-being in people with AIDS.	Lab values and medication use for BPF; Health distress, metal health, energy/fatigue and pain of Health Status Questionnaire (HSQ), HIV Symptom Check List and Sign and Symptom Check List for Persons with HIV Disease (SSC-HIV) as SS; Physical, role, social and cognitive functioning of HSQ as FS; Quality Audit Marker (QAM) and general health perceptions of HSQ as GHP; Overall quality of life of HSQ as OQL; Demographic information as COI & COE.	Descriptive statistics and logistic regression	The five dimensions of the Wilson and Cleary model offered significant predictability for anemia only (p = .02). Patients with higher symptom scores were more likely to have treatable anemia (p = .008). There were no meaningful relationships among any of the demographic variables (age, gender, ethnicity, or history of IVD use) and any of the three dependent variables.
Nokes et al., (2000)	713 patients with HIV diseases, age 20 – 64, 23% were female,	To explore the differences in health-related quality of life among people under or over 50 years of age	HIV disease severity and comorbidities based on medical charts or reported by subjects were used for BPF; Problem Checklist (10 signs and 31 symptoms rated on an 4-point Likert-type scale: absent, mild,	Chi-square or two directional independent sample t tests were used to determine whether	Older subjects reported significantly more medical conditions such as diabetes or hypertension (p < .001) and more limitations in physical

Note: The detailed footnotes are listed at the end of the table.

Table 2-3: Overviews of Studies Using Wilson and Cleary's Conceptual Model (continued)

Authors	Primary Disease and Population	Study's Objective	Variables	Analytical Methods	Findings
	over 70% had a high school diploma for both groups	who had HIV disease	moderate, severe. For each sign and symptom, respondents then rate the extent to which the problem interferes with their lives: mild, moderate, severe). The HIV Assessment Tool, the Pain subscale on the SF-36, and the CES-D for SS; Physical Functioning and Fulfilling Physical Role subscales of the SF-36 for FS; General Health and Health Transitions subscales of the SF-36, the Contentment subscale of the HIV Assessment Tool, Physical Health subscale of SF-36, and the Health Status Questionnaire (HIV version) for GHP; the Living with HIV and Quality of Life subscale on the Health Status Questionnaire for OQL; Mental Health., Vitality, and Role/Emotional subscales, Forgiveness, Keeping Attention, and Doing Activities subscales of the Health Status Questionnaire, the Medication Use Scale for COI; Social Function subscale of the SF-36 and a self-disclosure checklist were used for COE.	significant difference exists on each of the variables	functioning (p = .006), and they disclosed their HIV status to fewer people (p < .001) than younger subjects.
Sullivan et al., (2000)	5,279 Dutch elderly	To evaluate the relationships among physical symptoms, physical function, psychological symptom, general health perceptions and overall quality of life.	Number of chronic medical conditions as BPF; Factor score from SF-20 pain item and SCL-90 somatic symptom scale for SS; Physical and Social function scale of SF-20 and ADL/IADL scale scores from Groningen Activity Restriction Schedule as FS; SF-20 General Health item and RAND-HIE 4-item Vitality Scale as GHP; Cantril's Ladder Score as OQL.	SEM	The initial seven-level linear model poorly fit the data. The model was modified by allowing the effects between non-adjacent variables. GHP is related to SS (*beta* = -0.39) almost as strongly as it is related to FS (*beta* = -0.41). Anxiety and depressive symptoms mediated the

Note: The detailed footnotes are listed at the end of the table.

Table 2-3: Overviews of Studies Using Wilson and Cleary's Conceptual Model (continued)

Authors	Primary Disease and Population	Study's Objective	Variables	Analytical Methods	Findings
					relation between GHP and OQL. The chi-square of the final alternate model was 79.92 with 5 df and $p < .001$.
Wilson and Cleary, (1997)	201 patients with AIDS, mean age of 36 years	To determine clinical predictors of decline in physical functioning in persons with AIDS	Modified three questions about basic activities of daily living (BADLs) and three about intermediate(IADLs) from the Functional Status Questionnaire and Functional Status Questionnaire and SF-36 were used for FS; Ten symptoms (severe pain, nausea, inability to eat solid food, shortness of breath, diarrhea, fever, sleep disturbance, neurological symptoms, memory difficulties, and energy/fatigue) for SS; specific disease diagnoses and laboratory values, medical chart review and Pharmacologic therapies record were used for BPF.	A regression model and forward stepwise selection procedure were used to select independent predictors of functional status at the 8-month follow-up interview.	Changes in two symptom complexes-fatigue ($p = .0002$) and neurological symptoms ($p = .001$) significantly predicted declines in physical functioning. Three comorbidities: hypertension ($p = .0005$), depression ($p = .004$), and GI problems ($p = .018$) and weight change ($p = .0001$) significantly predicted declines in physical functioning. The variables presented in the model explained 56% of the variance in 8-month physical functioning

ANOVA = analysis of variance; **BPF** = biological and physiological factors; **COE** = characteristics of environment; **COI** = characteristics of individual; **FS** = functional status; **GHP** = general health perceptions; **MANOVA** = multivariate analysis of variance; **MR** = multiple regression analysis; **OQL** = overall quality of life; **PA** = path analysis; **SEM** = structural equation modeling; **SS** = symptom status

Note: The detailed footnotes are listed at the end of the table.

3.0 METHODOLOGY

This chapter discusses the methodologies employed in the current and parent study including research design, characteristics of sample, data collection methods, human rights protection and instruments. Additionally, data screening procedures; treatment of extreme values, outliers and missing data; and data analysis methods are presented.

3.1 RESEARCH DESIGN

The present study involved a secondary analysis of data collected from participants in a randomized controlled trial. The purpose of the parent study was to compare the impact of a problem-solving based, multi-component, intervention delivered by telephone and usual care on adherence to multiple medications among patients with type-2 diabetes and hypertension and/or hyperlipidemia. The overview of the parent study design is illustrated in Figure 3-1.

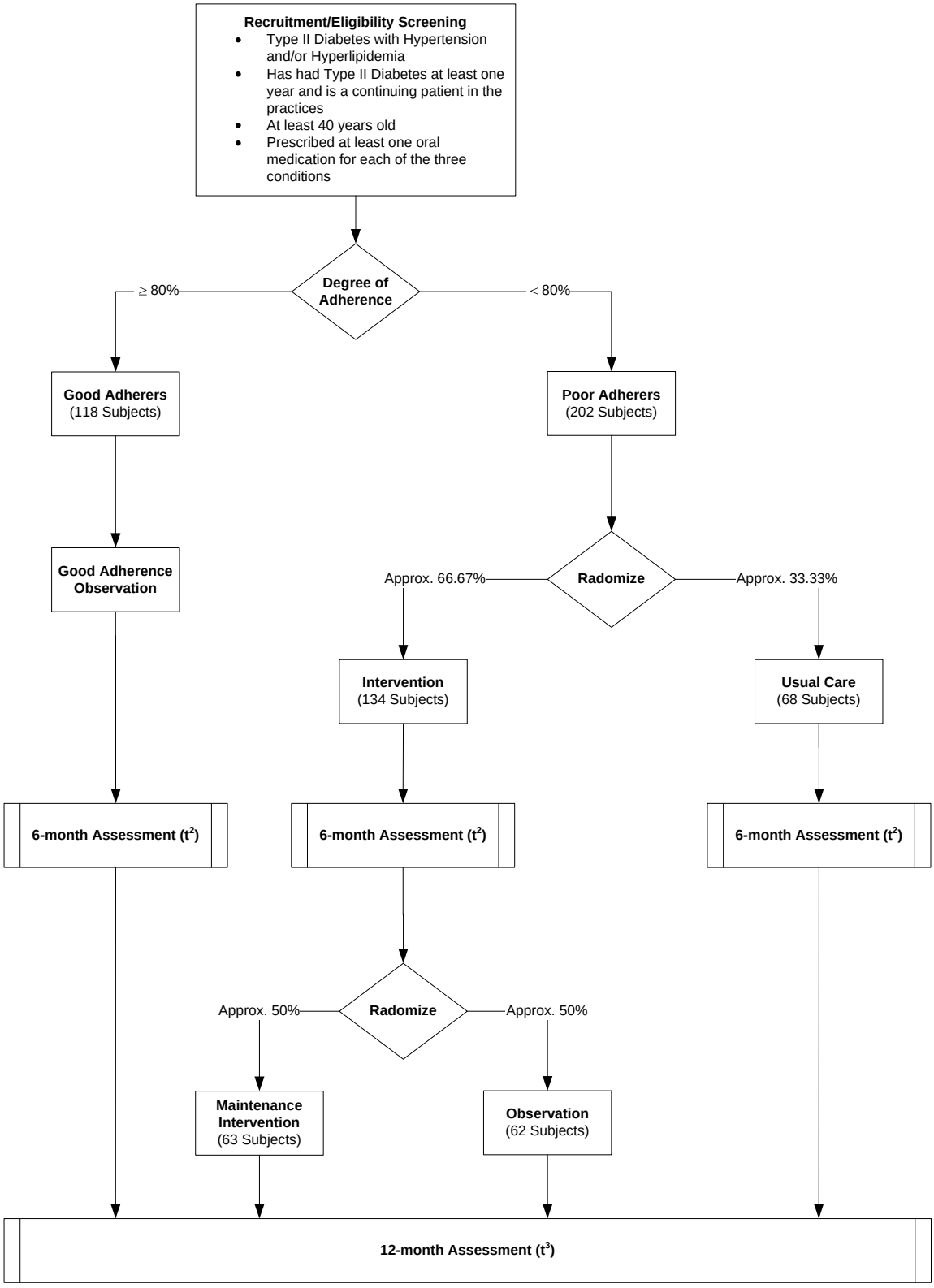

Figure 3-1: Overview of Parent Research Design

Secondary data analysis is a method of analyzing data that were collected for a different research purpose than the one under analysis (Gillis & Jackson, 2002). Secondary analysis is efficient, permits creative thinking, and avoids data collection problems. A major limitation of secondary analysis is that often the essential information is not available; therefore, researchers have to look for proxy variables (Gillis & Jackson, 2002). Using subjects from the parent study, the specific aims of the current study were to: (1) examine the relationships between demographic characteristics and general health-related and disease specific quality of life, (2) examine the relationships between general health and disease specific quality of life, (3) examine the associations between the number and types of study-focused comorbidities and general health-related and disease specific quality of life, and (4) test the revised Wilson and Cleary Conceptual model.

3.1.1 Sample and Setting

The sample for the parent study consisted of 396 subjects who had type-2 diabetes with hypertension and/or hyperlipidemia. Subjects were recruited from a variety of clinical settings including two geriatric clinics that are a part of the UPMC Health System. One-third of the participants (66 subjects) were randomized to usual care (UC) and followed for 12 months, and the other two-thirds (132 subjects) were randomized to the intervention group. At the end of the 6 month treatment phase, intervention subjects were stratified on initial group assignment and level of adherence at the end of treatment and again randomized with equal allocation to either a maintenance intervention (AIM) group or an observation only (AIO) group with 66 subjects in each group. They continued to be monitored for 6 more months. One hundred ninety-eight (198) consenting subjects with adherence rates of ≥ 80% to the three medications for the target

conditions were followed for a 12-month period to observe the natural course of adherence over time in order to identify predictors of good adherence.

To be eligible for the parent study, individuals needed to:

- Have type-2 diabetes with hypertension and/or hyperlipidemia
- Have had type-2 diabetes for at least one year and be a continuing patient in one of the participating practices
- Be at least 40 years old
- To be eligible for randomization, subjects had to be prescribed at least one oral medication for diabetes and one of the other two conditions (hypertension or hyperlipidemia) and have poor adherence (< 80%) to at least one of the medications over a one-month period based on electronic event monitoring
- Good adherers (≥ 80% to all three medications) were eligible for an observational group

In addition to the criteria of the parent study, to be eligible for the present study participants had to have completed the baseline questionnaires that were used for the study. Both good and poor adherers were included in the present study.

3.1.2 Sample Size Justification

One of the main goals of this study was to test the revised Wilson and Cleary conceptual model using Structural Equation Modeling (SEM). Since SEM is a large-sample statistical method, a reasonable sample size is required. In general, it is known that larger sample sizes yield greater estimation precision. However, it is difficult to tell exactly when the sample size is large enough (Kline, 2005, p. 14). Depending on variety of factors such as the type and complexity of model,

number of estimated parameters, and estimation algorithm, there are several methods to calculate a sample size for SEM. Kline (2005) recommended that a desirable goal is to have at least 20 cases of each free parameter (20:1 ratio). Since SEM is closely related to multiple regressions in many respects, another reasonable approach is to use the same sample size rule used with regression. The sample size recommendation for multiple linear regression (Stevens, 1996), based on standard ordinary least squares multiple regression analysis, is approximately 15 cases per measured variable.

Since the current study is a secondary data analysis, the sample size was fixed. After data screening, 321 subjects met the eligibility criteria of the study. The tested model in this study had 20 observed variables giving a subject to variable ratio of 16:1.

3.1.3 Human Rights Protection

The parent study was approved by the Institutional Review Board of the University of Pittsburgh (see Appendix). Informed consent was obtained for all participants in the parent study. Prior to use in the current study, all information was de-identified by assigning a unique code number for this study. The security of data was maintained through the use of computer password protection and storing research files in a locked file cabinet in a restricted area accessible only by authorized personnel. Consent forms and a list linking subject names and parent study code numbers were retained in a locked file cabinet in the office of the principal investigator of the parent study. As a member of the parent study's staff, the PI of the current study was required to attend a full day IRB-sponsored workshop on ethical and regulatory matters in the conduct of clinical research.

3.2 INSTRUMENTS AND VARIABLES

Data used in the current study came from a pool of 9 questionnaires, one performance-based test and three lab tests completed during the baseline evaluation of the parent study. The following sections will discuss the instruments in greater detail.

3.2.1 CRCD Sociodemographic Questionnaire

Over time the Center for Research in Chronic Disorders (CRCD) at the University of Pittsburgh has developed a common format for capturing sociodemographic data across studies of patients with chronic disorders to facilitate pooled analyses (Sereika & Engberg, 2006). The questionnaire consists of 25 primary questions, which were designed to assess standard sociodemographic and socioeconomic characteristics including age, gender, marital status, education, employment status, income, and ethnic/racial background. Use of this standardized instrument permits consistent data collection across the CRCD research studies. Age, gender, marital status, level of education, household size, health insurance coverage and annual gross income variables were of interest in the current study.

Age was calculated from the subjects' recorded birth-date (date of administration minus date of birth). Level of education was measured by 2 variables: years of formal education and the highest level of education. In the current study, the highest level of education was classified into 4 categories: grade/high school [0], vocational school, associate's degree or some college [1], bachelor's degree [2], or post-baccalaureate [3].

3.2.2 CRCD Comorbidity Questionnaire

The CRCD also developed the CRCD Comorbidity Questionnaire based on the Charlson Comorbidity Index (CCI). The CCI was designed as a predictor of 1-year mortality in a cohort of inpatients on a medical service, and medical record review procedure was the process used for data collection (Charlson, Pompei, Ales, & MacKenzie, 1987).

Departing from the original CCI, the CRCD Comorbidity Questionnaire is a self-report measure of comorbidities. It has been used across CRCD studies to assess the number and type of comorbidities in various populations. The current study used CRCD Comorbidity data to determine the presence or absence of the following study-focused comorbid conditions: [1] heart attack/coronary artery disease (CAD), [2] peripheral vascular disease (PVD), [3] stroke/mini stroke (TIAs), [4] renal disease, [5] psychological problem (anxiety and/or depression and/or other mental health problems), [6] high blood pressure, and [7] arthritis or rheumatic disease. These study-focused comorbidities were selected because of their association with diabetes and/or because they were commonly reported by study participants. The number of study-focused comorbidities was based on how many of the seven comorbidities subjects reported.

In addition to asking about the presence of a variety of diseases, the CRCD Comorbidity Questionnaire was also designed to collect symptom information. It asks subjects about the presence of 39 symptoms as well as the impact of each symptom on the individual's quality of life from no impact (0) to extreme impact (4) (Sereika & Engberg, 2006). However, only five study focused symptoms known to be associated with diabetes (ADA, 2006a, 2006b) were used in this study: [1] fatigue, [2] diarrhea, [3] vision problems, [4] dizziness or light-headedness (with standing), and [5] frequent urination. The presence of each symptom was weighted by its effects on quality life to yield symptom score. The symptom score was equal to 0 when the

symptom was not present, 1 when a symptoms was reported but with no effect on quality of life, and 2 when a symptom was reported with an effect (slight to extreme) on quality of life. Symptom scores were summed across the five symptoms to yield a total symptom score which ranged from 0 to 10. Higher scores reflected greater symptom impact on quality of life.

3.2.3 Medical Outcomes Study Short Form-36 (MOS SF-36)

In order to facilitate comparison of findings across various chronic disorders studies, the CRCD asked all ongoing studies to add a common quality of life measurement, the Medical Outcomes Study Short Form 36 Version 2 (MOS SF-36 v.2), to their existing study instruments (Dunbar-Jacob, Erlen, Schlenk, Sereika, & Doswell, 1998). Compared to Version 1 of the SF-36, some wordings and the number of response choices have been revised in Version 2 but neither the validity nor the assumptions nor the method of scoring scales have changed. Correlations between the subscales on the two versions are high (Ware, Kosinski, & Dewey, 2000). The SF-36 is one of the most widely used general HRQoL measures and is considered to be the most relevant to the diabetes population (Bradley, 1996; Garratt et al., 2002; McColl et al., 1995). The survey has been used in various populations, including type-2 diabetics (De Berardis et al., 2005; Paschalides et al., 2004; Trief et al., 2003; Woodcock et al., 2001).

As a part of the CRCD, the parent study administered the MOS SF-36 during the baseline evaluation of subjects. One of items assesses overall well-being and asks persons to rate their health on a 5-point Likert scale ranging from excellent [1] to poor [5]. This instrument consists of eight subscales that use 4-week recall to assess different dimensions of health related quality of life. The subscales are: Physical Functioning (PF), Role Physical (RP), Bodily Pain (BP),

General Health (GH), Vitality (VT), Social Functioning (SF), Role-Emotional (RE), and Mental Health (MH).

The instrument yields eight subscale transformed scores, each ranging from 0-100 with higher scores indicating better quality of life. The mean of valid responses was used to substitute for missing values for up to 50% of the items in each subscale. If more than 50% of the items were missing, the subscale score was considered to be missing. To facilitate interpretation and comparison to population data, the subscale scores were transformed to norm-based scores (NBS), which have a mean of 50 and standard deviations of 10 based on the 1998 general U.S. population (Ware et al., 2000). Two summary scores, physical function and psychological function, can also be derived from the subscale scores. Using norm-based scores as linkages, researchers can easily compare results across studies relying on the eight-subscale profile or two summary measures (Ware et al., 2000). For the current study, Cronbach's alpha for the eight subscales ranged from 0.776 to 0.934 (see Table 3-1). Previous studies of patients with diabetes have reported internal consistency scores for the subscales ranging from 0.62-0.96, and two-week test-retest reliability ranging from 0.60-0.81 with a median of 0.76 (McHorney, Ware, Lu, & Sherbourne, 1994). The MOS SF-36 v.2 has established content, criterion and construct validity. The latter was assessed using the Quality of Well-Being Scale, Sickness Impact Profile, Katz Activities of Daily Living scale, Duke Health Profile, Nottingham Health Profile, Functional Status Questionnaire, Modified Health Assessment Questionnaire, and the Shortened Arthritis Impact Measurement Scales (McHorney et al., 1993). To reduce the number of indicators during the SEM analysis, the current study combined the scores of the Role-Physical and Role-Emotional subscales to yield a Role Functioning subscale score.

3.2.4 Diabetes Quality of Life Measure (DQOL)

Diabetes-specific quality of life was measured by the Diabetes Quality of Life Measure (DQOL). The content of the DQOL was derived from the input from type-1 diabetes patients and clinicians along with literature reviews on the concerns of diabetic patients and the problems that impact their lives (Garratt et al., 2002; Jacobson, 1994). The 46-item instrument yields a total diabetes-related quality of life score and is composed of four subscales that measure (1) satisfaction (Satisfaction), (2) the impact of diabetes and its treatment (Impact), (3) concerns about social and vocational issues (Worry: Social/Vocational), and (4) concerns about diabetes and its future effects (Worry: Diabetes Related) (DCCT Research Group, 1988; Jacobson, 1994). In spite of being developed for type-1 diabetes studies, the DQOL has been used in studies of subjects with both type-1 and type-2 diabetes (Graue et al., 2003; Jacobs, 2000; Jacobson et al., 1994; Ward, Lin, Heron, & Lajoie, 1997). The DQOL was also translated to other languages, such as Chinese (Cheng, Tsui, Hanley, & Zinman, 1999; Wang, Sun, Cai, & Zhou, 2005). Low to acceptable total and subscale reliability estimates were reported in both type-1 and type-2 diabetes populations (Watkins & Connell, 2004).

The 46 core-items of the DQOL use a 5-point Likert scale to measure: (1) individuals' satisfaction with treatment (very satisfied [1] to very dissatisfied [5]), (2) the impact of treatment on quality of life (no impact [1] to always impacted [5]), (3) worry about the future effect of diabetes (never worried [1] to always worried [5]), and (4) worry about social/vocational issues (never worried [1] to always worried [5]). In a study of 240 patients with type-1 diabetes mellitus by the Diabetes Control and Complications Trail (DCCT) Research Group, internal consistencies (Cronbach's alpha) of 0.46 to 0.92 were reported for the subscales, and the 1-week test-retest reliability was r = 0.78 to 0.92 for adults and adolescents (DCCT Research Group,

1988). In the current study, Cronbach's alpha was 0.924 for all 46 DQOL items and 0.735 to 0.911 for the four subscales, (Table 3-1). Both construct and discriminant validities have been established (Jacobson et al., 1995).

As suggested by Jacobson and colleagues (1994), all patient responses were reverse scored with the exception of impact items 8 and 16, so that higher scores reflected more a positive quality of life. This questionnaire yields an overall score and four subscales scores. Lower scores represent poor quality of life. Missing responses were replaced by the item mean calculated from valid responses to the item. If subjects skipped items or marked them as not applicable for 4 or more of 15 core items in the Satisfaction subscale, the subscale score was considered missing when analyzing the data. For the Impact subscale, up to 4 of the 20 core items were allowed to be missing while only one missing item was allowed for the Diabetes-Related Worry (7 core items) and Social Worry (4 core items) subscales (Jacobson & The DCCT Research Group, 1994).

3.2.5 Beck Depression Inventory-II (BDI-II)

The Beck Depression Inventory (BDI) is widely used to measure depressive symptoms in both research and clinical settings. To date, Dr. Aaron Temkin Beck has published three versions of this instrument (BDI in 1961, BDI-IA in 1971, and BDI-II in 1996). The latest version, the BDI-II (used in the parent study), consists 21 items with 4 ordered responses (from 'no bad feelings' [0] to 'very bad feelings' [3]) indicating how severe each symptom was over the past two weeks. Not only was this version developed in order to improve the previous versions, but also to adhere more closely with the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV - American Psychiatric Association, 1994) criteria for major depressive episodes. The BDI-II

yields two factors instead of the three in the previous versions and 18 of the 21 items were revised, evidence that the BDI-II represents a substantial revision over the original BDI (Whisman, Perez, & Ramel, 2000). The total score of the BDI-II ranges from 0 to 63, and is calculated by summing the number corresponding to level of severity indicated for each symptom. Missing responses were imputed by a calculated mean based on valid response to the items. If subjects responded to less than half of the item, the total score was treated as missing when data were analyzed. Higher scores on the BDI-II indicate more severe depressive symptoms.

According to the cut points and interpretive labels provided by Beck and colleagues (1996), the severity of depressive symptoms is rated as: 'minimum' [0 – 13], 'mild' [14 – 19], 'moderate' [20 – 28], and 'severe' [29 – 63]. The BDI-II has good internal consistency. A coefficient alpha of 0.92 was reported in 500 psychiatric outpatients, which was higher than the original BDI reliability (coefficient alpha = 0.86), and test-retest reliability was 0.93 in 26 psychiatric outpatients. The correlation between scores on the BDI-II and the Revised Hamilton Psychiatric Rating Scale for Depression was 0.71 (n=87). For the current study, the Cronbach's alpha for this instrument was 0.88 (see Table 3-1).

3.2.6 Spielberger State-Trait Anxiety Inventory

The Spielberger State-Trait Anxiety Inventory (STAI) is comprised of 40 items rated on a 4-point intensity scale, ranging from not at all/almost never [1] to very much so/almost always [4], that measure the frequency with which persons perceive encountered situations to be threatening and respond to such situations with subjective feelings of apprehension, tension and increased

activity of the autonomic nervous system. It consists of both trait (predisposition) and state scales.

Trait anxiety refers to individual differences in the frequency and intensity with which anxiety manifests itself over time (Barnes, Harp, & Jung, 2002) and is seen as a relatively stable personality trait (Spielberger, 1972). People with high trait anxiety tend to perceive more situations as threatening or dangerous than people who have lower trait anxiety scores (Spielberger, 1972). State anxiety, on the other hand, fluctuates, and is a function of the stressors impacting an individual. People tend to have lower state anxiety in a non-stressful situation or in a situation where an existing danger is not perceived as threatening (Barnes et al., 2002).

The STAI manual (Spielberger, Gorsuch, & Lushene, 1970) reported that test-retest coefficients were higher for scores on the trait scale (0.84 for men and 0.76 for women) than the state scale (0.33 for men and 0.16 for women). This is not surprising given that state anxiety is not a stable trait. Internal consistencies for state scale scores ranged from 0.83 to 0.92 for male and female high school and college students, compared to 0.86 to 0.92 for the trait scale scores. This instrument also has satisfactory extensive validation (Spielberger & Gorsuch, 1983). In the current study, internal consistency was 0.94 for the state anxiety scale and 0.94 for the trait anxiety scale (see Table 3-1). Prior to data analysis, the anxiety-absent items (S-Anxiety: 1, 2, 5, 8 10, 11, 15, 16, 19, 20 and T-Anxiety: 21, 23, 26, 27, 30, 33, 34, 36, 39) were reverse scored (Spielberger et al., 1970). Then each of the items was weighted as recommended by Spielberger before the sum for each subscale scores was calculated. Each subscale score ranged from a minimum of 20 to a maximum of 80. Higher scores indicated a higher degree of anxiety. Only the State Anxiety score was used in this study.

3.2.7 Interpersonal Support Evaluation List (ISEL)

Cohen and Hoberman (1983) designed the Interpersonal Support Evaluation List (ISEL) to measure the perceived availability of social support and resource provided by other people (Cohen & Syme, 1985). There are three versions of this instrument: the general population, college student and a shorter version (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). The CRCD uses the general population version of the ISEL as a measure to evaluate interpersonal support. This version has a list of 40-random-ordered statements. There are four 10-item subscales (Cohen et al., 1985). Each item uses a 4-point Likert response format ranging from definitely false [0] to definitely true [3]. The Tangible subscale is intended to measure "perceived availability of material aid" and the Appraisal subscale measures "perceived availability of someone to talk to about one's problems". The Self-esteem subscale measures the "perceived availability of a positive comparison when comparing one's self to others", while the Belonging subscale assesses "perceived availability of people one can do things with" (Cohen & Hoberman, 1983).

The items are counterbalanced with half of the statements being positive statements about social relationships and another half being negative statements (Cohen & Hoberman, 1983). The negatively stated items (3, 6, 9, 10, 11, 13, 14, 15, 17, 24, 25, 27, 28, 29, 30, 34, 35, 36, 39, and 40) were reverse scored prior to calculating the subscale and total scores. Missing items were replaced by the average response to valid items. Conservatively, when more than 50% of the items on any of subscale were missing, it was considered missing. Each subscale has a score ranging from 0 to 100 where 0 represents the lowest possible score and a 100 represents the highest possible score.

Cohen reported a moderate degree of independence between the subscales with correlation values ranging from 0.30 to 0.50. Cronbach's alpha coefficients of 0.88 to 0.90 have been reported for the total score of the general population ISEL with the internal consistency coefficients of [1] 0.70 – 0.82 for Appraisal, [2] 0.62 – 0.73 for Self-esteem, [3] 0.73 – 0.78 for Belonging, and [4] 0.73 – 0.81 for Tangible Support. Six month test-retest correlations were [1] 0.74 for the entire ISEL, [2] 0.49 for the Tangible, [3] 0.54 for the Self-esteem, [4] 0.68 for the Belonging, and [5] 0.60 for the Appraisal subscales (Cohen et al., 1985). For the current study, the reliability statistics (Cronbach's alpha) were 0.96 for the total instrument and varied from 0.81 (Self-esteem) to 0.90 (Appraisal) for the subscales (see Table 3-1). The current study used the Tangible and Belonging subscale scores as characteristics of the environment in the revised Wilson and Cleary model.

3.2.8 Diabetes Study Questionnaire (DSQ)

This questionnaire was designed specifically for the parent study to collect regimen and disease data from subjects with type-2 diabetes and hypertension and/or hyperlipidemia. It collected information on medications taken, the estimated numbers of missed dose for a one-month and one-week period, reasons for missed doses, the typical daily medication routine, and the occurrence of physical symptoms that may be common side effects of the drugs used for type 2 diabetes, hypertension, and hyperlipidemia. Similar information on other regimen components for these three disorders was also gathered to determine whether the patient was having difficulties with regimen management in general or whether difficulties were limited to the medication management aspect. The DSQ also collected information on the duration of diabetes. The current study used only DSQ data on the duration of diabetes.

3.2.9 Laboratory Variables

During the study visit, patients' blood was obtained by a licensed nurse using a tube with EDTA preservative and maintained at 4° C until assayed. The blood tests were performed by the Heinz Nutrition Lipid Laboratory of the University of Pittsburgh, which has kept the accuracy and precision standards of the Centers for Disease Control and Prevention since 1982.

HbA1c, also known as glycated hemoglobin (GHb), is a test that measures the amount of glycosylated hemoglobin in patients' blood to evaluate how well their diabetes has been managed over time, approximately the past 120 days (Gale Research, 2002). The results are obtained from the blood sample after 5 minutes in a fully automated high-performance liquid chromatography instrument for measurement of hemoglobin A1c (Tosoh 2.2 A1c Plus Glycohemoglobin Analyzer, Tosoh Medics, Foster City, CA). In general, a higher HbA1c value is associated with a greater risk for diabetic complications such as eye disease, kidney disease, and heart disease (Nordenson, 2006). The current study used HbA1c as an indicator of how well subjects managed their blood sugar. The normal value of HbA1c in non-diabetes persons is less than 6% (120 mg/dL). Among diabetes patients being treated, HbA1c values above 7% indicate poorly controlled diabetes. The study used HbA1c as a biological and physiological factor in the revised Wilson and Clearly Model.

Insulin resistance is a treatable precursor of diabetes and has the capability to explain a large group of common metabolic and cardiovascular disorders (e.g., obesity, type 2 diabetes, hypertension, hyperlipidemia) (DeFronzo, 1997; Stern et al., 2005). Measures of insulin resistance such as fasting insulin have gained more attention with the development of various pharmaceutical agents, particularly metformin and thiazolidinediones that sensitize the body to the action of endogenous insulin. An optimal insulin resistance cutoff of < 28 mol/min is used

for people without diabetes (Stern et al., 2005). The current study used the insulin as one of the measured variables for biological and physiological factors.

High density lipid (HDL) to total cholesterol ratio is helpful in predicting a person's risk of developing atherosclerosis. An average ratio is about 4.5, and the optimal ratio is less than 4 (Boers et al., 2003). High HDL to total cholesterol ratio is associated with a higher risk of developing ischemic heart disease (CAD and myocardial infarction. The current study calculated the ratio by dividing the HDL cholesterol by the total cholesterol (Boers et al., 2003).

3.2.10 Physical Performance Test

A measure of subjects' functional exercise capacity was performed. Assessment of functional exercise capacity has been recognized as an important part of the evaluation of patients with various disease states (Troosters, Gosselink, & Decramer, 1999). Traditionally, this has been done using a self-report measure. However, patients may report over- or under-estimate their true functional capacity. Thus, objective measurements are generally considered better measures of functional exercise capacity than self-report (American Thoracic Society [ATS],2002).

The 6-minute walk test (6MWT) is one of the most popular clinical exercise measures used to estimate functional exercise capacity in patients with chronic diseases. The test measures the distance that patients can quickly walk on a flat, hard surface in a period of 6 minutes. It was a modification of the 12-minute field performance test by Balke (1963) in an attempt to accommodate patients with respiratory disease for whom walking 12 minutes was too exhausting (Butland, Pang, Gross, Woodcock, & Geddes, 1982). It was not designed to assess the maximal exercise capacity. Instead, it allows patients to choose their own intensity of exercise, and they can rest or stop at anytime during the test (ATS, 2002). A review of functional walking tests

concluded that "the 6MWT is easy to administer, better tolerated, and more reflective of typical activities of daily living than other walk tests" (Solway, Brooks, Lacasse, & Thomas, 2001, p. 256). It was found to perform as well as the 12-minute walk (Butland et al., 1982). Guidelines for the Six-Minute Walk Test by the American Thoracic Society (ATS) also suggest that the 6MWD (six-minute walk distance) may better reflect the functional exercise level for daily physical activities because most activities of daily living are performed at sub-maximal levels of exercise. On an empirical basis, Redelmeier and colleagues (1997) suggested that 700 meters is a normal 6MWD, but they did not specify whether this applies to all ages. Troosters and colleagues (1999) noted that a normal 6MWD should not be fixed at 600 or 700 m since height, weight, gender and age also play important roles in explaining the variability of the 6MWD. They also reported that among 51 healthy subjects age 50-85 yrs, the average 6MWD was 631 ± 93 m. with an 83 m. greater distance in males than females. In the current study, the 6MWT was conducted by trained research staff in a 50-foot long hall-way of the General Clinical Research Center (GCRC) facility located in the Montefiore Hospital in Pittsburgh, PA. Standardized phases were used for feedback and encouragement (e.g., "You are doing well and you have only 1 minute to go") during the test as recommend by the Guidelines for the Six-Minute Walk Test. A nurse was present during the 6MWT and evaluated the subjects' condition prior to and during testing. The test was not performed if the subject declined to walk. The test was immediately discontinued if the subject developed any of the following: (1) chest pain, (2) intolerable dyspnea, (3) leg cramps, (4) staggering, (5) diaphoresis, or (6) pale or ashen appearance. Reasons for the absence or discontinuing of the test were recorded. The 6MWD was utilized as an indicator of functional status in the Wilson and Clearly Model. Among the 321 participants of the current study, there were 44 subjects (13.7%) who couldn't walk or

refused to walk due to physical limitation. Two subjects (0.6%) didn't walk due to time constrains and their 6MWDs were treated as missing. The average 6MWD among subjects who walked was significantly lower, 343.49 ± 100.40 m. (1144.98 ± 334.66 ft.), than the reported average 6MWD among normal middle age and older adults. On average, men in the current study walked 52.81 m. (176.03 ft.) farther than women. The maximum 6MWD in males was 624.00 m. (2080 ft.), while it was 525.90 m. (1753 ft.) among females. Both men and women shared the same minimum 6MWD of 33.30 m. (111 ft.).

3.3 EXPLORATORY DATA ANALYSIS

Data were evaluated using two computer software packages: Statistical Package for the Social Sciences software (SPSS version 13.0 for Windows - SPSS Inc., 2004) for the sample characteristics and specific aims 1, 2, and 3 and Analysis of Moment Structure (AMOS version 6.0 for Windows - SPSS Inc., 2005) for specific aim 4. The following sections will discuss the exploratory data analysis for the study in detail.

3.3.1 Data Screening Procedures

Since the choice of statistical tests should consider the distributional characteristics of the data, it is important to carefully consider the quality of the input prior to performing the primary analyses to address the study specific aims. SPSS 13.0 (SPSS Inc., 2004) was employed for data screening. Because this is a secondary data analysis, the sample size of this analysis was fixed at 372 subjects, based on the availability of baseline data from the parent study. In addition to the laboratory and 6MWT data, the current study utilized data from nine of the baseline questionnaires from the parent study. Internal consistency coefficients (Cronbach's alpha) for the current study were computed for all instruments used and compared to published values for each instrument. In general, Cronbach's alpha coefficients greater than 0.90 are considered as "excellent", values around 0.80 are "very good", and values around 0.70 are "adequate" (Kline, 2005). The results, presented in see Table 3-1, show that the instruments used in the current study had adequate to excellent internal consistency reliability with Cronbach's alpha

coefficients ranging from 0.71 for the number of symptoms measured by the CRCD Comorbidity Questionnaire to 0.97 for the State Anxiety score on the Spielberger State-Trait Inventory.

Univariate descriptive statistics were computed to assess out-of-range values, means/standard deviations and coefficients of variation. Since one of the specific aims was to fit a model by using Structural Equation Modeling (SEM) which assumes multivariate normality, univariate distributions and bivariate scatter-plots were reviewed to evaluate the skewness (the degree of symmetry about the mean); kurtosis (the degree of flatness or peakness of a distribution) and, for the bivariate distributions, linearity. Skewness and kurtosis values near zero indicate symmetrical and mesokutotic distributions. Research suggests that variables with absolute values of the skewness greater than 3.0 may be considered as "extremely" skewed (Kline, 2005), and, more conservatively, absolute values of the kurtosis index greater than 10 may evidence a problem and greater than 20 may indicate a more serious one. These "rules of thumb" were implemented to assess the distributional properties of the variables in this study (DeCarlo, 1997). Results of the skewness and kurtosis assessments suggested that a few variables did not have approximately normal distributions (see Table 3-2). Shapes of distribution of those variables were examined and decisions about how to deal with them are presented in later sections. All of the observed bivariate scatter plots appeared to satisfy the SEM assumption of linearity.

To prevent a singular covariance matrix, in which certain mathematical operations would fail because of problems such as a dividing by zero error and out-of-bounds correlations, the existence of multicollinearity within the covariance matrices was checked. Correlations (r_{xy}), squared multiple correlations (R^2_{smc}) and tolerances ($1-R^2_{smc}$) were utilized as measurements to identify inter-correlations and redundancies among variables. Highly correlated (r_{xy} or R^2_{smc} >

0.90) variables were eliminated or combined into a composite variable when appropriate (Kline, 2005). No strong bivariate correlations were found.

To detect multicollinearity of all predictor variables together, the condition indices were examined. A common rule of thumb is that a condition index larger 15 indicates a possible multicollinearity problem and a condition index over 30 suggests a serious multicollinearity problem because one variable may present little or no unique information (Garson, 2006a). When a high condition index was found the variance proportions were examined. A sizable proportion of the variance, larger than 0.5, in two or more variables is a sign of a multicollinearity problem. A multicollinearity problem was detected between the DQOL total score and its subscale scores (condition index = 356.567 and variance proportions > 0.75). The DQOL total score was not used in the current study.

Table 3-1: Reliability Estimates for the Variables

Source	Description	No. of Items	Cronbach's alpha
Medical Outcomes Study Short Form-36	Physical Functioning	10	0.917
	Role-Physical	4	0.929
	Bodily Pain	2	0.912
	General Health	5	0.795
	Vitality	4	0.866
	Social Functioning	2	0.776
	Role-Emotional	3	0.934
	Mental Health	5	0.858
	Reported Health Transition	1	n/a
Diabetes Quality of Life Measure	Satisfaction	15	0.874
	Impact	20	0.826
	Social/Vocational Worry	7	0.911
	Diabetes Related Worry	4	0.735
	Total	46	0.924
Interpersonal Support Evaluation List	Appraisal	10	0.904
	Tangible	10	0.868
	Self-esteem	10	0.809
	Belonging	10	0.883
	Total	40	0.958
Beck Depression Inventory-II	Beck Depression Inventory - II Score	21	0.880
Spielberger State-Trait Anxiety Inventory	State Anxiety	20	0.943
	Trait Anxiety	20	0.942
CRCD Co-Morbidity Questionnaire	Number of Study focused Comorbidities	56	0.934
	Degree of Study focused Symptoms	10	0.707
Diabetes Study Questionnaire	Years with diabetes	1	n/a
Lab Variables	HBA1C	1	n/a
	Fasting Insulin	1	n/a
	HDL to CHOL ratio	1	n/a
Physical Performance Test	6-Minutes Walk Distance	1	n/a

Table 3-2: Univariate Statistics for the Raw Data

	Variables	N	No. of Missing	Mean ± SD.	Skewness (S.E.)	Kurtosis (S.E.)
Socio-demographic	Age	321	0	2.93 ± 1.073	-0.126 (0.136)	-0.761 (0.271)
	Gender	321	0	1.57 ± 0.496	-0.272 (0.136)	-1.938 (0.271)
	Marital Status	321	0	2.37 ± 0.835	0.740 (0.136)	-0.151 (0.271)
	Education	321	0	2.13 ± 1.120	0.486 (0.136)	-1.166 (0.271)
	Number of adults in household	321	0	1.97 ± 0.815	0.748 (0.136)	0.332 (0.271)
	Household's gross income	315	6	2.24 ± 0.633	-0.245 (0.137)	-0.642 (0.274)
SF-36	Physical Functioning Subscale	320	1	66.16 ± 26.924	-0.592 (0.136)	-0.621 (0.272)
	Role-Physical Subscale	320	1	69.51 ± 27.890	-0.630 (0.136)	-0.603 (0.272)
	Bodily Pain Subscale	319	2	63.44 ± 24.730	-0.249 (0.137)	-0.644 (0.272)
	General Health Subscale	318	3	58.20 ± 19.920	-0.168 (0.137)	-0.412 (0.273)
	Vitality Subscale	319	2	56.62 ± 21.232	-0.446 (0.137)	-0.148 (0.272)
	Social Functioning Subscale	320	1	81.76 ± 22.673	-1.168 (0.136)	0.686 (0.272)
	Role-Emotional Subscale	318	3	81.37 ± 24.702	-1.244 (0.137)	0.631 (0.273)
	Mental Health Subscale	319	2	75.36 ± 18.572	-1.110 (0.137)	1.014 (0.272)

Table 3-2: Univariate Statistics for the Raw Data (continued)

	Variables	N	No. of Missing	Mean ± SD.	Skewness (S.E.)	Kurtosis (S.E.)
DQOL	Satisfaction Subscale	321	0	53.89 ± 10.063	-0.247 (0.136)	-0.522 (0.271)
	Impact Subscale	321	0	77.62 ± 11.040	-0.635 (0.136)	-0.317 (0.271)
	Social/Vocational Worry Subscale	320	1	30.15 ± 5.957	-0.989 (0.136)	-0.348 (0.272)
	Diabetes Related Worry Subscale	320	1	15.96 ± 3.338	-0.728 (0.136)	-0.346 (0.272)
Comorbidity Questionnaire	Having Heart Attack or Coronary Artery Disease	321	0	0.24 ± 0.428	1.224 (0.136)	-0.505 (0.271)
	Having Peripheral Vascular Disease	321	0	0.21 ± 0.407	1.440 (0.136)	0.075 (0.271)
	Having Stroke / Mini Stroke	321	0	0.07 ± 0.258	3.337 (0.136)	9.195 (0.271)
	Having Renal (Kidney) Disease	321	0	0.14 ± 0.344	2.120 (0.136)	2.512 (0.271)
	Having Psychological Problems	321	0	0.23 ± 0.424	1.265 (0.136)	-0.403 (0.271)
	Having High Blood Pressure	321	0	0.81 ± 0.390	-1.614 (0.136)	0.608 (0.271)
	Having Arthritis or Rheumatic Disease	321	0	0.51 ± 0.501	-0.031 (0.136)	-2.012 (0.271)
	Number of Study Focused Comorbidities	321	0	2.21 ± 1.276	0.856 (0.136)	0.947 (0.271)
	Study Focused Symptom Degree	320	1	2.57 ± 2.124	0.877 (0.136)	-0.431 (0.272)

Table 3-2: Univariate Statistics for the Raw Data (continued)

	Variables	N	No. of Missing	Mean ± SD.	Skewness (S.E.)	Kurtosis (S.E.)
ISEL	Appraisal Subscale	319	2	73.13 ± 22.128	-0.833 (0.137)	0.309 (0.272)
	Tangible Subscale	319	2	78.75 ± 18.998	-1.267 (0.137)	2.124 (0.272)
	Self-esteem Subscale	319	2	68.51 ± 15.816	-0.804 (0.137)	1.442 (0.272)
	Belonging Subscale	319	2	75.21 ± 19.535	-1.019 (0.137)	1.223 (0.272)
	BDI-II Total Score	321	0	7.66 ± 6.714	1.632 (0.136)	3.082 (0.271)
	State Anxiety	320	1	34.45 ± 12.245	0.692 (0.136)	-0.407 (0.272)
	Years with diabetes	318	3	9.47 ± 7.480	1.334 (0.137)	1.743 (0.273)
	HbA1c	317	4	7.39 ± 1.321	1.295 (0.137)	2.151 (0.273)
	Fasting Insulin	308	13	18.26 ± 16.954	4.456 (0.139)	34.209 (0.277)
	HDL to CHOL ratio	308	13	0.27 ± 0.075	1.001 (0.139)	3.819 (0.277)
	6-minute Walk Distance	301	20	1046.08 ± 453.981	-1.030 (0.140)	0.450 (0.280)

3.3.2 Treating Missing Data

It is common in clinical research studies to have some missing data. That was the case in the current study. Not every participant completed all nine questionnaires used in the study and for those completed, there were some non-response items. Since one of the analyses of this study was to test the model fit of the revised Wilson and Cleary Model using Structural Equation Model (SEM) which is very sensitive to the sample size, utilizing a conservative method such as listwise deletion (LD) to deal with missing data was avoided. Reasons for the missing values, such as data entry errors were identified and corrected when possible. Since the parent study was a longitudinal study, there were 6-month and 12-month datasets available in addition to the baseline data. Missing values expected to be stable over time such as "What year were you first found to have diabetes or high blood sugar" were replaced with data available at later time points in the parent study. Three hundred seventy-two records (372) of subjects who provided baseline information were extracted from the database of the parent study. A preliminary criterion of missing values for more than 25% of the variables was used as a cut point to eliminate 41 subjects (11.02 %) from the current study.

Prior to the omission of participants with limited information, independent-samples t-tests and chi-square tests were performed to determine whether there were any significant differences between excluded and retained subjects in relation to demographic characteristics. The results confirmed that there were no significant differences in age ($t_{(363)} = -1.881$, $p = 0.061$), gender ($\chi^2_{(1)} = 0.022$, $p = 0.883$), current marital status ($\chi^2_{(3)} = 0.090$, $p = 0.993$), highest level of education ($\chi^2_{(3)} = 0.273$, $p = 0.965$), employment status ($\chi^2_{(2)} = 0.126$, $p = 0.939$),

number of adult in the household ($\chi^2_{(3)} = 0.131$, $p = 0.988$) or the household's gross income ($\chi^2_{(2)} = 0.025$, $p = 0.988$). Therefore, only the 331 cases (88.98%) with complete or nearly complete data were included in the next step of the data screening.

Missing Value Analysis (MVA) of SPSS 13.0 (Hill & SPSS Inc., 1997; SPSS Inc., 2004) was implemented to examine the patterns and extent of missing data. The result for the 331 subjects showed that 10 subjects had the same pattern of missing on the variables of interest (number of study-focused comorbidities, number of study-focused symptoms, BDI-II total score, HBA1C and 6-minute walk distance). The results of t-tests and chi-square tests indicated that these 10 subject were not significantly different from the remaining subjects in relation to age ($t_{(329)} = 1.002$, $p = 0.317$), gender ($\chi^2_{(1)} = 0.021$, $p = 0.884$), current marital status ($\chi^2_{(3)} = 0.116$, $p = 0.990$), highest level of education ($\chi^2_{(3)} = 0.083$, $p = 0.994$), number of adult in the household ($\chi^2_{(3)} = 0.054$, $p = 0.997$) or the household's gross income ($\chi^2_{(2)} = 0.244$, $p = 0.970$). Therefore, those 10 subjects were excluded, and only 321 subjects were retained in subsequent analyses.

Table 3-2 reports the distribution statistics of the 321 subjects retained for analysis. The missing values were treated separately in two distinct steps. First, to evaluate the relationship between quality of life and demographic information and relationships between the number and type of study-focused comorbidities and quality of life, only variables from four questionnaires (sociodemographic, SF-36, DQOL and comorbidities Questionnaires) were included in the initial missing data imputation. Then, variables from the remaining questionnaires along with selected variables from the first imputation were included in the second data imputation for the SEM analysis.

Missing Value Analysis (MVA) of SPSS 13.0 was utilized to conduct the first data imputation. To deal with the missing data, all missing values were replaced by estimated values. Expectation-Maximization (EM) algorithm of Maximum-Likelihood (ML) estimation was utilized for missing value imputation. This approach offers the simplest and most reasonable way to impute missing data as long as the data are missing randomly (Tabachnick & Fidell, 2000). It improves the power of estimation by recovering more data. The EM algorithm has two steps: (1) estimating the moments based on the data, and (2) estimating the data based on the moments, which continue iteratively until convergence. Application of Little's chi-square to test whether data are missing completely at random (MCAR) indicated that the pattern of the missing values was completely at random ($\chi^2_{(67)} = 58.320$, $p = 0.766$). Since the missing pattern was MCAR, the EM imputation of SPSS MVA was suitable to produce asymptotically unbiased estimates (HIPPEL, 2004). More powerful missing data estimation techniques, such as multiple imputations (MI), which make no assumptions about whether data are randomly missing, were not required for the current study (Tabachnick & Fidell, 2000). As expected, since values were missing randomly, the estimates obtained using different methods (listwise deletion, available cases, regression and EM) to handle missing data were not significantly different.

3.3.3 Outlier Assessments

Several statistical and graphical methods were utilized to address both univariate and multivariate outliers. All extreme outliers were checked to assure the accuracy of data entry. When errors were found, the values were corrected to appropriate values. Kline (2005) also noted that there is no single definition of an extreme outlier, but a common rule of thumb is that

values more than 3 standard deviations beyond the mean (the criterion at $p < 0.001$ is $z \leq 3.29$, two tail test) may be described as extreme outliers.

Similar to the missing value analysis, outlier assessments were evaluated separately in two steps. Potential univariate outliers were pinpointed by inspecting the frequency distribution of z scores. Since SEM is very sensitive to sample size, the deletion of cases with outliers was avoided. When univariate outliers were detected and the distributions were not normal, appropriate data transformations were applied to reduce or eliminate the possible influence of the outliers and improve the skewness of distributions. Table 3-3 illustrates the list of variables and their transformation methods. A method based on the Mahalanobis distance (D), the distance of a case from the centroid of all cases, was implemented to evaluate multivariate outliers of two or more variables. A conservative probability estimate for a case being an outlier, $p < 0.001$ for the χ^2 value, was used to evaluate Mahalanobis distance with the degree of freedom equal to the number of variables of interest. When there was evidence of multiple outliers, a dichotomous dependent variable was created, and then SPSS regressions were run to determine which variables were the significant predictors of the multivariate outliers. Extreme multivariate outliers were detected at significance levels of $p < 0.05$. To preserve the sample size, appropriate data transformations were implemented to reduce their influences. The multivariate outliers and modification details are presented in the following sections.

During the first step of outlier assessments, there were 28 variables with outliers (six variables from the sociodemographic questionnaire, eight from the SF-36, 4 from DQOL and 10 from the comorbidity questionnaire). Using $| z | = 3.29$ as the criterion, extreme values or outliers were found on the SF-36: Social Functioning, Role-Emotional and Mental Health subscales. A decision to transform the scores was made to treat both outliers and their skewness

(see Table 3-3). Square power / 100 transformations were used to transform the Social Functioning, Role-Emotional and Mental Health subscale scores. A few outliers were found on the DQOL Impact, Social/Vocational Worry and Diabetes Related Worry subscale scores. The square power / 100 transformations were applied to them as well. There were also a few outliers for both the number of study-focused comorbidities and study-focused symptoms. Square root transformation was applied to the number of study-focused symptoms but not the number of study-focused comorbidities since the shape of its distribution was already approximately normal, the outliers were not corrected and the transformation only worsened its distribution.

Mahalanobis distances, computed by SPSS Regression, were evaluated against a critical value of 56.892 (χ^2 with 28 degree of freedom at $\alpha = 0.001$) to access multivariate outliers. The results show that there were no multivariate outliers. The maximum *D* was 54.182, which belongs to case 83.

Table 3-3: Summary of Transformation of Variables

Variables	Before The Transformation						After The Transformation & Imputation				
	Missing	Min	Max	Outliers *(z)*	Skewness	Kurtosis	Min	Max	Outliers *(z)*	Skewness	Kurtosis
SF-36: Feeling full of life [a]	2	1	5	-2.48 to 1.67	-0.587	-0.191	1.00	25.00	-1.88 to 2.05	0.060	-0.481
SF-36: Social Functioning [b]	1	0	100	-3.61 to 0.80	-1.168	0.686	0.00	100.00	-2.27 to 0.89	-0.657	-0.968
SF-36: Role-Emotional [b]	3	0	100	-3.29 to 0.75	-1.244	0.631	0.00	100.00	-2.17 to 0.83	-0.778	-0.890
SF-36: Mental Health [b]	3	0	100	-4.06 to 1.33	-1.110	1.014	0.00	100.00	-2.33 to 2.78	-0.481	-0.653
SF-36: Role Functioning [i]	3	0	200	-3.21 to 1.05	-0.889	-0.077	0.00	100.00	-1.95 to 1.23	-0.259	-1.240
DQOL: Overall satisfaction with life [c]	1	1	5	-2.53 to 1.04	-1.003	0.208	0.00	0.70	-1.29 to 1.93	0.147	-0.884
DQOL: Impact [b]	0	43	97	-3.14 to 1.76	-0.635	-0.317	18.49	94.09	-2.62 to 1.99	-0.359	-0.700
DQOL: Social/Vocational Worry [b]	0	11	35	-3.21 to 0.18	-0.989	-0.348	1.21	12.25	-2.53 to 0.86	-0.792	0.915
DQOL: Diabetes Related Worry [b]	0	5	20	-3.28 to 1.21	-0.728	-0.346	0.25	4.00	-2.43 to 1.35	-0.373	-0.949
DQOL: Total Score [b]	0	104	225	-3.04 to 2.00	-0.499	-0.233	108.16	506.25	-2.56 to 2.27	-0.231	-0.586
Weighted Study-focused Symptoms [d]	0	0	10	-1.21 to 3.50	0.879	0.443	0.00	3.16	-1.73 to 2.21	-0.362	-0.552
BDI-II Total Score [d]	1	0	34	-1.14 to 3.92	1.627	3.061	0.00	5.83	-2.03 to 2.73	0.175	0.279
Spielberger State Anxiety Total Score [d]	3	20	77	-1.16 to 3.45	0.721	-0.273	4.33	8.77	-1.28 to 2.93	0.457	0.797
HBA1C [e]	7	5.2	13.1	-1.65 to 4.31	1.294	2.134	0.76	1.92	-2.88 to 2.44	-0.274	-0.046
Fasting Insulin [f]	13	2	186	-0.96 to 9.89	4.456	34.209	0.30	2.05	-2.71 to 2.94	0.068	-0.167
HDL to CHOL Ratio [g]	13	0.06	0.71	-2.77 to 6.07	1.001	3.819	3.04	7.18	-3.05 to 3.06	0.092	0.364
6-Minute Walk Distance [h]	20	0	2080	-2.30 to 2.28	-1.030	0.450	0.00	355.00	-1.96 to 2.34	0.036	-0.213
Year of Formal Education [e]	0	8	30	-2.20 to 5.04	1.289	2.787	0.33	1.00	-2.94 to 2.32	-0.235	-0.453

Note: Transformation method:

a. = Score^2 b. = $\text{Score}^2 / 100$ c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score} \times 100}$ h. = $\text{Score}^2 / 10000$ i. = $\text{Score}^2 / 200$

Table 3-3: Summary of Transformation of Variables (continued)

Variables	Before The Transformation						After The Transformation & Imputation				
	Missing	**Min**	**Max**	**Outliers *(z)***	**Skewness**	**Kurtosis**	**Min**	**Max**	**Outliers *(z)***	**Skewness**	**Kurtosis**
Duration of Diabetes [f]	3	0	40	-1.27 to 4.08	1.334	1.743	0.00	1.61	-2.93 to 2.24	-0.105	-0.595
Number of Adults Living in Household [f]	0	1	4	-1.19 to 2.49	0.748	0.332	0.00	0.78	-1.38 to 2.76	-0.010	0.573
ISEL: Tangible [b]	2	0	30	-4.15 to 1.12	-1.269	2.140	0.00	9.00	-1.70 to 2.57	-0.425	-0.650
ISEL: Belonging [b]	2	0	30	-3.85 to 1.27	-1.020	1.226	0.00	9.00	-2.31 to 1.52	-0.226	-0.775

Note: Transformation method:

a. = Score^2 b. = $\text{Score}^2 / 100$ c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score} \times 100}$ h. = $\text{Score}^2 / 10000$ i. = $\text{Score}^2 / 200$

3.4 DATA ANALYSIS PROCEDURES

3.4.1 Descriptive Statistics

SPSS version 13.0 was used to describe the samples characteristics. The demographic characteristics were described using frequencies and proportions for the entire sample and by gender. Means and standard deviations were calculated for quality of life subscale and total scores as well as other continuous variables.

3.4.2 Specific Aim #1

The first specific aim of the current study was to examine the relationship between quality of life and demographic characteristics. The independent sample t-test and one-way ANOVA were utilized to compare mean quality of life scores of groups of subjects with different demographic characteristics. The Brown-Forsythe statistic tests were used, instead of the F statistic, when the assumption of equal variances was violated. Only the values with $p < .01$ were considered significant. Post-hoc tests (e.g., Tukey) were performed when indicated to identify which group(s) differed from the others. When the assumption of homogeneity of variance was violated, the Tamhane test was employed instead of the Tukey test.

3.4.3 Specific Aim #2

The second specific aim was to evaluate the relationships SF-36 subscale and DQOL subscale/total scores. A correlation matrix was utilized for the evaluation. Relationships between quality of life subscale and total scores significant at a $p < .01$ were reported. Furthermore, to examine the impact of the number of study-focused comorbidities on the relationships between SF-36 subscale and DQOL subscale/total scores, a partial correlation matrix among the quality of life subscale/total scores controlling for the effects of the number of study-focused comorbidities was created using Partial Correlations of SPSS and compared with the previous correlation matrix.

3.4.4 Specific Aim #3

The second specific aim of this study was to examine the association between the number and types of study-focused comorbidities and quality of life as measured by both the SF-36 subscales and DQOL subscale/total scores. Five study-focused comorbidities (heart attack/coronary artery disease, peripheral vascular disease, stroke/mini stroke, renal problems, and psychological problems) and two common comorbidities among the subjects (high blood pressure and arthritis/ rheumatic disease) were included in the analysis. T-tests were utilized to compare mean quality of life scores of subjects without and without each comorbid condition. *P*-values of < .01 were considered significant.

Data from the Comorbidity Questionnaire developed by CRCD was utilized to calculate the number of study-focused comorbidities. Therefore, Pearson's correlation coefficients were calculated to examine the relationships between the number of comorbidities and quality of life

subscale/total scores at a significant level of $p < .01$. In addition, simple linear regression was performed to test whether the number of study-focused comorbidities significantly predicted quality of life subscale/total scores. Significant predictors (*Beta*) at $p < .01$ levels were reported along with the proportion of the variability explained by the number of study-focused comorbidities adjusted by the effective sample size ($R^2_{(adj.)}$).

3.4.5 Specific Aim #4

3.4.5.1 SEM Model Specification

The last specific aim was to test whether the current data was explainable by the revised Wilson and Cleary conceptual model. AMOS 6.0 was implemented to fit the model and assess the resulting fit the model. Since the conceptual model contained only the structural part of the model, each latent variable was arbitrarily loaded with observed variables from the current data based on the model guideline (Wilson & Cleary, 1995). Following the two-indicator rule of Bollen (1989), at least two observed variables were assigned to each latent variable. The SF-36 Role-Physical and Role-Emotional subscales were combined to reduce the number of observed variables for functional status. A total of 20 observed variables were loaded into the tested model depicted in the Figure 3-2.

The model includes seven hypothesized factors:

1) Biological and physiological factors with the HbA1c, fasting insulin and HDL to total cholesterol (CHOL) values as the indicators;
2) Symptom status with the weighted number study-specific symptoms, the Beck Depression Index-II total score, and the Spielberger State-Anxiety score as indicators;

3) Functional status with the Physical Functioning, Role Functioning, Social Functioning, and Mental Health subscale scores of SF-36 and the Six-minute Walk Distance (6MWD) as indicators;
4) General health perceptions with the General Health subscale score of SF-36 and the DQOL Impact subscale score serving as indicators;
5) Overall quality of life with item 9a from the SF-36 (feeling full of life) and item 15a from the DQOL (overall satisfaction with life) as indicators;
6) Characteristics of the individual with age, years of education, and duration of diabetes serving as indicators; and
7) Characteristics of the environment with ISEL Tangible subscale scores, gross annual household income and the number adults in the household serving as indicators.

To set the scales for the factors, the unstandardized loading or paths predicting SF-36 Feeling Full of Life scores from overall quality of life, SF-36 General Health subscale scores from general health perceptions, SF-36 Physical Functioning subscale scores from functional status, BDI-II total scores from symptom status, fasting insulin from biological and physiological factors, age from characteristics of the individual, and ISEL Tangible subscale scores from characteristics of the environment were fixed to 1.

As a preliminary check of the identifiability of the tested model, the numbers of data points and parameters to be estimated were determined. There were 20 measured variables which produced (20 (20 + 1)) / 2 = 210 data points. The hypothesized model illustrated in Figure 3-2 contains 55 parameters to be estimated (25 regression coefficients, 27 variances and 3 covariances). Therefore, the model is over-identified with 155 degrees of freedom.

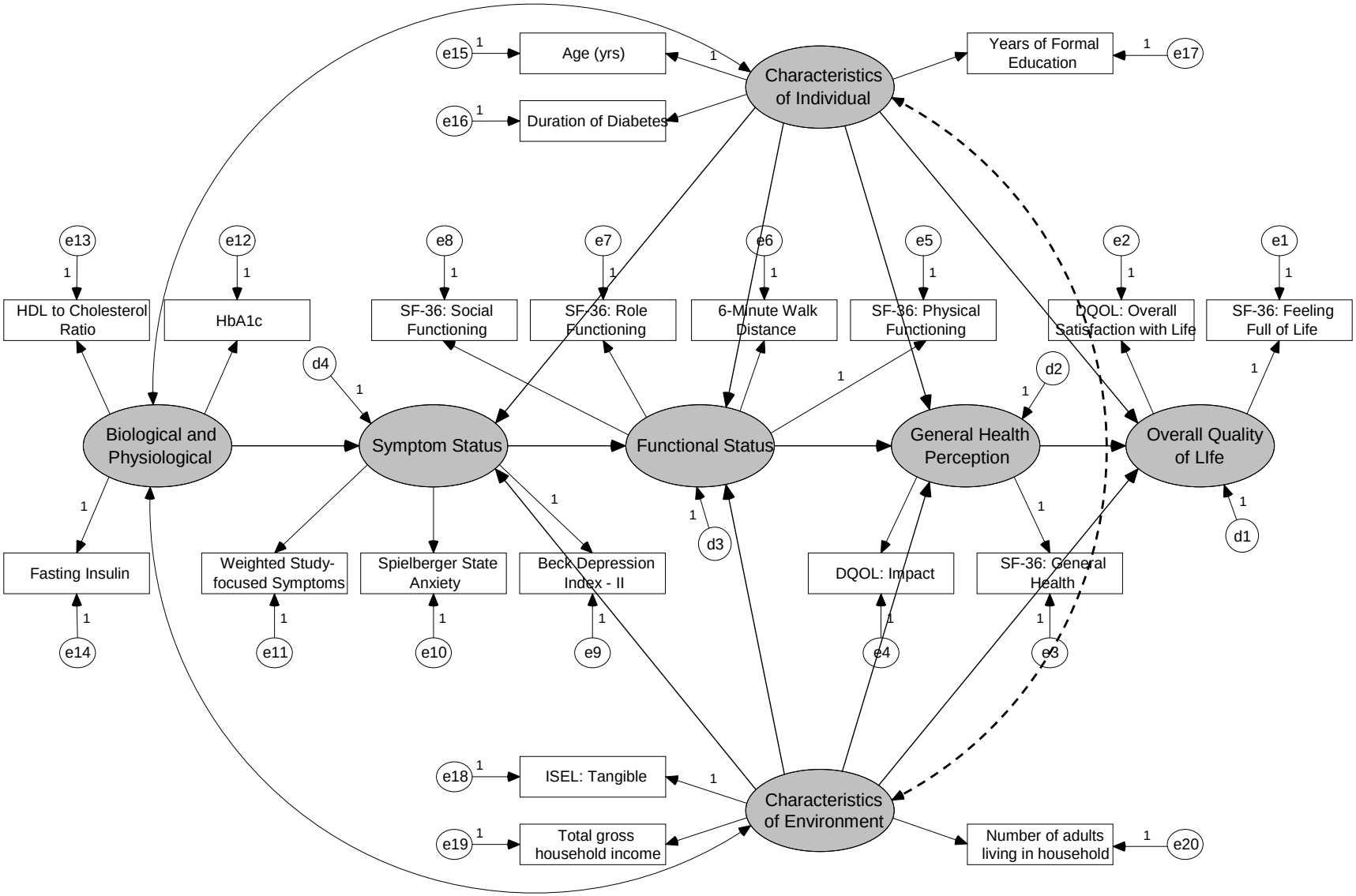

Figure 3-2: Revised Wilson and Cleary Conceptual Model with 20 Observed Variables

Although SEM is capable of testing the measurement model and structural model simultaneously, the recommendation is that the measurement model should be tested separately to detect any inadequate fits prior to testing the full model (Byrne, 2001). This allows the researcher to pinpoint where the model is misspecified (whether the measurement portion or the structural portion). As described by Kline (2005), there are two approaches that can be used: (1) two-step modeling as proposed by Anderson and Gerbing (1988) and (2) four-step modeling as recommended by Mulaik and Millsap (2000). The two-step approach has the advantage of simplicity and does not require at least four indicators per factor (Kline, 2005, p. 218). Therefore, the two-step modeling approach was implemented for the analysis. Three main questions of interest were (1) does the seven-factor measurement model fit the data, (2) to what extent is the revised Wilson and Cleary conceptual model of health-related quality of life consistent with data collected from individuals with type-2 diabetes and/or hypertension and/or hyperlipidemia and (3) is there a significant relationship between the characteristics of the individual and characteristics of the environment?

3.4.5.2 Evaluation of SEM Assumptions

Prior to the SEM analysis, the assumptions for SEM were evaluated. Reliability coefficients (Cronbach's alpha) were computed to access the reliability of the indicators for all observed variables. The results, presented in Table 3-1, show that the measures used for the current study had adequate to excellent internal reliability, Cronbach's alphas ranging from 0.71 for the number of study-focused symptoms to 0.94 for the Spielberger State-Trait Anxiety Inventory total score.

SEM is based on covariances and becomes less stable and chi-square values are somewhat inflated when estimated from a small sample (Byrne, 2001, p. 268). Basically, a non-

significant chi-square is desired. The chi-square value depends on sample sizes. In a large sample, chi-square value is more likely to be significant solely because of the sample size. There were 20 observed variables in the tested model, and there were missing data for most variables. As presented in the Table 3-2, only a few of missing values (less than 4) were detected for many variables, but the maximum number of subjects missing data on a variable was 20 (out of 321) on the 6MWD variable. The pattern of the missing seemed to be completely at random. To preserve the sample size, a data imputation was conducted using Regression Imputation in AMOS 6.0 for Windows (SPSS Inc., 2005). AMOS uses Maximum Likelihood (ML) to estimate missing values (T. W. Anderson, 1957), which is more powerful than SPSS MVA. The model was first fitted using maximum likelihood. After that, model parameters were set equal to their maximum likelihood estimates, linear regression was utilized to predict the unobserved values for each case as a linear combination of the observed values for that same case. Then the missing values are replaced by the imputed values. Differing from SPSS MVA, AMOS only assumes that the missing values are missing at random (MAR). When the assumption is satisfied, AMOS provides estimates that are efficient and consistent. A saturated, or just-identified, model of 20 observed variables was used to perform the data imputation.

The ratio of cases to the observed variables was approximately 16:1 (321/20), and the ratio of cases to free parameter to be estimated was 6:1 (321/55). These ratios were quite low. Univariate distributions and bivariate scatter-plots were reviewed to evaluate the skewness, kurtosis, outliers and linearity for the 20 variables that were used for the SEM analysis. Using the conventional 0.05 cutoff level, absolute critical ratio (*C.R.*) values exceeding 2.00 indicate statistically significant degrees of non-normality. Potential outliers were identified with standardized scores (*z*-scores) in excess of 3.29 ($p < .001$, two-tailed test). A few univariate

outliers were found on many variables. Appropriate data transformations were applied to reduce their influence and improve the shape of their distributions. A list of variables and transformation methods were summarized in the Table 3-1 along with their skewness and kurtosis values both before and after the transformations.

Multivariate outlier assessment was performed by evaluating Mahalanobis distance (D). At significant levels of $p < .001$, the chi-square with 20 degrees of freedom was 45.315. This criterion was used to detect multivariate outliers. There was evidence of a multivariate outlier on case 301 ($D^2 = 50.342$). Case 301 differed from the remaining cases with a combination of low scores on the ISEL Tangible subscale (0.16 compared with a sample mean of 5.90 ± 2.330) and high scores on HDL to cholesterol ratio (6.65 compared with the sample mean of 5.11 ± 0.678) along with the lowest possible scores on fasting insulin (0.30 compared with the sample mean of 1.14 ± 0.310). Therefore, the case was deleted and only 320 cases were included in the SEM analysis.

Outliers no longer existed after the data transformations and the deletion of a single multivariate outlier. However, approximately half of variables were not normally distributed, and the multivariate kurtosis (Mardia's coefficient) was 11.182 (normalized estimate = 3.372). Mardia's coefficient values > 3 mean there is significant kurtosis, which indicates significant non-normality (Garson, 2006c). The skewness values ranged from -0.661 (SF-36 Social Functioning, *C.R.* = -4.827) to 0.742 (number of adults living in the household, *C.R.* = 5.420), and from -1.232 (SF-36 Role Functioning, *C.R.* = -4.497) to 0.356 for (HDL to cholesterol ratio, *C.R.* = 1.298) for the kurtosis, which was an indication of mild non-normality. The method of correcting non-normality in the underlying database based on Bollen-Stine corrected *p*-value bootstrapping was implemented to assess overall model fit along with other fit indexes.

The sample covariance matrix value was evaluated to confirm multicollinearity and to determine if singularity problems existed. A high value of determinant on the sample covariance matrix (3.519606185896E+9) was found in the Sample Moments section. It was much larger than zero. Therefore, there was no singularity problem among the tested variables.

Vast differences in the scaling of the observed variables may cause difficulties with the SEM computations. The power transformed variables were scaled down (divided by 100 or 10,000). Among observed variables, the largest variance was the 4286.503 for the error term of the 6-minute Walk Distance (e6), and the smallest error term variance was 0.016 for years of formal education (e16). Although the range of variance estimates was large, the preliminary run of the saturated model showed convergence after 13 iterations. No further rescaling was required for the current data.

3.4.5.3 Model Estimation

After the evaluation of the SEM assumptions, two-step modeling estimation procedure was implemented. The first part of two-step modeling procedure involved assessing the fit of the unidimensional measurement model with the current data, as depicted in the Figure 3-3. Since the revised Wilson and Cleary conceptual model contained only the linear structural portion of the proposed model and board guideline for what the constructs should be, it was important to evaluate whether the selected variables were suitable in the model.

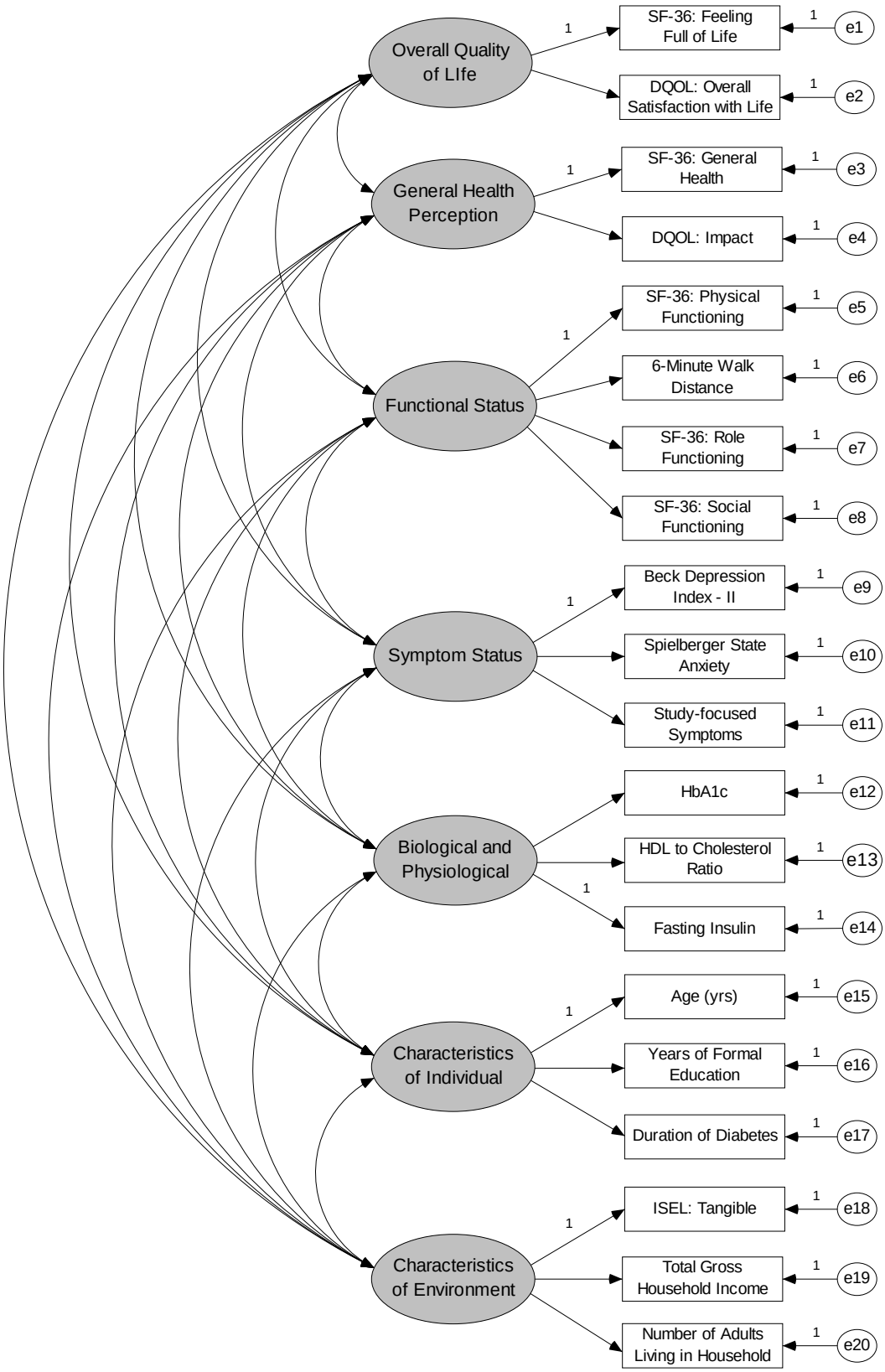

Figure 3-3: Seven-Factor Measurement Model with 17 Observed Variables

Confirmatory Factor Analysis (CFA) with ML estimation was used to fit the model. If the a priori measurement model is reasonably correct, one should see the following patterns: (1) all indicators specified to measure a common underlying factor have relatively high standardized loadings on that factor and (2) estimated correlations between factors are not excessively high (e.g., > 0.85) (Kline, 2005). The solution is not admissible when some variance estimates are negative, or some exogenous variables have an estimated covariance matrix that is not positive. It suggests that either the model is wrong or the sample is too small (Jöreskog & Sörbom, 1984).

As a preliminary check of the identifiability of the model, the numbers of data points and parameters to be estimated were counted. The seven-factor measurement model contains 210 data points and 61 parameters to be estimated (13 regression coefficients, 21 covariances and 27 variances). Therefore, the model is over-identified with 149 degree of freedom. In addition to the chi-square fit index (*CMIN* or χ^2) and relative chi-square (*CMIN/DF* or χ^2/df), a method to correct for non-normality in the underlying database based on Bollen-Stine corrected *p*-value bootstrapping along with the Comparative Fit Index (CFI: Bentler, 1990), the Root Mean Square Error of Approximation (RMSEA: Browne & Cudeck, 1993) and the Standardized Root Mean Square Residual (SRMR) were used to evaluate the goodness-of-fit of the structural model.

The *CMIN* or chi-square (χ^2) is the most common fit test and is reported by all SEM packages. A significant chi-square indicates lack of satisfactory of model fit. A criterion of model χ^2 at $p < .05$ is generally used to reject the model. There are three cases in which the chi-square test may be misleading. First, the chi-square test is very sensitive to the complexity of the model, the more complex the model, the more likely the results will indicate a good model fit. Second, it is very sensitive to the sample size; the larger the sample size, the more likely it is that the model will be rejected even if in it is, in reality, a good fit with the data (a type-II error -

accepting a false null hypothesis). Finally, it is also very sensitive to violations of the assumption of multivariate normality. SEM assumes that the data used to test the model came from a joint multivariate normal distribution (JMVN) in the population from which the sample data were drawn. When this assumption is known to be violated, the chi-square test statistic for overall model fit will be inflated and the standard errors used to test the significance of individual parameter estimates will be deflated, which means that there are more chances to reject models that may not be false (inflated type-II error), and either Bollen-Stine bootstrap or Satorra-Bentler scaled chi-square, which infer the exact structural fit for non-normality, is preferred (Garson, 2006b; Information Technology Services, 2004). The current study dealt with non-normal distributed data by using AMOS Bollen-Stine bootstrapping to compute a new critical chi-square value, parameter estimates, and standard errors. In Contrast to the robust scaling approach, this bootstrapping method adjusts the critical value of the chi-square test instead of the obtained chi-square test statistic.

It is known that the chi-square statistic is highly sensitive to sample size, and thus should not be used at the sole indicator of the goodness of fit between model and data (Bryant, 2000). Other fit indexes were evaluated. The *CMIN/DF* or relative chi-square was used in an attempt to make the chi-square less dependent on sample size by dividing the chi-square fit index by the degrees of freedom. Carmines and McIver (1981, p. 80) stated that the *CMIN/DF* should be in the 2:1 or 3:1 range for an acceptable model, and Kline (1998; 2005) suggests that 3 or less is acceptable. Different researchers recommended using ratios as low as 2 or as high as 5 to indicate a reasonable fit (Marsh & Hocevar, 1985). The CFI estimates the proportion of improvement in the specified covariance model beyond the null model, and it also does a good job of estimating model fit even in a small-sample data. The CFI has a value ranging from 0 to

1, with a value of 1 indicating a perfectly fit model. Hu and Bentler (1999) suggested that a CFI value greater than 0.95 indicates a good-fitting model. RMSEA estimates the lack of fit in a model compared to a perfect (saturated) model. A value of 0.06 or less indicates a good-fitting model relative to the model degrees of freedom (Hu & Bentler, 1999), while a value greater than 0.10 represents a poor-fitting model (Browne & Cudeck, 1993). The 90% confidence intervals for RMSEA were calculated to assess its precision. SRMR, a standardized version of Root Mean Square Residual, is the average difference between the sample variances and covariances and the estimated population variances and covariances. SRMR values range from 0 to 1, with values of 0.08 or less representing good model fit (Hu & Bentler, 1999).

The Power Analysis module of STATISTICA 6.0 was implemented to estimate the power to reject the close-fit hypothesis, H_0: $\varepsilon_0 \leq .06$ assuming $\varepsilon_1 = .08$ and $\alpha = .05$ where $df = 155$ and $N = 320$. If the model does not have close fit in the population, the estimated probability of rejecting the incorrect model is very high (98.68%) with a sample size of 320 cases, given the other assumptions of this analysis.

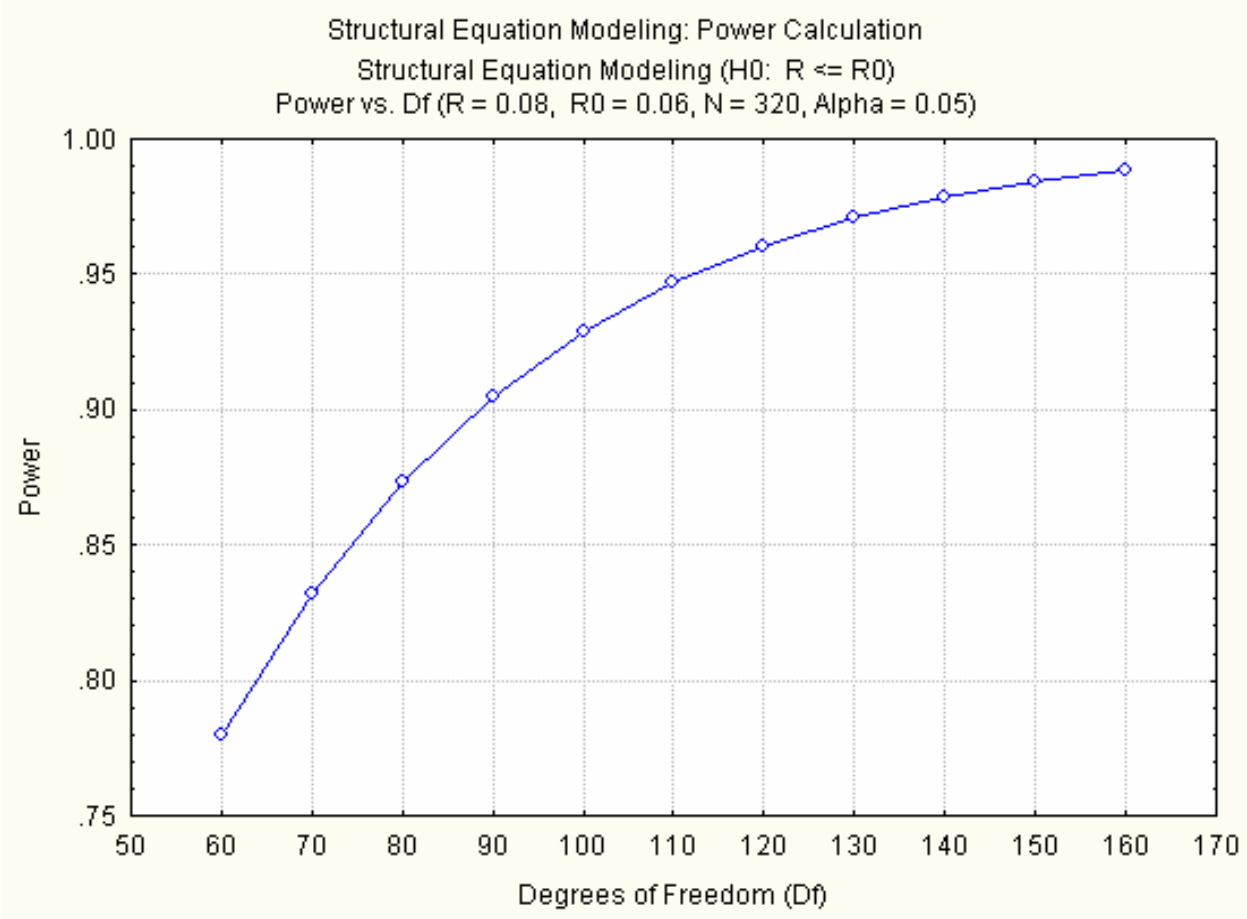

Figure 3-4: SEM Power Calculation (*df* = 60 to 160)

When a model is found not to fit well with the data, the standardized Residual Covariance Matrix should be examined for sources of poor model fit. When the model fits well, the absolute standardized residuals should be less than 2.0 (Jöreskog & Sörbom, 1984). In the current study, the sizable standardized residuals > 2.5 were found, indicating that the model did not adequately estimate the relationship between the two variables. The model was modified from a unidimensional to a multidimensional measurement model by allowing indicators' error terms to covary with those of other indicators. The measurement error correlations reflected the assumption that two corresponding indicators measured something in common that was not explicitly presented in the model.

The multivariate Lagrange Multiplier (LM) test was implemented to assist in modification of the model to improve its fit. The LM test asks whether the model is improved if one or more of the parameters in the model that are currently fixed become estimated (Tabachnick & Fidell, 2000). When it was reasonable, the modification was implemented. AMOS presented only univariate LM tests, called Modification Indices (MI). After the modification, the model was re-estimated, and chi-square difference test was conducted to evaluate whether the modification significantly improved the model fit at $p < .01$ level.

The second stage of two-step modeling procedure dealt with the structural portion of the SEM to identify the relationships among the latent variables. The previous modified seven-factor CFA measurement model was re-specified as a Structural Regression (SR) model as suggested by Wilson and Cleary (1995). Based on the revised Wilson and Cleary model, there were two exogenous variables: (1) characteristics of the individual and (2) characteristics of environment. They were assumed to covary so that the SEM estimation could converge. The final admissible model contained 17 variables that generated 153 data points, and 51 parameters to be estimated (20 regression coefficients, 22 variances, 3 covariances and 6 residual covariances). Therefore, the model was over-identified with 102 degree of freedom. The model was evaluated for the goodness-of-fit. The model chi-square and Bollen-Stine corrected *p* were reported along with other selected fit indices. Then, the fit of the tested model was compared to the fit of the measurement model with the chi-square difference test, assuming a hierarchical structural model (Kline, 2005). The relationships among three exogenous variables, square multiple correlations of each endogenous variables and paths for the hypothesized relationships were reported along with their significance levels and confidence intervals.

4.0 RESULTS

The findings of the current study are summarized in the following sections starting with the characteristics of the sample. The results related to each research question are presented.

4.1 SAMPLE CHARACTERISTICS

The demographic characteristics of the subjects are shown in Table 4-1. Characteristics are presented for the overall sample (N = 321) and the males and females. The remaining characteristics are presented in Table 4-2. There were 139 (43.30%) male and 182 (56.70%) female subjects. Ages of participants ranged from 42 to 91 years with an average of 65 years. More than half of the subjects (59.8%) were between 60 and 80 years of age. Approximately 60% of the participants were married or living with a partner/significant other. More than 70% of the respondents indicated that they did not live alone (i.e. that the number of adult presently living in their household was more than one), and 6.2% had four or more adults living in their household. Reported years of formal education ranged from 8 to 30 with an average of 14.69 years. Most of the subjects (60.7%) indicated that their highest level of education was above high school. Thirty-eight percent (38.0%) of the subjects were still employed. Almost all subjects (98.4%) had health care insurance, and approximately 40% reported that their insurance fully covered their health care costs.

Table 4-1: Demographic Characteristics

Demographic Characteristic	**Male** (*N*=139) *n* (%)	**Female** (*N*=182) *n* (%)	**Overall** (*N*=321) *n* (%)
Age (Years)			
40 to 49	12 (8.6%)	22 (12.1%)	34 (10.6%)
50 to 59	32 (23.0%)	47 (25.8%)	79 (24.6%)
60 to 69	43 (30.9%)	58 (31.9%)	101 (31.5%)
70 to 79	46 (33.1%)	45 (24.7%)	91 (28.3%)
80 and Above	6 (4.3%)	10 (5.5%)	16 (5.0%)
Current Marital Status			
Never married	11 (7.9%)	16 (8.8%)	27 (8.4%)
Currently married or living with partner/significant other	100 (71.9%)	95 (52.2%)	195 (60.7%)
Widowed	14 (10.1%)	38 (20.9%)	52 (16.2%)
Separated or Divorced	14 (10.1%)	33 (18.1%)	47 (14.6%)
Highest Level of Education			
Grade/high school	44 (31.7%)	82 (45.1%)	126 (39.3%)
Vocational school, associate's level and some college	30 (21.6%)	52 (28.6%)	82 (25.5%)
Bachelor's level	36 (25.9%)	21 (11.5%)	57 (17.8%)
Post-undergraduate level	29 (20.9%)	27 (14.8%)	56 (17.4%)
Number of adults presently living in household (including self)			
1	27 (19.4%)	64 (35.2%)	91 (28.3%)
2	83 (59.7%)	85 (46.7%)	168 (52.3%)
3	21 (15.1%)	21 (11.5%)	42 (13.1%)
4 and more	8 (5.8%)	12 (6.6%)	20 (6.2%)

Table 4-1: Demographic Characteristics (continued)

Demographic Characteristic	**Male** (*N*=139) *n* (%)	**Female** (*N*=182) *n* (%)	**Overall** (*N*=321) *n* (%)
Employment Status			
Currently employed	50 (36.0%)	72 (49.6%)	122 (38.0%)
Currently unemployed	89 (64.0%)	104 (57.1%)	193 (50.1%)
Never employed	0 (0.0%)	6 (3.3%)	6 (1.9%)
Do you have health care insurance?			
Yes	136 (97.8%)	180 (98.9%)	316 (98.4%)
No	3 (2.2%)	2 (1.1%)	5 (1.6%)
Does your insurance cover the cost of health care?			
Yes, all	47 (33.8%)	82 (45.1%)	129 (40.2%)
Yes, some	88 (63.3%)	97 (53.3%)	185 (57.6%)
No	1 (0.7%)	0 (0.0%)	1 (0.3%)
Not sure	0 (0.0%)	1 (0.5%)	1 (0.3%)
Do not have insurance	3 (2.2%)	2 (1.1%)	5 (1.6%)
What is the total gross annual income for your household from all sources?			
Under $13,000	8 (5.8%)	26 (14.3%)	34 (10.6%)
$13,000 to $50,000	67 (48.2%)	104 (57.1%)	171 (53.2%)
Over $50,000	61 (43.9%)	49 (26.9%)	110 (34.3%)
Not specified	3 (2.2%)	3 (1.6%)	6 (1.9%)

Based on U.S. Census Bureau data (2005), 34 subjects (10.6%) reported having a gross household income less than the U.S. poverty level (Poverty Thresholds 2005: $13,145 for a two-person householder under 65 years old). Most subjects (53.2%) had a gross annual household income between $13,000 and $50,000, while 34.4% had a gross household income above $50,000. Six subjects (1.9%) did not report their total gross annual household income.

The mean scores on three SF-36 subscales (Physical Functioning, Role-Physical and Bodily Pain) were between 60 and 70. Mean scores on two subscales (General Health and Vitality) were below 60, while mean scores on the remaining three subscales (Social Functioning, Role-Emotional and Mental Health) were above 70. Independent sample t-test results revealed that male subjects had significant higher scores on two SF-36 subscales (Physical Functioning and Bodily Pain) than female subjects. The SF-36 subscale scores are summarized in the Table 4-2.

Subjects' subscale scores were compared to 1998 SF-36 norms using norm-based scoring (NBS). The norm-based scoring of SF-36 profile of the current sample is shown in Figure 4-1. The study sample had average SF-36 subscale scores lower than 1998 norms on every subscale except the Mental Health subscale (NBS=50.24). Four norm-based subscale scores (Bodily Pain, Vitality, Social Functioning and Role-Emotional) were between 45 and 50, and the remaining three norm-based scores (Physical Functioning Role-Physical and General Health) were between 40 and 45.

DQOL subscale and total scores are presented in Table 4-2. Subjects' scores ranged from (1) 27.0 to 75.0 on the Satisfaction subscale (mean = 53.89), (2) 43.0 to 97.0 on the Impact subscale (mean = 77.62), (3) 11.0 to 35.0 on the Social/Vocational Worry subscale (mean = 30.15), (4) 5.0 to 20.0 on the Diabetes Related Worry subscale (mean = 15.96) and (5) 104.0 to

225.0 on the DQOL total score (mean = 177.61). Data from the CRCD Comorbidity Questionnaire were analyzed to determine the number of self-reported, study-focused comorbidities and symptoms. The number of study-focused comorbidities varied from 0 to 8 with an average of 2.26 ± 1.301. The total number of study-focused symptoms (existence of symptoms weighted by their effects on quality of life) ranged from 0 to 10 with an average of 2.56 ± 2.121.

ISEL subscale scores varied from a mean of 20.54 ± 4.728 on the Self-esteem subscale to 23.62 ± 5.675 on the Tangible subscale. Female subjects had higher scores than males on every ISEL subscale but none of the differences were statistically significant. The average BDI-II and Spielberger State Anxiety scores were 7.67 ± 6.71 and 34.45 ± 12.32, respectively. Female subjects had higher depression and anxiety scores than male subjects. On the other hand, male subjects could walk a significantly longer distance in 6 minutes than female subjects (mean=1124.4 vs. 971.3 meters). The average of HbA1c was 7.39% ± 1.31. HbA1c values were similar for men and women (7.50% vs. 7.30).

Table 4-2: Sample Characteristics

Variable	Overall (n = 321) Mean (SD)	Male (n = 139) Mean (SD)	Female (n = 182) Mean (SD)	p-value
SF-36				
Physical Functioning	66.19 (26.887)	70.70 (25.129)	62.74 (27.730)	.008
Role-Physical	69.54 (27.850)	70.39 (27.602)	68.89 (28.097)	n.s.
Bodily Pain	63.52 (24.672)	68.73 (23.002)	59.54 (25.220)	.001
General Health	58.16 (19.855)	59.49 (20.146)	57.14 (19.624)	n.s.
Vitality	56.65 (21.173)	59.57 (20.181)	54.42 (21.691)	n.s.
Social Functioning	81.78 (22.642)	84.37 (20.642)	79.81 (23.925)	n.s.
Transformed Social Functioning score [b]	72.00 (31.608)	75.41 (30.130)	69.39 (32.532)	n.s.
Role-Emotional	81.51 (24.630)	85.43 (22.343)	78.51 (25.904)	n.s.
Transformed Role-Emotional score [b]	72.48 (33.165)	77.93 (31.348)	68.31 (33.986)	.010
Mental Health	75.41 (18.527)	76.95 (18.114)	74.24 (18.801)	n.s.
Transformed Mental Health score [b]	60.29 (24.553)	62.47 (24.664)	58.63 (24.404)	n.s.
DQOL				
Satisfaction	53.89 (10.063)	54.89 (10.359)	53.12 (9.789)	n.s.
Impact	77.62 (11.040)	77.57 (10.689)	77.65 (11.329)	n.s.
Transformed Impact score [b]	61.46 (16.425)	61.30 (15.940)	61.58 (16.829)	n.s.
Social/Vocational Worry	30.15 (5.948)	30.12 (6.143)	30.16 (5.812)	n.s.
Transformed Social/ Vocational Worry score [b]	9.44 (3.251)	9.45 (3.356)	9.43 (3.178)	n.s.
Diabetes Related Worry	15.96 (3.334)	16.31 (3.444)	15.70 (3.232)	n.s.
Transformed Diabetes Related Worry score [b]	2.66 (0.991)	2.78 (1.033)	2.57 (0.950)	n.s.
DQOL Total	177.61 (24.189)	178.89 (24.360)	176.64 (24.078)	n.s.
Transformed DQOL Total score [b]	321.29 (83.125)	325.90 (84.386)	317.77 (81.207)	n.s.
ISEL				

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

Table 4-2: Sample Characteristics

Variable	Overall (n = 321) Mean (SD)	Male (n = 139) Mean (SD)	Female (n = 182) Mean (SD)	p-value
Appraisal	21.94 (6.615)	20.58 (6.551)	22.98 (6.492)	.001
Transformed Appraisal score [b]	2.50 (1.345)	2.79 (1.275)	2.28 (1.358)	< .001
Tangible	23.62 (5.675)	23.21 (5.778)	23.93 (5.591)	n.s.
Transformed Tangible score [b]	5.90 (2.330)	5.71 (2.397)	6.04 (2.274)	n.s.
Self-esteem	20.54 (4.728)	20.30 (4.526)	20.73 (4.880)	n.s.
Transformed Self-esteem score [b]	4.44 (1.804)	4.32 (1.691)	4.54 (1.885)	n.s.
Belonging	22.55 (5.835)	21.91 (5.670)	23.04 (5.927)	n.s.
Transformed Belonging score [b]	5.43 (2.341)	5.12 (2.242)	5.66 (2.394)	n.s.
Others				
Number of Study-Focused Comorbidities	2.26 (1.301)	2.22 (1.378)	2.29 (1.243)	n.s.
Weighted Study-Focused Symptoms	2.56 (2.121)	2.38 (2.114)	2.70 (2.121)	n.s.
Transformed Weighted Study-focused Symptoms [d]	1.39 (0.801)	1.31 (0.822)	1.45 (0.781)	n.s.
BDI-II Total Score	7.67 (6.713)	6.85 (5.751)	8.29 (7.318)	n.s.
Transformed BDI-II Total Score [d]	2.49 (1.222)	2.37 (1.123)	2.58 (1.288)	n.s.
Spielberger State Anxiety Total Score	34.45 (12.317)	33.24 (11.783)	35.37 (12.664)	n.s.
Transformed Spielberger State Anxiety Total Score [d]	5.78 (1.021)	5.68 (0.986)	5.85 (1.044)	n.s.
6-Minute Walk Distance	1037.6 (450.58)	1124.4 (474.75)	971.3 (420.58)	.005
Transformed 6-Minute Walk Distance [h]	128.6 (76.268)	148.72 (82.912)	113.19 (67.010)	< .001
HBA1C	7.39 (1.313)	7.50 (1.379)	7.30 (1.258)	n.s.
Transformed HBA1C [e]	1.39 (0.218)	1.38 (0.228)	1.40 (0.210)	n.s.
Fasting Insulin	18.26 (16.954)	16.12 (14.174)	19.86 (18.649)	n.s.
Transformed Fasting Insulin [f]	1.14 (0.309)	1.09 (0.321)	1.18 (0.295)	.005
HDL to CHOL Ratio	0.266 (0.075)	0.253 (0.066)	0.276 (0.079)	.007
Transformed HDL to CHOL Ratio [g]	5.106 (0.678)	4.996 (0.639)	5.191 (0.695)	.010

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

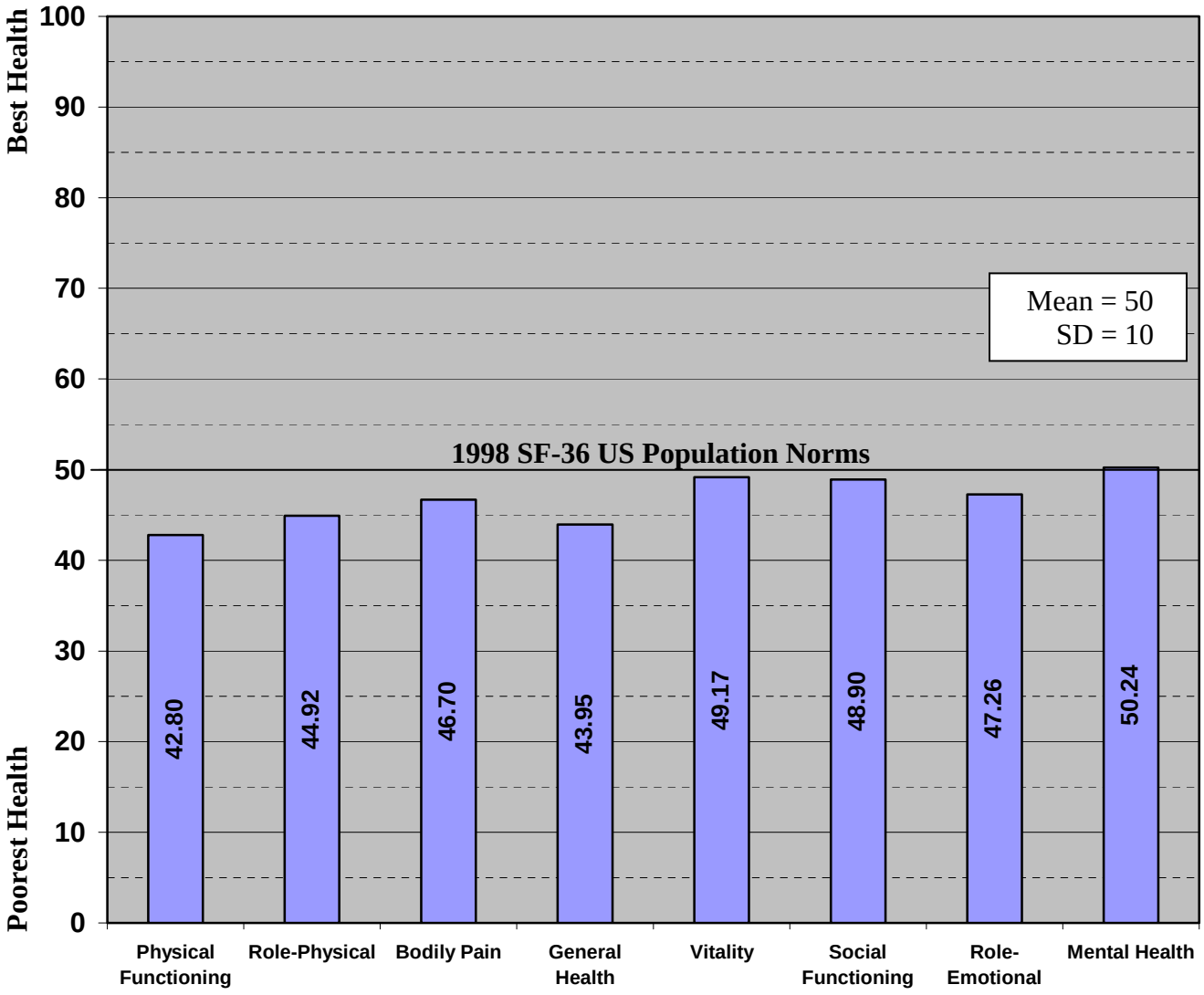

Figure 4-1: Sample Norm-based Scoring on the SF-36 Profile

4.2 SPECIFIC AIM # 1

TO EXAMINE THE RELATIONSHIPS BETWEEN DEMOGRAPHIC CHARACTERISTICS AND BOTH GENERAL HEALTH-RELATED AND DIABETES SPECIFIC QUALITY OF LIFE IN INDIVIDUALS WITH TYPE-2 DIABETES AND HYPERTENSION AND/OR HYPERLIPIDEMIA

4.2.1 Research Question # 1:

What are the relationships between both general and disease specific quality of life and sociodemographic characteristics among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?

The relationships between demographic variables and general health-related and diabetes specific quality of life were examined. The demographic variables examined were gender, age, current marital status, highest educational level, and gross household income. The findings are summarized in Table 4-3 and Table 4-4.

Gender: Male subjects (n = 139) had higher scores on all of the SF-36 subscales than female subjects (n = 182), but the differences were statistically significant at a $p < .01$ level for only three subscales: (1) Physical Functioning (mean = 70.70 vs. 62.74; 99%CI for group differences = 0.19 - 15.74), (2) Bodily Pain (mean = 68.73 vs. 59.54; 99% CI for group differences from 2.10 to 16.28) and (3) Role-Emotional (mean = 77.93 vs. 68.31; 99%

confidence interval for group differences from 0.02 to 19.21). There were no significant differences in any DQOL subscale/ total scores among male and female subjects.

Age: Subjects' ages ranged from 42 to 91 years old. The results of the Simple Linear Regression for quality of life (SF-36 and DQOL) subscale/total scores based on subjects' ages are summarized in Table 4-5. Age was a statistically significant predictor of subjects' quality of life as measured by both SF-36 and DQOL subscale/total scores. Age had a positive relationship with all quality of life subscale/total scores except SF-36 Physical Functioning (*Beta* = -0.133, p = .017, 2-tailed) and Role-Physical subscale scores (*Beta* = -0.152, p = .006, 2-tailed). The relationships were statistically significant on 3 of 8 subscale scores on SF-36 (Role-Physical, General Health and Mental Health), 3 of 4 DQOL subscales scores (Satisfaction, Social/Vocation Worry and Diabetes Related Worry) and the DQOL total score..

Among the significant predictors, the proportion of the variance in general health-related quality of life (SF-36) explained by age adjusted by the effective sample size ($R^2_{(adj.)}$) varied from 2.0% (*Beta* = -0.152, R^2 = 0.023, f^2 = 0.024, 99% CI = -0.019 to 0.065) for the Role-Physical subscale to 5.5% (*Beta* = 0.241, R^2 = 0.058, f^2 = 0.062, 99% CI = -0.069 to 0.123) for the General Health subscale. Age explained more of the variance in diabetes-specific quality of life as measured by the DQOL. Among the significant predictors of DQOL scores, the proportion of variance explained varied from 5.2% for the Diabetes Related Worry subscale (*Beta* = 0.234, R^2 = 0.055, f^2 = 0.058, 99% CI = -0.084 to 0.118) to 12.9% for the Satisfaction subscale (*Beta* = 0.362, R^2 = 0.131, f^2 = 0.151, 99% CI = 0.041 to 0.221).

Marital Status: Most subjects were currently married or living with a partner/ significant other (n = 195, 60.7%). There were only two significant differences in SF-36 subscale scores at a $p < .01$ level (Physical Functioning and Role-Emotional) based on marital status. Post-hoc

analysis did not reveal any statistically differences at a $p < .01$ level between any of the marital status groups. No significant group differences were found on any DQOL scores.

Education: Approximately 40% ($n = 126$) of the subjects reported that their highest level of education was high/grade school. There were no significant differences ($p<.01$) in either SF-36 or DQOL subscale/total scores based on educational level. The results of the Simple Linear Regression for quality of life (SF-36 and DQOL) subscale/total scores based on years of formal education are summarized in Table 4-6. Years of formal education was not a significant predictor of subjects' quality of life as measured by either SF-36 or DQOL subscale/total scores.

Income: Most subjects ($n = 171$, 53.27%) reported that their household's annual income was between $13,000 and $50,000. There were 6 subjects (1.87%) who did not report their household's income. These subjects had relatively high scores on almost every quality of life scale. Their scoring profile was similar to that of subjects with household incomes over $50,000. The results revealed that there were significant group differences ($p < .001$) on all SF-36 subscale scores except the General Health subscale. Post-hoc analysis revealed that subjects with gross household incomes over $50,000 had significantly higher scores on the SF-36 Physical Functioning and Role-Physical subscales than subjects with lower gross household incomes. Subjects with gross household incomes over $50,000 also had significantly higher scores on the SF-36 Bodily Pain and Vitality subscales than subject with gross household income less than $13,000 ($p < .001$). The mean difference was 19.21 with a 99% confidence interval from 4.39 to 34.02 for the Bodily Pain subscale and 16.30 with a confidence interval of 2.39 to 30.21 for the Vitality subscale. For the SF-36 Role-Emotional and Mental Health subscales, subjects with gross household incomes less than $13,000 had significantly lower scores than subjects with higher gross household incomes. The mean difference was 37.53 (99% CI = 18.13

to 56.93) for the Role-Emotion subscale, and 22.33 (99% CI = 7.71 to 36.95) for the Mental Health subscale.

For the DQOL, the only difference was on the Impact subscale. Post-hoc testing revealed that subjects with a gross household income over $50,000 had significantly higher DQOL Impact subscale scores than subjects with a gross household income under $13,000 (mean = 63.82 vs. 53.28, p = .005, 99% CI for group differences = 0.58 to 20.50)

Number of adults in household: The number of adults presently living in subjects' households ranged from 1 to 14. Ninety one subjects (28.35%) reported that they were living alone, and 168 subjects (52.34%) indicated that there were 2 people in their household. Only 62 (19.31%) subjects reported that there were 3 or more people in their household. The only SF-36 subscale score that differed significantly across the three groups was the Role-Emotional subscale. Post-hoc analysis revealed that subjects who lived alone had significantly lower Role-Emotional subscale scores than subjects who had two or more adults in their household (mean = 56.43 vs. 62.24, p = .006, 99% CI for group differences = 0.72 to 27.21). There were no significant differences in any of the DQOL scores.

Table 4-3: Relationships between Demographic Characteristics and SF-36 Scores

Demographic Characteristics	*n*	Physical Functioning	Role – Physical	Bodily Pain	General Health	Vitality	Social Functioning [b]	Role - Emotional [b]	Mental Health [b]
Current Marital Status									
Never married	27	65.23 ±23.339	73.38 ±25.274	67.33 ±22.790	54.11 ±22.378	52.78 ±22.154	67.82 ±29.745	66.59 ±33.479	53.06 ±22.718
Current married or living with partner/ significant other	195	70.25 ±24.529	72.24 ±26.357	65.09 ±24.253	59.42 ±19.114	59.17 ±20.020	75.69 ±29.867	77.99 ±30.603	62.61 ±24.449
Widowed	52	60.41 ±29.896	64.42 ±27.883	59.98 ±23.026	60.12 ±17.624	55.97 ±19.969	68.60 ±32.410	63.67 ±35.704	63.40 ±25.099
Separated or divorced	47	56.28 ±31.373	61.76 ±33.343	58.69 ±28.556	53.07 ±22.957	49.18 ±24.811	62.83 ±36.830	62.73 ±36.348	51.37 ±23.168
F ($df_1 = 3$, $df_2 = 317$)		4.567	2.632	1.442	1.848	3.254	2.600	4.820	3.804
***p*-value**		.004	.050	.231	.138	.022	.052	.003	.011
Highest Level of Education									
Grade/high school	126	63.37 ±26.324	68.90 ±28.134	61.33 ±23.918	58.40 ±19.424	56.93 ±20.881	75.47 ±30.924	72.30 ±33.971	62.28 ±25.620
Vocational school, associate's level and some college	82	64.14 ±26.539	66.92 ±28.658	61.73 ±25.518	55.59 ±20.244	53.20 ±22.763	64.23 ±32.013	66.27 ±33.934	56.69 ±23.632
Bachelor's level	57	68.60 ±27.723	67.92 ±28.125	64.25 ±24.847	59.74 ±17.346	59.30 ±18.758	77.30 ±29.599	79.29 ±29.834	61.26 ±21.222

Note: Transformation method:

a. = Score^2 b. = $\text{Score}^2 / 100$ c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score} \times 100}$ h. = $\text{Score}^2 / 10000$ i. = $\text{Score}^2 / 200$

Table 4-3: Relationships between Demographic Characteristics and SF-36 Scores (continued)

Demographic Characteristics	*n*	Physical Functioning	Role – Physical	Bodily Pain	General Health	Vitality	Social Functioning[b]	Role - Emotional[b]	Mental Health[b]
Post-undergraduate level	56	73.06 ±27.070	76.45 ±25.226	70.32 ±24.297	59.75 ±22.607	58.37 ±21.627	70.15 ±32.984	75.04 ±32.593	60.12 ±26.554
F ($df_1 = 3$, $df_2 = 317$), p-value		2.010	1.485	1.928	0.701	1.156	2.802	1.887	0.894
***p*-value**		.113	.219	.125	.552	.327	.040	.132	.444
Household's gross annual income									
Not specified	6	75.00 ±21.909	69.79 ±24.817	69.67 ±15.135	71.58 ±19.915	63.54 ±25.744	85.42 ±22.592	83.45 ±25.911	71.79 ±16.994
Under $13,000	34	52.02 ±27.284	55.22 ±26.645	51.08 ±25.792	53.25 ±21.207	45.01 ±21.403	51.88 ±35.564	43.93 ±36.268	41.81 ±24.691
$13,000 to $50,000	171	61.99 ±27.470	66.26 ±28.741	61.42 ±24.405	58.17 ±19.206	55.73 ±19.773	73.05 ±30.385	71.99 ±32.623	61.09 ±23.044
Above $50,000	110	76.60 ±22.228	79.03 ±23.954	70.28 ±23.297	58.92 ±20.239	61.31 ±21.659	75.84 ±30.563	81.46 ±28.243	64.14 ±24.778
F ($df_1 = 3$, $df_2 = 317$)		11.233	8.619	6.49	1.672	5.768	5.807	12.541	8.360
***p*-value**		< .001	< .001	< .001	.173	.001	.001	< .001	< .001
Number of adults presently living in household (including self)									
1	91	61.62 ±29.303	66.79 ±29.822	61.72 ±26.122	57.97 ±21.595	54.16 ±22.559	66.83 ±34.236	64.54 ±35.974	56.43 ±25.012

Note: Transformation method:

a. = Score^2 b. = Score^2 / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score^2 / 10000 i. = Score^2 / 200

Table 4-3: Relationships between Demographic Characteristics and SF-36 Scores (continued)

Demographic Characteristics	*n*	Physical Functioning	Role – Physical	Bodily Pain	General Health	Vitality	Social Functioning[b]	Role - Emotional[b]	Mental Health[b]
2	168	69.57 ±25.016	71.91 ±26.719	66.50 ±23.818	59.08 ±19.505	58.97 ±20.955	75.62 ±29.326	78.51 ±30.552	62.24 ±24.475
3 or more	62	63.71 ±27.265	67.14 ±27.742	58.08 ±23.961	55.94 ±18.194	54.03 ±19.175	69.76 ±32.803	67.79 ±32.996	60.69 ±23.802
F ($df_1 = 2$, $df_2 = 318$)		2.938	1.287	3.008	0.571	2.125	2.502	6.198	1.667
***p*-value**		.054	.278	.051	.566	.121	.083	.002	.190

Note: Transformation method:

a. = Score^2 b. = Score^2 / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score^2 / 10000 i. = Score^2 / 200

Table 4-4: Relationships between DQOL Subscale and Total Scores and Demographic Characteristics

Demographic Characteristics	*n*	Satisfaction	Impact[b]	Social / Vocational Worry[b]	Diabetes Related Worry[b]	DQOL Total Score[b]
Current Marital Status						
Never married	27	53.64 ±10.048	57.18 ±13.080	9.02 ±3.021	2.55 ±0.935	306.15 ±66.619
Current married or living with partner/ significant other	195	54.05 ±10.275	62.62 ±16.195	9.66 ±3.168	2.69 ±0.979	326.26 ±82.295
Widowed	52	56.47 ±8.358	62.48 ±15.875	9.83 ±3.000	2.82 ±0.964	336.72 ±77.069
Separated or divorced	47	50.47 ±10.249	57.97 ±19.089	8.32 ±3.783	2.44 ±1.082	292.32 ±95.111
F ($df_1 = 3$, $df_2 = 317$), p-value		3.020	1.723	2.543	1.399	3.091
		.030	.162	.052	.243	.027
Highest Level of Education						
Grade/high school	126	53.99 ±10.113	62.44 ±16.499	9.85 ±3.164	2.69 ±0.969	326.71 ±82.982
Vocational school, associate's level and some college	82	52.25 ±9.797	56.56 ±16.352	8.69 ±3.409	2.47 ±1.085	297.45 ±84.500
Bachelor's level	57	55.45 ±8.845	64.09 ±14.912	9.69 ±3.120	2.68 ±0.893	334.43 ±72.537
Post-undergraduate level	56	54.46 ±11.347	63.75 ±16.740	9.37 ±3.229	2.83 ±0.974	330.64 ±86.586
F ($df_1 = 3$, $df_2 = 317$)		1.251	3.519	2.187	1.549	3.202
***p*-value**		.291	.015	.079	.202	.024

Note: Transformation method:

a. = $Score^2$ b. = $Score^2 / 100$ c. = log (6 – Score) d. = $\sqrt{Score}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{Score \times 100}$ h. = $Score^2 / 10000$ i. = $Score^2 / 200$

Table 4-4: Relationships between DQOL Subscale and Total Scores and Demographic Characteristics (continued)

Demographic Characteristics	*n*	Satisfaction	Impact[b]	Social / Vocational Worry[b]	Diabetes Related Worry[b]	DQOL Total Score[b]
Household's gross annual income						
Not specified	6	57.83 ±13.586	71.12 ±16.657	9.74 ±4.214	3.19 ±1.145	369.00 ±117.609
Under $13,000	34	52.30 ±10.176	53.28 ±17.305	8.44 ±3.559	2.22 ±1.102	285.61 ±86.932
$13,000 to $50,000	171	54.18 ±9.573	61.23 ±16.143	9.39 ±3.264	2.71 ±0.943	321.95 ±80.596
Above $50,000	110	53.71 ±10.617	63.82 ±15.828	9.81 ±3.052	2.68 ±0.993	328.70 ±81.571
F ($df_1 = 3$, $df_2 = 317$)		0.646	4.407**	1.578	3.062	3.101
***p*-value**		.586	.005	.195	.028	.027
Number of adults presently living in household (including self)						
1	91	54.07 ±9.993	59.71 ±17.742	9.00 ±3.542	2.55 ±1.051	313.78 ±87.886
2	168	54.96 ±9.956	63.18 ±15.222	9.65 ±3.048	2.71 ±0.949	330.84 ±77.607
3 or more	62	50.71 ±9.950	59.36 ±17.300	9.52 ±3.330	2.68 ±1.016	306.44 ±88.341
F ($df_1 = 2$, $df_2 = 318$)		4.140	1.959	1.137	0.757	2.491
***p*-value**		.017	.143	.301	.470	.084

Note: Transformation method:

a. = Score^2 b. = Score^2 / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score^2 / 10000 i. = Score^2 / 200

Table 4-5: Regression Summary Statistics for Age and Quality of Life Scores (SF-36 and DQOL)

	Dependent Variable	Standardized Coefficient (Beta)	*t*-value	*p*-value	R^2	$R^2_{(adjusted)}$	Effect Size (f^2)	99% CI of f^2
SF-36	Physical Functioning	-0.133	-2.394	.017	0.018	0.015	0.0183	-0.0197 to 0.0557
	Role-Physical	-0.152	-2.745	.006	0.023	0.020	0.0235	-0.0194 to 0.0654
	Bodily Pain	0.016	0.281	.779	0.000	-0.003	n/a	n/a
	General Health	0.241	4.442	< .001	0.058	0.055	0.0616	-0.0069 to 0.1229
	Vitality	0.128	2.301	.022	0.016	0.013	0.0163	-0.0196 to 0.0516
	Social Functioning [b]	0.096	1.722	.086	0.009	0.006	0.0091	-0.0179 to 0.0359
	Role-Emotional [b]	0.030	0.527	.598	0.001	-0.002	0.0010	-0.0080 to 0.0100
	Mental Health [b]	0.216	3.944	< .001	0.046	0.044	0.0482	-0.0125 to 0.1045
DQOL	Satisfaction	0.362	6.943	< .001	0.131	0.129	0.1507	0.0410 to 0.2210
	Impact [b]	0.141	2.543	.011	0.020	0.017	0.0204	-0.0197 to 0.0597
	Social/Vocational Worry [b]	0.256	4.736	< .001	0.066	0.063	0.0707	-0.0027 to 0.1347
	Diabetes Related Worry [b]	0.234	4.307	< .001	0.055	0.052	0.0582	-0.0084 to 0.1184
	Total [b]	0.307	5.763	< .001	0.094	0.091	0.1038	0.0145 to 0.1735

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

Table 4-6: Regression Summary Statistics for Years of Formal Education and Quality of Life Scores (SF-36 and DQOL)

	Dependent Variable	Standardized Coefficient (Beta)	*t*-value	*p*-value	R^2	$R^2_{(adjusted)}$	Effect Size (f^2)	99% CI of f^2
SF-36	Physical Functioning	0.138	2.497	.013	0.019	0.016	0.0194	-0.0197 to 0.0577
	Role-Physical	0.084	1.514	.131	0.007	0.004	0.0070	-0.0168 to 0.0308
	Bodily Pain	0.121	2.177	.030	0.015	0.012	0.0152	-0.0195 to 0.0495
	General Health	0.061	1.090	.276	0.004	0.001	0.0040	-0.0140 to 0.0220
	Vitality	0.069	1.232	.219	0.005	0.002	0.0050	-0.0151 to 0.0251
	Social Functioning [b]	0.005	0.083	.934	0.000	-0.003	n/a	n/a
	Role-Emotional [b]	0.089	1.590	.113	0.008	0.005	0.0081	-0.0174 to 0.0334
	Mental Health [b]	0.041	0.734	.464	0.002	-0.001	0.0020	-0.0108 to 0.0148
DQOL	Satisfaction	0.069	1.228	.220	0.005	0.002	0.0050	-0.0151 to 0.0251
	Impact [b]	0.079	1.407	.161	0.006	0.003	0.0060	-0.0160 to 0.0280
	Social/Vocational Worry [b]	-0.024	-0.421	.674	0.001	-0.003	0.0010	-0.0080 to 0.0100
	Diabetes Related Worry [b]	0.077	1.375	.170	0.006	0.003	0.0060	-0.0160 to 0.0280
	Total [b]	0.072	1.292	.197	0.005	0.002	0.0050	-0.0151 to 0.0251

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

4.3 SPECIFIC AIM # 2

TO EVALUATE THE RELATIONSHIPS BETWEEN GENERAL HEALTH-RELATED AND DIABETES SPECIFIC QUALITY OF LIFE IN INDIVIDAULS WITH TYPE-2 DIABETES AND HYPERTENSION AND/OR HYPERLIPIDEMIA

4.3.1 Research Question # 2:

What is the relationship between general health-related quality of life and diabetes specific quality of Life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?

The correlation matrix in the Table 4-7 revealed that all general health-related and diabetes-specific quality of life subscale scores were positively correlated at a significance level of $p < .01$ (2-tailed) except the DQOL Social/Vocational Worry and SF-36 Physical Functioning subscale scores ($r = 0.13$, $p = .019$). The correlations between SF-36 and DQOL subscales ranged from $r = 0.13$ (SF-36 Physical Functioning and DQOL Social/Vocational Worry) to $r = 0.62$ (SF-36 General Health and DQOL Satisfaction). Among the DQOL subscales, only the Satisfaction subscale had a positive correlation greater than 0.50 with three of the SF-36 subscales: General Health ($r = 0.62$), Vitality ($r = 0.52$) and Mental Health ($r = 0.56$). Correlations between SF-36 subscale scores and the DQOL total score ranged from $r = 0.37$ (Physical Functioning) to $r = 0.58$ (General Health). The DQOL total score was moderately correlated ($r > 0.50$) with three SF-36 subscale scores: General Health ($r = 0.58$), Vitality ($r = 0.51$) and Mental Health ($r = 0.57$).

The partial correlation results in Table 4-7 show that the number of comorbidities had minimal effects on the observed relationships between SF-36 subscale and DQOL subscale/total scores. After controlling for the number of study-focused comorbidities, partial correlations between the SF-36 and DQOL subscales became slightly smaller, compared to the correlations without controlling the number of study-focus comorbidities. They varied from $r = 0.11$ (SF-36 Physical Functioning and DQOL Social/Vocation Worry subscales) to $r = 0.55$ (SF-36 General Health and DQOL Satisfaction subscales). All partial correlations remained statistically significant except the: (1) SF-36 Role-Physical and DQOL Social/Vocational subscales ($r = 0.14$, $p = .014$), (2) SF-36 Physical Functioning and DQOL Diabetes Related Worry subscales ($r = 0.14$, $p = .014$), (3) SF-36 Role-Physical and DQOL Diabetes Related Worry subscales ($r = 0.08$, $p = .153$), and (4) SF-36 Social Functioning and DQOL Diabetes Related Worry subscales ($r = 0.14$, $p = .011$).

Table 4-7: Correlations among Quality of Life Subscales and Partial Correlations among Quality of Life Subscales Controlling for the Number of Study Specific Comorbidities (n = 321)

		1	2	3	4	5	6	7	8	9	10	11	12	13
1. SF36: Physical Functioning	Correlation	-												
	Partial correlation													
2. SF36: Role-Physical	Correlation	.738	-											
	Partial correlation	.699												
3. SF36: Bodily Pain	Correlation	.526	.611	-										
	Partial correlation	.456	.541											
4. SF36: General Health	Correlation	.437	.444	.359	-									
	Partial correlation	.349	.338	.238										
5. SF36: Vitality	Correlation	.504	.618	.474	.563	-								
	Partial correlation	.431	.551	.382	.482									
6. SF36: Social Functioning [b]	Correlation	.442	.549	.472	.429	.583	-							
	Partial correlation	.359	.468	.378	.322	.510								
7. SF36: Role-Emotional [b]	Correlation	.426	.583	.473	.429	.570	.673	-						
	Partial correlation	.356	.523	.398	.343	.510	.628							
8. SF36: Mental Health [b]	Correlation	.261	.422	.351	.490	.655	.630	.673	-					
	Partial correlation	.176	.345	.264	.420	.611	.582	.637						
9. DQOL: Satisfaction	Correlation	.283	.306	.330	.615	.521	.414	.434	.558	-				
	Partial correlation	.190	.199	.229	.554	.449	.325	.364	.507					
10. DQOL: Impact [b]	Correlation	.394	.411	.448	.489	.454	.447	.443	.483	.573	-			
	Partial correlation	.304	.305	.350	.392	.358	.349	.364	.415	.509				
11. DQOL: Social/ Vocational Worry [b]	Correlation	.132*	.161	.179	.195	.172	.241	.203	.289	.330	.383	-		
	Partial correlation	.108*	.137*	.157	.175	.150	.225	.185	.276	.320	.380			
12. DQOL: Diabetes Related Worry [b]	Correlation	.220	.183	.286	.348	.238	.236	.300	.334	.465	.612	.515	-	
	Partial correlation	.137*	.080*	.198	.264	.145	.142*	.228	.270	.408	.567	.513		
13. DQOL Total [b]	Correlation	.367	.383	.430	.577	.508	.469	.481	.574	.832	.861	.622	.728	-
	Partial correlation	.275	.275	.332	.499	.423	.377	.408	.519	.807	.837	.639	.698	

Note: ***** Correlations not significant at $p < .01$ level.

Transformation method: a. = Score^2 b. = Score^2 / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score} \times 100}$ h. = Score^2 / 10000 i. = Score^2 / 200

4.4 SPECIFIC AIM # 3

TO EXAMINE THE ASSOCIATIONS BETWEEN THE NUMBER AND TYPES OF COMOBIDITIES AND GENERAL HEALTH-RELATED AND DIABETES SPECIFIC QUALITY OF LIFE IN INDIVIDUALS WITH TYPE-2 DIABETES AND HYPERTENSION AND/OR HYPERLIPIDEMIA

4.4.1 Research Question # 3:

Is there a relationship between study-specific comorbidities and general health-related and diabetes specific quality of life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?

The relationships between individual and the number of study-specific comorbidities and general health-related and diabetes specific quality of life are reported in Table 4-8 and the following section.

Heart Attack/ Coronary Artery Disease (CAD): Most subjects did not have a history of CAD (n = 244, 76.01%). There were no significant differences in either general health-related or diabetes specific quality of life between subjects with or without a history of CAD.

Peripheral Vascular Disease (PVD): Subjects with a history of PVD (n = 67, 20.87%) had significantly lower scores on six of the SF-36 subscales than subjects without a history of PVD (n = 254): (1) Physical Functioning (55.79 vs. 68.93, p < .001, 99% CI for group differences = 3.75 to 22.53), (2) Role-Physical (54.57 vs. 73.48, p < .001, 99% CI for group

differences = 9.37 to 28.45), (3) Bodily Pain (48.11 vs. 67.58, $p < .001$, 99% CI for group differences = 11.14 to 27.80), (4) Vitality (49.25 vs. 58.60, $p = .001$, 99% CI for group differences = 1.92 to 16.77), (5) Social Functioning (58.51 vs. 75.55, $p < .001$, 99% CI for group differences = 6.05 to 28.03), and (6) Role-Emotional (61.76 vs. 75.31, $p = .006$, 99% CI for group differences = 0.83 to 26.25). There were no significant differences in DQOL subscale or total scores of subjects with and without a history of PVD.

Stroke / Mini Stroke (TIA): While subjects with a history of a stroke or TIA ($n = 39$, 12.15%) had lower scores on all SF-36 subscales than those who had a negative history of stroke or TIA ($n = 282$), the difference was statistically significantly only for the Bodily Pain subscale (53.85 vs. 64.85, $p = .009$, 99% CI for group differences = 0.19 to 21.83). There were no statistically significant differences in diabetes-specific quality of life between subjects with and without a history of TIA or stroke.

Renal (Kidney) Disease: Subjects with renal disease ($n = 44$, 13.71%) had lower scores on all SF-36 subscales than subjects without kidney disease ($n = 277$). The differences, however, were significant only for the Physical Functioning (54.89 vs. 67.98, $p = .003$, 99% CI for group differences = 1.93 to 24.26), Role-Physical (59.23 vs. 71.17, $p = .008$, 99% CI for group differences = 0.34 to 23.54), Bodily Pain (51.00 vs. 65.51, $p < .001$, 99% CI for group differences = 4.33 to 24.68), and General Health (50.87 vs. 59.32, $p = .009$, 99% CI for group differences = 0.18 to 16.72) subscales. There were no statistically significant differences in DQOL total or subscale scores for subjects with and without kidney disease.

Mental Health Problem: Subjects with psychological problems (anxiety and/or depression and/or other mental health problems) ($n = 75$, 23.36%) had lower SF-36 subscale scores than subjects without psychological problems ($n = 246$). The differences were significant

for six out of eight SF-36 subscales: (1) Bodily Pain (54.11 vs. 66.39, p = .001, 99% CI for group differences = 2.68 to 21.87), (2) General Health (50.87 vs. 60.38, p < .001, 99% CI = for group differences 2.86 to 16.17), (3) Vitality (47.25 vs. 59.51, p < .001, 99% CI = for group differences 5.24 to 19.29), (4) Social Functioning (53.50 vs. 77.64, p < .001, 99% CI for group differences = 13.90 to 34.37), (5) Role-Emotional (51.41 vs. 78.90, p < .001, 99% CI for group differences = 15.99 to 39.00), and (6) Mental Health (43.84 vs. 65.31, p < .001, 99% CI for group differences = 13.67 to 29.28). Subjects with psychological problems also had significantly lower DQOL total and subscale scores than those without psychological problem: (1) Satisfaction (50.02 vs. 55.07, p < .001, 99% CI for group differences = 1.68 to 8.41), (2) Impact (55.78 vs. 63.19, p = .001, 99% CI for group differences = 1.89 to 12.93), (3) Social/Vocational Worry (8.53 vs. 9.72, p = .005, 99% CI for group differences = 0.09 to 2.29), (4) Diabetes-Related Worry (2.25 vs. 2.78, p < .001, 99% CI for group differences = 0.21 to 0.87) and (5) DQOL Total (284.28 vs. 332.58, p < .001, 99% CI for group differences = 20.72 to 75.88).

High Blood Pressure: More than 80% of the subjects in the current study reported having hypertension. There were no statistically significant differences in the SF-36 or DQOL scores of subjects with (n = 261) and without hypertension (n = 60) except the DQOL Diabetes Related Worry subscale (2.59 vs. 2.97, p = .007, 99% CI for group differences = 0.01 to 0.74).

Arthritis or Rheumatic Disease: Approximately half of the subjects had arthritis or a rheumatic disease. Subjects with one of these conditions (n = 163, 50.78%) had significantly lower scores on the Physical Functioning (59.07 vs. 73.52, p < .001, 99% CI for group differences = 6.95 to 21.96), Role-Physical (64.49 vs. 74.74, p = .001, 99% CI for group differences = 2.31 to 18.18), and Bodily Pain (54.19 vs. 73.14, p < .001, 99% CI for group

differences = 12.35 to 25.55) subscales of the SF-36 than the subjects without these conditions (*n* = 158). There were no significant differences in any of the DQOL scores.

Table 4-8: Relationships between Study-Focused Comorbidities and General Health-Related and Diabetes-Specific Quality of Life

		Mean ± SD		Mean ± SD		*p*-value	*t*-value	*df.*
Having heart attack/ coronary artery disease (CAD)		**Yes (*n* = 77)**		**No (*n* = 244)**				
SF-36	Physical Functioning	63.15	±26.70	67.14	±26.93	.257	1.136	319
	Role-Physical	64.04	±30.16	71.27	±26.91	.047	1.995	319
	Bodily Pain	60.55	±25.78	64.45	±24.29	.226	1.213	319
	General Health	55.32	±20.30	59.05	±19.67	.150	1.442	319
	Vitality	56.41	±21.12	56.72	±21.23	.911	0.112	319
	Social Functioning [b]	67.63	±31.97	73.37	±31.43	.165	1.391	319
	Role-Emotional [b]	70.18	±34.86	73.21	±32.65	.485	0.699	319
	Mental Health [b]	60.04	±25.82	60.37	±24.19	.918	0.103	319
DQOL	Satisfaction	54.33	±10.02	53.75	±10.09	.661	-0.439	319
	Impact [b]	60.39	±16.59	61.80	±16.39	.511	0.657	319
	Social/ Vocational Worry [b]	9.25	±3.32	9.50	±3.24	.553	0.594	319
	Diabetes Related Worry [b]	2.71	±1.01	2.64	±0.99	.606	-0.517	319
	Total Score [b]	319.81	±84.38	321.76	±82.90	.858	0.179	319
Having peripheral vascular disease (PVD)		**Yes (*n* = 67)**		**No (*n* = 254)**				
SF-36	Physical Functioning	55.79	±25.47	68.93	±26.62	.000	3.626	319
	Role-Physical	54.57	±25.87	73.48	±27.04	.000	5.137	319

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

Table 4-8: Relationships between Study-Focused Comorbidities and General Health-Related and Diabetes Specific Quality of Life (continued)

		Mean ± SD		Mean ± SD		*p*-value	*t*-value	*df.*
SF-36	Bodily Pain	48.11	±23.97	67.58	±23.25	.000	6.059	319
	General Health	52.67	±18.83	59.60	±19.90	.011	2.565	319
	Vitality	49.25	±20.57	58.60	±20.94	.001	3.262	319
	Social Functioning [b]	58.51	±34.05	75.55	±30.01	.000	4.017	319
	Role-Emotional [b]	61.76	±36.03	75.31	±31.84	.006	2.801	94.95
	Mental Health [b]	54.91	±24.99	61.71	±24.29	.043	2.028	319
DQOL	Satisfaction	52.49	±10.09	54.25	±10.04	.203	1.275	319
	Impact [b]	57.06	±15.67	62.62	±16.45	.013	2.487	319
	Social/ Vocational Worry [b]	9.25	±3.14	9.49	±3.29	.591	0.538	319
	Diabetes Related Worry [b]	2.43	±0.96	2.72	±0.99	.033	2.136	319
	Total Score [b]	302.51	±77.72	326.24	±83.94	.037	2.090	319
Having stroke / mini stroke (TIAs)		**Yes (*n* = 39)**		**No (*n* = 282)**				
SF-36	Physical Functioning	58.97	±26.31	67.18	±26.86	.074	1.793	319
	Role-Physical	60.58	±32.29	70.78	±27.01	.032	2.156	319
	Bodily Pain	53.85	±22.57	64.85	±24.69	.009	2.636	319
	General Health	53.90	±20.92	58.75	±19.67	.153	1.432	319
	Vitality	56.09	±21.39	56.73	±21.18	.861	0.176	319
	Social Functioning [b]	58.77	±35.85	73.82	±30.60	.016	2.499	45.98
	Role-Emotional [b]	61.02	±37.70	74.06	±32.24	.045	2.059	46.01
	Mental Health [b]	54.58	±27.26	61.08	±24.10	.121	1.555	319
DQOL	Satisfaction	53.21	±9.93	53.98	±10.09	.653	0.450	319
	Impact [b]	57.59	±16.95	61.99	±16.31	.117	1.572	319

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

Table 4-8: Relationships between Study-Focused Comorbidities and General Health-Related and Diabetes Specific Quality of Life (continued)

		Mean ± SD		Mean ± SD		*p*-value	*t*-value	*df.*
DQOL	Social/ Vocational Worry [b]	9.09	±3.34	9.49	±3.24	.475	0.715	319
	Diabetes Related Worry [b]	2.38	±0.97	2.70	±0.99	.064	1.862	319
	Total Score [b]	305.81	±88.16	323.43	±82.34	.215	1.242	319
Having renal (kidney) disease		**Yes (*n* = 44)**		**No (*n* = 277)**				
SF36	Physical Functioning	54.89	±26.58	67.98	±26.54	.003	3.039	319
	Role-Physical	59.23	±28.80	71.17	±27.39	.008	2.667	319
	Bodily Pain	51.00	±24.14	65.51	±24.21	.000	3.694	319
	General Health	50.87	±18.69	59.32	±19.82	.009	2.647	319
	Vitality	51.28	±20.47	57.50	±21.19	.070	1.818	319
	Social Functioning [b]	63.10	±32.45	73.41	±31.30	.044	2.019	319
	Role-Emotional [b]	63.05	±34.06	73.98	±32.83	.042	2.040	319
	Mental Health [b]	54.91	±25.68	61.15	±24.31	.118	1.569	319
DQOL	Satisfaction	52.37	±10.83	54.13	±9.93	.281	1.080	319
	Impact [b]	56.98	±15.83	62.17	±16.43	.051	1.958	319
	Social/ Vocational Worry [b]	9.04	±3.41	9.50	±3.23	.384	0.872	319
	Diabetes Related Worry [b]	2.38	±1.02	2.70	±0.98	.043	2.034	319
	Total Score [b]	301.37	±89.82	324.46	±81.74	.087	1.717	319
Having psychological problem		**Yes (*n* = 75)**		**No (*n* = 246)**				
SF-36	Physical Functioning	61.63	±26.65	67.57	±26.86	.094	1.681	319
	Role-Physical	62.50	±29.58	71.68	±27.00	.012	2.520	319
	Bodily Pain	54.11	±29.13	66.39	±22.44	.001	3.360	102.19
	General Health	50.87	±20.07	60.38	±19.29	<.00	3.704	319

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

Table 4-8: Relationships between Study-Focused Comorbidities and General Health-Related and Diabetes Specific Quality of Life (continued)

		Mean ± SD		Mean ± SD		*p*-value	*t*-value	*df.*
SF-36	Vitality	47.25	±19.88	59.51	±20.76	<.001	4.523	319
	Social Functioning [b]	53.50	±33.07	77.64	±28.95	<.001	6.109	319
	Role-Emotional [b]	51.41	±34.19	78.90	±30.10	<.001	6.263	111.23
	Mental Health [b]	43.84	±23.29	65.31	±22.70	<.00	7.128	319
DQOL	Satisfaction	50.02	±9.43	55.07	±9.97	<.001	3.887	319
	Impact [b]	55.78	±16.47	63.19	±16.05	.001	3.480	319
	Social/ Vocational Worry [b]	8.53	±3.19	9.72	±3.23	.005	2.801	319
	Diabetes Related Worry [b]	2.25	±0.91	2.78	±0.98	<.001	4.222	319
	Total Score [b]	284.28	±74.64	332.58	±82.43	<.001	4.538	319
Having high blood pressure		**Yes (*n* = 261)**		**No (*n* = 60)**				
SF36	Physical Functioning	64.58	±26.96	73.19	±25.60	.025	2.253	319
	Role-Physical	68.88	±28.08	72.40	±26.87	.379	0.881	319
	Bodily Pain	62.75	±24.89	66.87	±23.62	.244	1.167	319
	General Health	57.34	±20.06	61.71	±18.70	.123	1.541	319
	Vitality	56.62	±21.12	56.77	±21.57	.961	0.049	319
	Social Functioning [b]	72.03	±31.08	71.85	±34.08	.968	-0.040	319
	Role-Emotional [b]	71.92	±33.15	74.91	±33.39	.530	0.628	319
	Mental Health [b]	59.78	±24.41	62.53	±25.24	.435	0.782	319
DQOL	Satisfaction	53.51	±9.92	55.53	±10.59	.160	1.407	319
	Impact [b]	60.95	±16.50	63.70	±16.03	.243	1.170	319
	Social/ Vocational Worry [b]	9.35	±3.28	9.84	±3.10	.291	1.057	319
	Diabetes Related Worry [b]	2.59	±0.99	2.97	±0.95	.007	2.698	319
	Total Score [b]	317.19	±81.94	339.11	±86.55	.065	1.848	319

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

Table 4-8: Relationships between Study-Focused Comorbidities and General Health-Related and Diabetes Specific Quality of Life (continued)

		Mean ± SD		Mean ± SD		*p*-value	*t*-value	*df.*
Having arthritis or rheumatic disease		**Yes (*n* = 163)**		**No (*n* = 158)**				
SF36	Physical Functioning	59.07	±25.15	73.52	±26.72	.000	4.991	319
	Role-Physical	64.49	±27.30	74.74	±27.53	.001	3.347	319
	Bodily Pain	54.19	±22.68	73.14	±22.94	.000	7.441	319
	General Health	56.60	±19.79	59.77	±19.85	.153	1.434	319
	Vitality	55.78	±21.17	57.55	±21.21	.454	0.749	319
	Social Functioning [b]	67.85	±32.50	76.27	±30.17	.017	2.405	319
	Role-Emotional [b]	68.87	±34.63	76.20	±31.26	.047	1.991	317.40
	Mental Health [b]	59.64	±24.35	60.97	±24.82	.628	0.485	319
DQOL	Satisfaction	53.60	±10.17	54.18	±9.97	.606	0.516	319
	Impact [b]	59.36	±16.47	63.62	±16.14	.020	2.340	319
	Social/ Vocational Worry [b]	9.42	±3.33	9.46	±3.18	.918	0.102	319
	Diabetes Related Worry [b]	2.55	±1.04	2.77	±0.93	.055	1.930	319
	Total Score [b]	314.10	±84.13	328.71	±81.68	.116	1.578	319

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

4.4.2 Research Question # 4:

Is there a relationship between the number of study-specific comorbidities and general health-related and diabetes specific quality of life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia?

The results of the regression analysis for quality of life (SF-36 and DQOL subscale/total) scores based on the number of study-specific comorbidities are summarized in Table 4-9. The number of comorbidities was a statistically significant predictor of subjects' quality of life as measured by both SF-36 and the DQOL subscale/total scores. The number of study-specific comorbidities was significantly negatively related to all quality of life subscale/total scores, except DQOL Satisfaction (*Beta* = -0.140, p = .012) and Social/Vocational Worry (*Beta* = -0.114, p = .042) subscale scores. The higher the number of study-specific comorbidities a subject had, the lower both his/her general health-related and diabetes-specific quality of life. The proportion of the variance in general health-related quality of life (SF-36) explained by the number of study-specific comorbidities adjusted by the effective sample size ($R^2_{(adj.)}$) varied from 3.1% (*Beta* = -0.184, R^2 = 0.034, f^2 = 0.035, 99% CI = -0.005 to 0.073) for the Vitality subscale to 19.9% (*Beta* = -0.449, R^2 = 0.202, f^2 = 0.253, 99% CI = 0.124 to 0.280) for the Bodily Pain subscale. The total number of study-specific comorbidities explained less of the variance in diabetes-specific quality of life (measured by the DQOL) than in general HRQoL. The proportion of variance explained varied from 1.0% for the Social/Vocational Worry subscale (*Beta* = -0.114, R^2 = 0.013, f^2 = 0.013, 99% CI = -0.011 to 0.037) to 5.7% for the Impact subscale (*Beta* = -0.238, R^2 = 0.057, f^2 = 0.060, 99% CI = 0.008 to 0.106).

Table 4-9: The Relationships between the Number of Study-Focused Comorbidities and Quality of Life Scores (SF-36 and DQOL)

	Dependent Variable	Standardized Coefficient (Beta)	*t*-value	*p*-value	R^2	$R^2_{(adjusted)}$	Effect Size (f^2)	99% CI of f^2
SF-36	Physical Functioning	-0.324	-6.121	< .001	0.105	0.102	0.117	0.0220 to 0.1880
	Role-Physical	-0.323	-6.102	< .001	0.105	0.102	0.117	0.0220 to 0.1880
	Bodily Pain	-0.449	-8.981	< .001	0.202	0.199	0.253	0.0994 to 0.3046
	General Health	-0.252	-4.660	< .001	0.064	0.061	0.068	-0.0038 to 0.1318
	Vitality	-0.184	-3.351	.001	0.034	0.031	0.035	-0.0170 to 0.0850
	Social Functioning [b]	-0.319	-6.014	< .001	0.102	0.099	0.114	0.0199 to 0.1841
	Role-Emotional [b]	-0.295	-5.509	< .001	0.087	0.084	0.095	0.0099 to 0.1641
	Mental Health [b]	-0.226	-4.152	< .001	0.051	0.048	0.054	-0.0103 to 0.1123
DQOL	Satisfaction	-0.140	-2.533	.012	0.020	0.017	0.020	-0.0197 to 0.0597
	Impact [b]	-0.238	-4.376	< .001	0.057	0.054	0.060	-0.0074 to 0.1214
	Social/Vocational Worry [b]	-0.114	-2.044	.042	0.013	0.010	0.013	-0.0192 to 0.0452
	Diabetes Related Worry [b]	-0.245	-4.507	< .001	0.060	0.057	0.064	-0.0059 to 0.1259
	Total [b]	-0.227	-4.169	< .001	0.052	0.049	0.055	-0.0099 to 0.1139

Note: Transformation method:
a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score
f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

4.5 SPECIFIC AIM # 4

TO TEST THE REVISED WILSON AND CLEARLY CONCEPTUAL MODEL IN THE TYPE-2 DIABETES POPULATION

4.5.1 Research Question # 5:

Does the seven-factor measurement model fit the data?

There were a total of 20 observed variables collected from 9 questionnaires as well as the six-minute walk distance and selected variables from the laboratory assay data to be loaded onto 7 latent variables of the revised Wilson and Cleary conceptual model. The correlation matrix for the 20 measured variables is presented in Table 4-10.

The unidimensional seven-factor measurement model of the tested hypothesized model is depicted in Figure 4-2. The model was over-identified with df = 149. Confirmatory factor analysis (CFA) resulted in a converged but not an admissible solution. The result of the ML-estimated chi-square ($\chi^2_M(149) = 504.938$, $p < .001$), and the bootstrap on 250 samples using ML estimation (Bollen-Stine corrected p = .004) were consistent, indicating rejection of goodness of fit at the $p < .05$ significant level. The value of selected fit indices indicated poor overall fit of the model: *CMIN/DF* = 3.389, CFI = 0.822, SRMR = 0.0776 and RMSEA = 0.087 with a 90% confidence interval of 0.078 to 0.095.

Table 4-10: Correlation matrix, means and standard deviations of 20 observed variables for proposed model (n = 320)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Overall Quality of Life																				
1. SF-36: Feeling Full of Life [a]	-																			
2. DQOL: Overall Satisfaction with Life [c]	-.566	-																		
General Health Perceptions																				
3. SF-36: General Health	.552	-.529	-																	
4. DQOL: Impact [b]	.433	-.427	.501	-																
Functional Status																				
5. SF-36: Physical Functioning	.414	-.260	.436	.405	-															
6. 6-Minute Walk Distance	.243	-.094*	.220	.133*	.620	-														
7. SF-36: Role Functioning [i]	.594	-.418	.496	.459	.696	.438	-													
8. SF-36: Social Functioning [b]	.528	-.471	.436	.437	.448	.275	.649	-												
Symptom Status																				
9. Beck Depression Index – II Score [d]	-.512	.471	-.454	-.455	-.432	-.289	-.581	-.559	-											
10. State Anxiety Score [d]	-.573	.593	-.432	-.491	-.269	-.115*	-.478	-.532	.586	-										
11. Study-focused Symptom Score [d]	-.328	.280	-.429	-.370	-.341	-.194	-.410	-.370	.435	.298	-									
Biological and Physiological Factors																				
12. HbA1c [e]	.166	-.105*	.176	.116*	-.044*	.012*	.039*	.005*	-.170	-.158	-.094*	-								
13. HDL to CHOL Ratio [g]	-.045*	.030*	-.009*	-.015	.033*	-.029*	.028*	-.042*	.023*	.074*	-.035*	.117*	-							
14. Insulin Level [f]	-.087*	.091*	-.184	-.147	-.110*	-.055*	-.060*	-.095*	.143*	.064*	.084*	-.131*	-.061*	-						
Characteristics of the Individual																				
15. Age	.111*	-.264	.237	.149	-.139*	-.181	-.110*	.105*	-.080*	-.137*	-.035*	.118*	.020*	-.221	-					
16. Years of Formal Education [e]	-.077*	.022*	-.054*	-.069	-.134	-.078*	-.083*	.011*	.129*	.067*	.111*	-.055*	.019*	.039*	.040*	-				
17. Duration of Diabetes [f]	-.036*	.021*	-.073*	-.035	-.181	-.200	-.122*	-.124*	.086*	.016*	.103*	-.207	-.002*	-.096*	.173	.003*	-			
Characteristics of the Environment																				
18. ISEL: Tangible [b]	.279	-.385	.261	.354	.193	.066*	.286	.277	-.353	-.384	-.215	.013*	-.011*	-.054*	.061*	-.092*	-.071*	-		
19. Gross Household Income	.214	-.080*	.083*	.164	.319	.222	.319	.172	-.176	-.183	-.145	-.070*	-.028*	.079*	-.140*	-.343	-.021*	.127*	-	
20. Number of Adults in Household [f]	.036*	.069*	-.020*	.002*	.046*	.146	.016*	.042*	.040*	-.014*	-.026*	-.041*	-.089*	.147	-.166	.008*	-.056*	.016*	.345	-
Mean ± SD	12.49 ± 6.116	0.28 ± 0.217	58.07 ± 19.820	61.54 ± 16.389	66.08 ± 26.862	128.97 ± 76.037	72.18 ± 31.491	61.46 ± 31.420	2.49 ± 1.224	5.77 ± 1.024	1.39 ± 0.802	1.39 ± 0.218	5.10 ± 0.673	1.14 ± 0.306	64.57 ± 10.412	0.71 ± 0.127	0.91 ± 0.312	5.92 ± 2.311	2.24 ± 0.626	0.26 ± 0.188

Note: ***** Correlations not significant at $p < .01$ level.

Transformation method: a. = Score ^{2} b. = Score ^{2} / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score ^{2} / 10000 i. = Score ^{2} / 200

The correlations of residuals were examined after evaluation of the model fit. Sizable residuals were detected between (1) gross household income and the number of adults living in household with a value of 4.9, (2) gross household income and years of formal education with a value of -6.1, (3) duration of diabetes and six-minute walk distance with a value of -3.4, (4) duration of diabetes and the SF-36 Physical Functioning subscale with a value of -3.0, (5) duration of diabetes and HbA1c with a value of -4.2, (6) the SF-36 Physical Functioning subscale and six-minute walk distance with a value of 4.0, (7) the SF-36 Physical Functioning subscale and Spielberger state anxiety score with a value of 2.8, (8) six-minute walk distance and the Spielberger state anxiety score with a value of 3.1, (9) six-minute walk distance and DQOL item 15A (overall satisfaction with life) with a value of 3.1, (10) age and the number of adults living in household with a value of -3.3, and (11) age and the SF-36 Social Functioning subscale with a value of 3.2. These large residuals indicated that the model did not adequately estimate the relationships between these variables, and that each pair of the indicators may covary. Table 4-11 summarized the modifications made in an attempt to improve model fit and the resultant changes in the fit statistics.

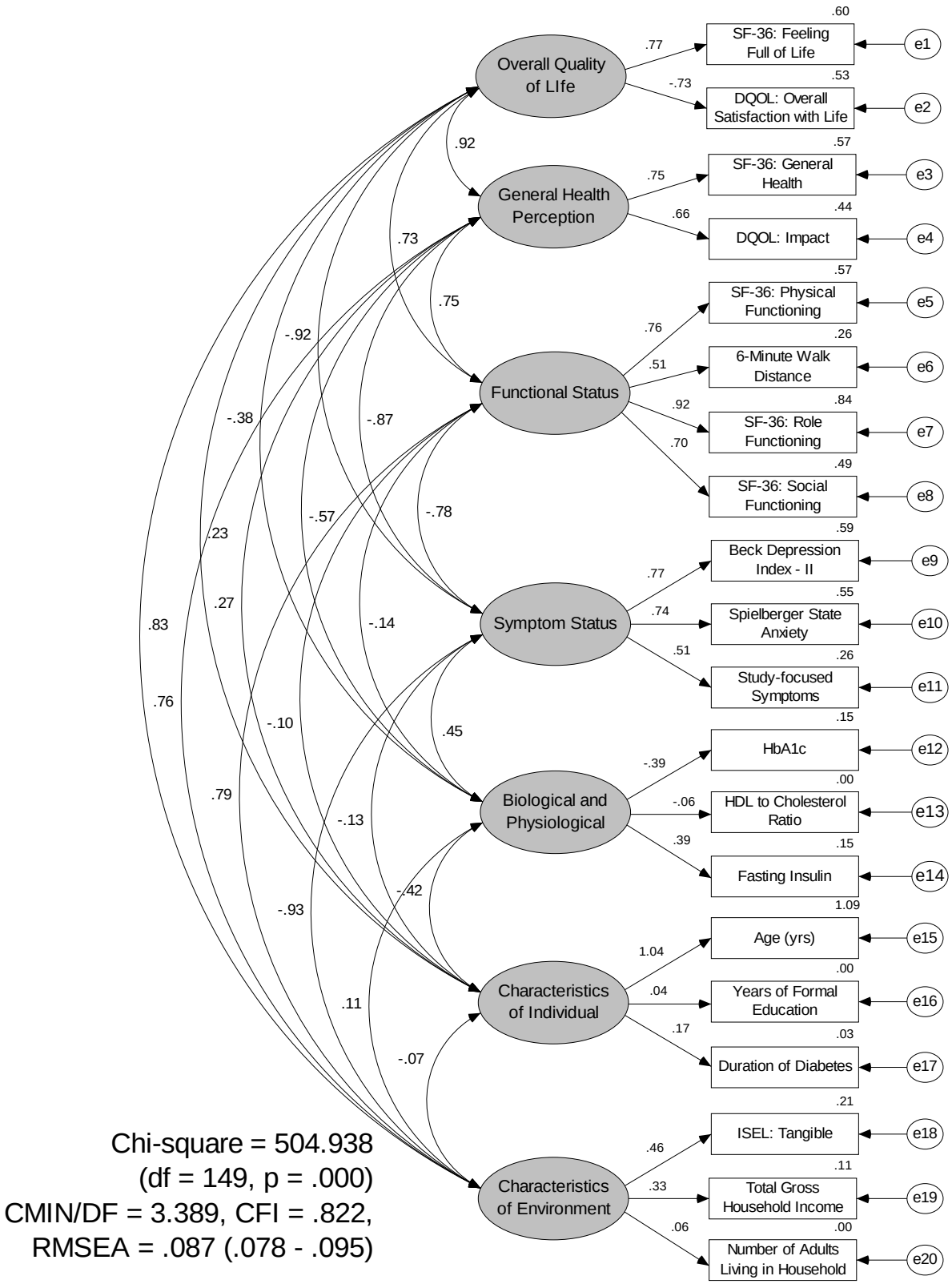

Figure 4-2: CFA Results for the Seven-Factor Measurement Model

Table 4-11: Model Modification Summary

Model	Admissible	Model Fit χ^2 (*p*-value)	χ^2/df	CFI	RMSEA	SRMR
1. Seven Factor CFA, 20 variables	No	504.938 (< .001)	3.389	0.822	0.087	0.0776
2. Added Path e5 (SF-36: Physical Functioning) to e6 (Six-minute Walk Distance)	No	431.756 (< .001)	2.917	0.858	0.078	0.0741
3. Added Path e16 (Years of Formal Education) to e19 (Total Gross Household Income)	No	395.849 (< .001)	2.693	0.876	0.073	0.0701
4. Added Path e19 (Total Gross Household Income) to e20 (Number of Adults Living in Household)	No	359.920 (< .001)	2.465	0.893	0.068	0.0670
5. Added Path e12 (HbA1c) to e17 (Duration of Diabetes)	No	340.768 (< .001)	2.341	0.902	0.065	0.0656
6. Added Path e8 (SF-36: Social Functioning) to e15 (Age)	No	325.104 (< .001)	2.258	0.910	0.063	0.0637
7. Dropped Number of Adults Living in Household	No	294.770 (< .001)	2.321	0.914	0.064	0.0627
8. Dropped Years of Formal Education	No	278.777 (< .001)	2.512	0.913	0.069	0.0615
9. Dropped HDL to Total Cholesterol Ratio	No	264.161 (< .001)	2.781	0.912	0.075	0.0631
10. Replaced Household Income with ISEL: Belonging subscale	Yes	242.204 (< .001)	2.550	0.934	0.070	0.0583
11. Added Path e2 (DQOL: Overall Satisfaction with Live) to e10 (Spielberger State Anxiety)	Yes	224.677 (< .001)	2.390	0.941	0.066	0.0575
12. Added Path e5 (SF-36: Physical Functioning) to e7 (SF-36: Role Functioning)	Yes	206.346 (< .001)	2.219	0.949	0.062	0.0546
13. Added Path e3 (SF-36: General Health) to e11 (Study-focused Symptoms)	Yes	196.921 (< .001)	2.140	0.953	0.060	0.0542
14. Re-specified into Revised Wilson and Cleary Model	Yes	203.986 (< .001)	2.081	0.952	0.058	0.0549

Note: e = residual covariance

In an attempt to obtain an admissible solution and improve the fit of the seven-factor measurement model, post-hoc model modifications were explored. The modification index (MI) results suggested that adding a path between the residual covariances of the SF-36 Physical Functioning (e5) and 6-minute walk distance (e6), which was fixed to zero, would significantly improve the model and lead to an approximate drop in model chi-square of 66.641. This was a reasonable parameter to add since both of the scales are measures of physical functioning. Thus, one would expect them to be correlated. The model was re-tested with this additional path. The results (see step 2 in Table 4-11) indicated that the overall fit of the model was improved but the solution was still not admissible. The chi-square difference test results indicated that the fit of the modified model was significantly improved from the original unconstrained 7-factor Confirmatory Factor Analysis (CFA) model ($\chi^2_D(1) = 504.938 - 431.756 = 73.175, p < .001$).

The model was then re-specified so that the error terms of the years of formal education and gross household income were correlated. The LM test indicated that by adding a path between their residual covariances (e16 and e19), the model was significantly improved with an approximate drop in model chi-square of 33.098. This was also a reasonable parameter to add since people with higher years of education tend to have higher income. The results indicated that the overall fit of the model was improved but the solution was still not admissible (see step 3 in Table 4-11). The modified model was significantly improved from the previous model ($\chi^2_D(1) = 431.756 - 395.849 = 35.907, p < .001$).

The model was next re-specified so that the error terms of the gross household income and number of adults living in household were correlated. The LM test indicated that by dropping the constraint that the correlation of their error terms (e19 and e20) be zero, the model was significantly improved with an approximate drop in model chi-square of 33.260. This was

also a reasonable parameter to add since more adults in the household generally means more sources of income. The results (see step 4 in Table 4-11) indicated that the overall fit of the model was improved but the solution was still not admissible. The model was statistically significantly improved from the previous model ($\chi^2_D(1) = 395.849 - 359.920 = 35.929$, $p < .001$).

In the next step, the model was re-specified so that the error terms of the HbA1c values and the duration of diabetes were correlated. The LM test indicated that by adding path between their residual covariances (e12 and e17), the model was significantly improved with an approximate drop in model chi-square of 14.677. This was also a reasonable parameter to add since HbA1c is an indicator of how well patients manage their diabetes overtime and there may be a relationship between the duration of diabetes and how well individuals manage their disease. The results (see step 5 in Table 4-11) indicated that the overall fit of the model was improved but the solution was still not admissible. The model demonstrated a significant improvement in fit relative to the previous model ($\chi^2_D(1) = 359.920 - 340.768 = 19.152$, $p < .001$).

Next the model was re-specified so that the error terms of the SF-36 Social Functioning and age were correlated. The LM test indicated that by adding path between their residual covariances (e8 and e15), the model was significantly improved with an approximate drop in model chi-square of 13.232. The results (see step 6 in Table 4-11) indicated that the overall fit of the model was improved, but the solution was still not admissible. The model was statistically improved relative to the previous model ($\chi^2_D(1) = 340.768 - 325.104 = 15.664$, $p < .001$).

Since an admissible solution could not be obtained from the proposed measurement model, it was concluded that the seven-factor measurement model with 20 measured variables did not fit the data. This suggested either that the model was wrong or that the sample was too

small. Based on the rule of thumb that 20 subjects per a measured variable is preferable (Kline, 2005), the appropriate sample size for the current measurement model was 400 subjects. Since this was a secondary data analysis, the sample size was fixed at 320 subjects.

In an attempt to obtain admissible solution, variables that explained almost none of the variance in their respective factors (R^2 close to zero) were deleted one by one. First, the number of adults living in the household ($R^2 = 0.00$) was dropped as a characteristics of the environment. Although the fit statistics improved, the revised measurement model remained inadmissible. Next, years of formal education ($R^2 = 0.01$) was dropped as a characteristics of the environment. The model remained inadmissible. Then HDL to total cholesterol ratio ($R^2 = 0.01$) was dropped as a measure of biological and physiological factors. The model remained inadmissible. Finally, gross household income ($R^2 = 0.09$) was dropped as a characteristic on the environment and replaced with the ISEL Belonging subscale score. At this point the solution became admissible (see step 10 in Table 4-11).

In an attempt to improve the fit of the seven-factor measurement model, post-hoc model modifications were explored. The modification index (MI) results suggested that adding a path between residual covariances of DQOL overall satisfaction with life (e2) and Spielberger state anxiety (e10), which was fixed to zero, would significantly improve the model and lead to an approximate drop in model chi-square of 14.223. It is reasonable to expect that higher levels of anxiety would affect overall satisfaction with life. Therefore, these scores were allowed to covary. The model was re-tested with this additional path. The results (see step 11 in Table 4-11) indicated that the overall fit of the model was improved. The chi-square difference test result indicated that the fit of the modified model was significantly improved from the previous model ($\chi^2_D(1) = 242.204 - 224.677 = 17.537, p < .001$).

Next the model was re-specified to add a pathway between the error terms of SF-36 Physical Functioning (e5) and SF-36 Role Functioning (e7). Adding this pathway significantly improved the model and lead to an approximate drop in model chi-square of 7.326. The SF-36 Role Functioning subscale was formed by combining the scores on the SF-36 Role-Physical and Role-Emotional subscales. One would expect limitations in physical functioning to be related to performance of daily activities and, thus, to the score on the Role Functioning subscale. Consequently, this was a reasonable parameter to add to the model. The model was re-tested with this additional path. The results (see step 12 in Table 4-11) indicated that the overall fit of the model was improved. The chi-square difference test result indicated that the fit of the modified model was significantly improved from the unconstrained previous model ($\chi^2_D(1) =$ 224.667 – 206.346 = 18.321, $p < .001$).

The model was then re-specified so that the error terms of the SF-36 General Health and study focused symptoms scores were correlated. The LM test indicated that by adding path between their residual covariances (e3 and e11), the model was significantly improved with an approximate drop in model chi-square of 8.846. This was also a reasonable parameter to add since how people perceive their health in general often influenced by their symptoms status. The results (step 13 in Table 4-11) indicated that the overall fit of the model was improved, and the model was significantly improved from the previous model: $\chi^2_D(1) = 206.346 – 196.921 = 9.425$, $p = .002$.

No further model modification was conducted. The final good-fit seven-factor measurement model ($\chi^2_M(92) = 196.921$, $p < .001$, *CMIN/DF* = 2.140, CFI = 0.953, SRMR = 0.0542 and RMSEA = 0.060 with the 90% confidence interval 0.048 to 0.071) is illustrated in Figure 4-3. The standardized solutions suggested a reasonable convergent validity among the

indicators of each factor. All indicators' loadings were significant at a $p < .01$ level. The absolute standardized regression loadings varied from 0.225 (duration of diabetes ← characteristics of the individual) to 0.943 (ISEL belonging subscale ← characteristics of the environment). The estimated factor correlations suggested good discriminant validity. The correlations ranged from -0.876 (overall quality of life and symptom status) to 0.941 (overall quality of life and general health perceptions). Four of them were not significantly different from zero at a $p < .05$ level (two-tailed): (1) functional status and biological & physiological factors ($r = -0.118$, $p = .345$), (2) characteristics of the individual and symptom status ($r = -0.111$, $p = .203$), (3) characteristics of the individual and characteristics of the environment ($r = 0.087$, $p = .268$), and (4) biological & physiological factors and characteristics of the environment ($r = -0.122$, $p = .300$). The range of estimated measurement error correlations varied from -0.277 between HbA1c values and years since diabetes was diagnosed (e12 ↔ e17) to 0.477 between the SF-36 Social Functioning subscale score and age (e8 ↔ e15). Table 4-12 summarizes the model concepts with revised corresponding study variables and sources. There were a total of 17 measured variables loaded into seven latent variables. The correlation matrix for those variables is presented in Table 4-13.

Table 4-12: Summary of Revised Latent Variables, Measured Variables and Instruments

Model Concepts	Study Variables	Sources
Overall Quality of Life	Full of Life	SF-36: Item# 9A
	Satisfied with Life	DQOL: Item# 15A
General Health Perceptions	General Health	SF-36: General Health subscale
	Diabetes-related Health	DQOL: Impact subscale
Functional Status	Physical Function	SF-36: Physical Function subscale
		6-Minute Walk Distance
	Role Function	SF-36: Role-Physical & Role-Emotional subscale
	Social Function	SF-36: Social Function subscale
Symptom Status	Weighted Physical Symptoms	CRCD Comorbidity Questionnaire: Symptom check list
	Depression	Beck Depression Inventory-II
	Anxiety	Spielberger State-Trait Anxiety Inventory: State anxiety
Biological & Physiological	Diabetes Management	Lab Values: HbA1c
		Lab Values: Insulin level
Characteristics of the Individual	Age	SDM: Age
	Duration of Diabetes	SDQ: Item# 11
Characteristics of the Environment	Perception in availability of material aid	ISEL: Tangible subscale
	Perception in availability of people one can do things with	ISEL: Belonging subscale

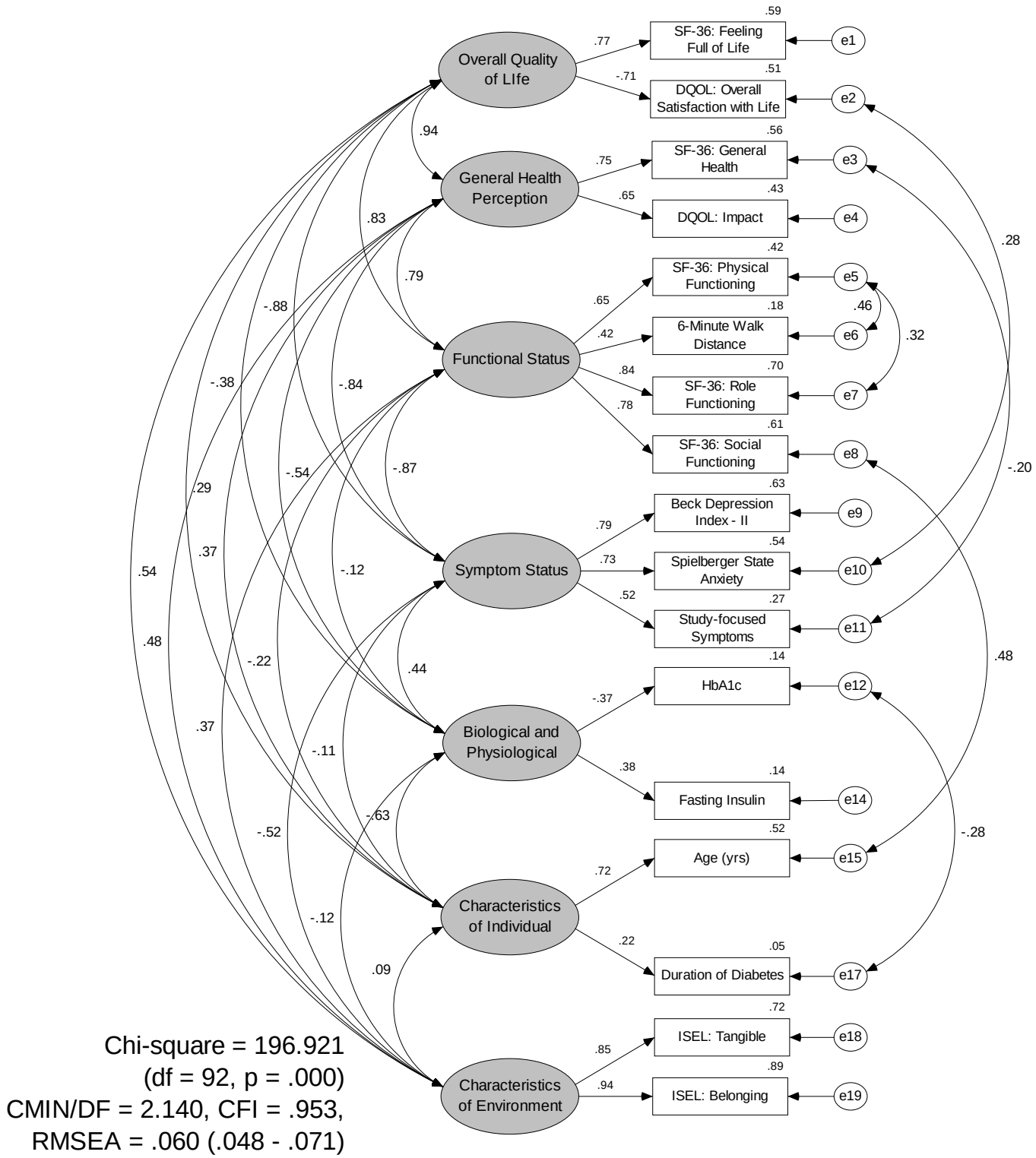

Figure 4-3: The CFA Result of the Final Seven-Factor Measurement Model with 17 Observed Variables and Post-hoc Modifications

Table 4-13: Correlation Matrix for the 17 Observed Variables of the Proposed Structural Equation Model (n = 320)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Overall Quality of Life																	
1. SF-36: Feeling full of life [a]	-																
2. DQOL: Overall satisfaction with life [c]	-.566	-															
General Health Perceptions																	
3. SF-36: General Health	.552	-.529	-														
4. DQOL: Impact [b]	.433	-.427	.501	-													
Functional Status																	
5. SF-36: Physical Functioning	.414	-.260	.436	.405	-												
6. 6-Minute Walk Distance	.243	-.094*	.220	.133*	.620	-											
7. SF-36: Role Functioning [i]	.594	-.418	.496	.459	.696	.438	-										
8. SF-36: Social Functioning [b]	.528	-.471	.436	.437	.448	.275	.649	-									
Symptom Status																	
9. Beck Depression Index – II Score [d]	-.512	.471	-.454	-.455	-.432	-.289	-.581	-.559	-								
10. State Anxiety Score [d]	-.573	.593	-.432	-.491	-.269	-.115*	-.478	-.532	.586	-							
11. Study-focused Symptom Score [d]	-.328	.280	-.429	-.370	-.341	-.194	-.410	-.370	.435	.298	-						
Biological and Physiological Factors																	
12. HbA1c [e]	.166	-.105*	.176	.116*	-.044*	.012*	.039*	.005*	-.170	-.158	-.094*	-					
13. Insulin Level [f]	-.087*	.091*	-.184	-.147	-.110*	-.055*	-.060*	-.095*	.143*	.064*	.084*	-.131*	-				
Characteristics of the Individual																	
14. Age	.111*	-.264	.237	.149	-.139*	-.181	-.110*	.105*	-.080*	-.137*	-.035*	.118*	-.221	-			
15. Duration of Diabetes [f]	-.036*	.021*	-.073*	-.035*	-.181	-.200	-.122*	-.124*	.086*	.016*	.103*	-.207	-.096*	.173	-		
Characteristics of the Environment																	
16. ISEL: Tangible [b]	.279	-.385	.261	.354	.193	.066*	.286	.277	-.353	-.384	-.215	.013*	-.054*	.061*	-.071*	-	
17. ISEL: Belonging [b]	.352	-.446	.316	.318	.214	.059*	.304	.259	-.366	-.396	-.221	.069*	-.051*	.070*	-.056*	.802	-
Mean ± SD	12.49 ± 6.116	0.28 ± 0.217	58.07 ± 19.820	61.54 ± 16.389	66.08 ± 26.862	128.97 ± 76.037	61.46 ± 31.420	72.18 ± 31.491	2.49 ± 1.224	5.77 ± 1.024	1.39 ± 0.802	1.39 ± 0.218	1.14 ± 0.306	64.57 ± 10.412	0.91 ± 0.312	5.92 ± 2.311	5.44 ± 2.329

Note: ***** Correlations not significant at $p < .01$ level.

Transformation method: a. = Score^2 b. = Score^2 / 100 c. = log (6 – Score) d. = $\sqrt{\text{Score}}$ e. = 10 / Score

f. = log (score) g. = $\sqrt{\text{Score x 100}}$ h. = Score^2 / 10000 i. = Score^2 / 200

4.5.2 Research Question # 6:

To what extent is the revised Wilson and Cleary conceptual model of health-related quality of life consistent with data collected from individuals with type-2 diabetes and hypertension and/or hyperlipidemia?

With an adequate measurement model, the second stage of two-step modeling was conducted. The reasonably good-fitting seven-factor model was re-specified into the revised Wilson and Cleary Conceptual model. The model was over-identified with 98 degree of freedom. The standardized ML test resulted in an admissible solution with an overall adequate fit model (see step 14 in Table 4-11).

The bootstrap on 250 samples using ML estimation (Bollen-Stine corrected p = .004) was consistent with the chi-square test result, which still resulted in rejecting the fit of the model at the p < .05 significant level. However, it is known that chi-square related tests are not reliable when the sample size is large (Kline, 2005). Despite rejection of the model fit based on the chi-square test, the other selected fit indices suggested that the data fit the model adequately: *CMIN/DF* = 2.081 (< 3.0), CFI = 0.952 (> 0.950), SRMR = 0.0549 (< 0.05) and RMSEA = 0.058 (< 0.08) with the 90% confidence interval of 0.047 to 0.069.

These results are virtually identical to those reported for the modified seven-factor CFA measurement model: $\chi^2_D(6) = 203.986 - 196.921 = 7.065$, p = .315. The standardized solution results of the tested model were also consistent with those of the previous measurement model. All indicators' loadings were significant at p < .001 level except the duration of diabetes as a characteristics of the individual (p = .002).

The absolute regression loadings varied from 0.232 (duration of diabetes ← characteristics of individual) to 0.946 (ISEL belonging ← characteristics of environment). The range of estimated measurement error correlations were between -0.277 (e12 ↔ e17: HbA1c and duration of diabetes) to 0.446 (e8 ↔ e15: SF-36 Social Functioning subscale score and age). The correlations between the exogenous variables, characteristics of the individual and characteristics of the environment ($r = 0.069$, $p = .383$) were not significantly different from zero at the 0.05 level (two-tailed).

For the main structural path of the Revised Wilson and Cleary conceptual model from biological and physiological factors → symptom status → functional status → general health perceptions → overall quality of life, the estimates of the direct effects for each path were statistically significant except that of the first one (biological and physiological factors → symptom status, $r = 0.631$, $p = .246$). These results indicate that (1) biological and physiological factors was not a strong predictor of symptom status (when biological and physiological factors score went up by one standard deviation, symptom status score went up only by 0.631 standard deviations), (2) symptom status was strongly predictive of less functional status (when symptom status score went up by one standard deviation, functional status score went down by 0.928 standard deviations), (3) functional status was strongly predictive of better general health perceptions (when functional status score went up by one standard deviation, general health perceptions score went up by 0.882 standard deviations) , and (4) general health perceptions was strongly predictive of better overall quality of life (when general health perceptions score went up by one standard deviation, overall quality of life score went up by 0.961 standard deviations).

The estimated direct effects of characteristics of individual were statistically significant on biological and physiological factors (standardized coefficient = -0.703, $p < .001$), functional

status (standardized coefficient = -0.316, $p < .001$) and general health perceptions (standardized coefficient = 0.571, $p < .001$) but not on the symptom status (standardized coefficient = 0.376, $p = .366$) or overall quality of life (standardized coefficient = -0.115, $p = .111$). The estimated direct effect of characteristics of environment was significant only on symptom status (standardized coefficient = -0.469, $p < .001$) but not on biological and physiological factors (standardized coefficient = -0.059, $p = .627$), functional status (standardized coefficient = -0.078, $p = .242$), general health perceptions (standardized coefficient = 0.114, $p = .106$) or overall quality of life (standardized coefficient = 0.090, $p = .191$).

Individual and environment characteristics explained 50.3% of the variance of biological and physiological factors (R^2 =0.503, 95% CI = 0.427 to 0.580). The predictors of symptom status explained 46.3% of its variance (R^2 =0.463, 95% CI = 0.384 to 0.542). In other words, the error variance of symptom status was 53.7% of its variance. The percentages of variance explained by the predictors were relatively high for functional status (R^2 = 0.836, 95% CI = 0.804 to 0.868), general health perceptions (R^2 = 0.973, 95% CI = 0.967 to 0.979) and overall quality of life (R^2 = 0.946, 95% CI = 0.935 to 0.957).

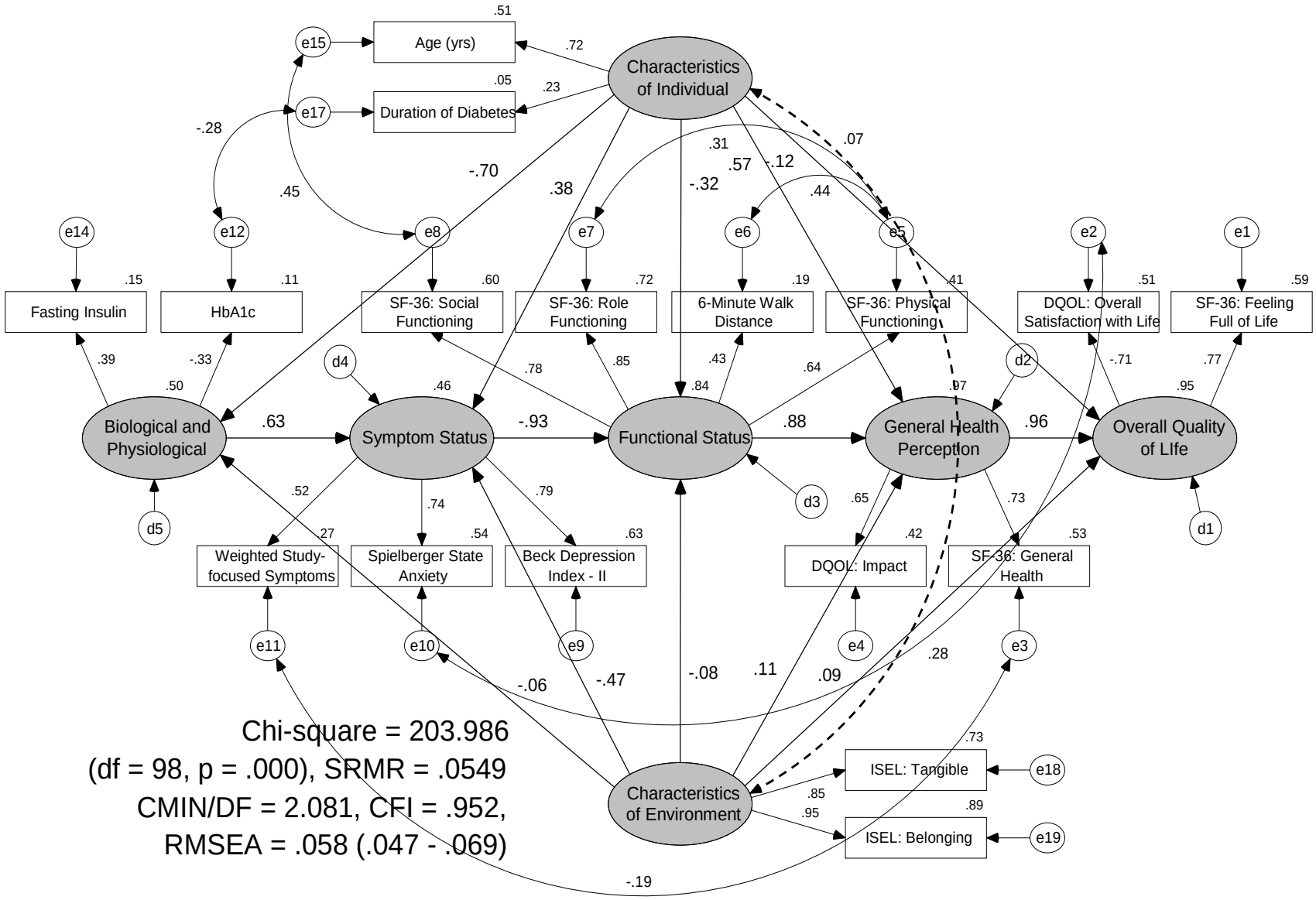

Figure 4-4: The Final SEM Results of the Revised Wilson and Cleary Conceptual Model

4.5.3 Research Question # 7:

Is there a significant relationship between Characteristics of the Individual and Characteristics of the Environment?

After the admissible solution was obtained, the associations between the exogenous factors, characteristics of the individual and characteristics of the environment, were examined. The results indicated that the latent variables of characteristics of the individual and the characteristics of the environment were not significantly correlated ($r = 0.069$, $p = .383$).

5.0 DISCUSSION AND IMPLICATIONS

This study set out to understand health related quality of life among individuals with type-2 diabetes and hypertension and/or hyperlipidemia. This final chapter presents the discussion related to each specific aim and its research questions. The implications and recommendations for future research follow the discussion.

5.1 SPECIFIC AIM #1

TO EXAMINE THE RELATIONSHIPS BETWEEN DEMOGRAPHIC CHARACTERISTICS AND BOTH GENERAL HEALTH RELATED AND DIABETES SPECIFIC QUALITY OF LIFE IN INDIVIDUALS WITH TYPE-2 DIABETES AND HYPERTENSION AND/OR HYPERLIPIDEMIA

Age, gender and marital status have been identified as predictors of HRQoL (Glasgow et al., 1997). The current study examined the relationship between selected demographic variables and general health-related quality of life (measured by the SF-36) and diabetes-specific quality of life (measured by the DQOL). Theoretically, disease-specific quality of life measures should be less responsive to demographic factors than general health-related measures. Disease-specific

measures are designed to assess the variables that are disease and treatment related in order to evaluate how different aspects of the illness affect patients' perceived quality of life.

In the current study, male subjects reported significantly higher scores than their female counterparts on three of the SF-36 subscales: the Physical Functioning, Bodily Pain and Role-Emotional subscales. There were no gender-related differences in the DQOL total and subscale scores. As anticipated, the general health-related measure (SF-36) was more sensitive to gender differences among type-2 diabetes than the diabetes specific measure (DQOL). Similar findings were reported by Shobhana and colleagues (2003) who investigated general health-related (psychological well-being scale) and diabetes specific (Diabetes Integration Scale) quality of life in individuals with type-2 diabetes. They found that there were gender differences in the general health-related quality of life measure with men scoring better in all the domains of psychological well-being than female subjects. No gender-related differences were found in diabetes-specific quality of life as measured by the Diabetes Integration Scale.

Older age is often associated with lower HRQoL due to the physical limitations and limited ability to engage in leisure-time activities (Mayou et al., 1990). In the current study being older was a significant predictor of lower Role-Physical subscale scores but higher General and Mental Health subscale scores on the SF-36 and higher Satisfaction, Social/Vocational Worry and Diabetes Related Worry subscale scores on the DQOL as well as higher DQOL total scores. One possible explanation is that older adults are more accustomed to the limited physical functioning and view declining physical abilities as part of the normal aging process. Quality of life is a dynamic construct and individuals' attitudes can vary with time and experience and be modified by psychological phenomena such as adaptation. As people age they may redefine their internal standards of what constitutes health and change their conceptualization of quality

of life (Schwartz, Sprangers, Carey, & Reed, 2004). This response shift may cause them to lower their expectations about what constitutes a good quality of life as compared to younger people, which results in better self-reported general and mental health (Camacho et al., 2002). Previous studies reported that older age was associated with lower physical related scores but higher scores on other subscales of the SF-36 (Camacho et al., 2002; Rejeski et al., 2006). Paschalides and colleagues (2004) found that older age was negatively associated with SF-36 Physical Component subscale scores in patients with type-2 diabetes.

Subjects who were currently married or living with partner/significant other reported significantly higher scores on the SF-36 Physical Functioning and Role-Emotional subscales than other groups. There were no significant differences on the remaining subscales of SF-36 or in DQOL total or subscales scores based on marital status. Jacobson and colleagues (1994) reported that marital status was the primary factor that influenced both SF-36 and DQOL scores of subjects with both type-1 and type-2 diabetes. Individuals who were married or single generally experienced better quality of life than those who were divorced or separated.

Educational level was not significantly related to either general health-related or disease specific quality of life. This is consistent with Jacobson and colleagues' (1994) findings that neither SF-36 and DQOL scores were influenced by level of education. This finding was also consistent with a previous study that reported there were no significant relationships between educational level and DQOL subscale or total scores (Parkerson et al., 1993). In contrast, Rejeski and colleagues (2006) reported that higher education was associated with higher HRQoL as measured by the physical component subscale of SF-36. Additionally, Glasgow et al. reported that lower education levels were associated with lower general health-related quality of life in a sample of patients with diabetes (Glasgow et al., 1997).

Subjects with lower annual income levels reported significantly lower scores on all SF-36 subscales except the General Health subscale than people with higher annually incomes. They also reported lower scores on the Impact subscale of the DQOL. Glasgow and colleagues also found subjects with lower household incomes had significantly lower physical, social, mental and general health quality of life sores compared to those with higher incomes.

There were no relationships between the number of adults presently living in the household and DQOL subscale or total scores. However, subjects who reported living with one additional adult in their household reported significantly higher score on the Role-Emotional subscale of the SF-36 than those living alone. These findings were supported by two other studies that reported that living alone had a negative effect on HRQoL (Glasgow et al., 1997; Hanestad, 1993).

In the current study there were more significant relationships between sociodemographic characteristics and general HRQoL than with diabetes-specific quality of life. All of the demographic characteristics examined were significantly related to one or more of the SF-36 subscale scores except years of education. In contrast, only age and annual income were significantly related to DQOL scores.

5.2 SPECIFIC AIM #2

TO EVALUATE THE RELATIONSHIPS BETWEEN GENERAL HEALTH RELATED AND DIABETES SPECIFIC QUALITY OF LIFE IN INDIVIDUALS WITH TYPE-2 DIABETES AND HYPERTENSION AND/OR HYPERLIPIDEMIA.

It is increasingly recognized that the measurement of medical outcomes should include an assessment of patients' quality of life rather than the mere presence or absence of disease (Watkins & Connell, 2004). There are two major types of measures used to assess the quality of life in health care research, general health-related and the disease-specific measures. In this study, the SF-36 was used to measure general HRQoL while the DQOL was used as the diabetes specific measure. These two measures assess HRQoL from diverse but complimentary perspectives (Jacobson et al., 1994). The SF-36 measures HRQoL as patients' perception of their health status in board areas of physical, psychological and social functioning while the DQOL assesses patients' HRQoL through their diabetic experience.

In the current study, estimates of internal consistency (Cronbach's alpha) ranged from 0.735 to 0.911 for the DQOL and from 0.776 to 0.934 for the SF-36 subscales. These values were similar to published findings from previous research on these two measures (DCCT Research Group, 1988; Jacobson et al., 1994; McHorney et al., 1994). All except one of the correlations between the two measures were significant at a $p < .01$ level, and they ranged from 0.132 to 0.615. No negative correlation was found. The Satisfaction and Impact subscales of DQOL had stronger relationships with the SF-36 subscales than those of the Social/Vocational Worry and Diabetes Worry subscales. Most of the correlations remained significant even after controlling for the effects of the number of study-focused comorbidities. This suggests that almost all domains addressed by the SF-36 and DQOL overlapped with each other to a minimum to moderate degree. This is consistent with Jacobson et al. (1994) who also reported positive correlations between all SF-36 subscale and DQOL total and subscale scores except SF-36 Bodily Pain and DQOL Social Worry ($r = -.003$).

5.3 SPECIFIC AIM #3

TO EXAMINE THE ASSOCIATIONS BETWEEN THE NUMBER AND TYPES OF COMORBIDITIES AND GENERAL HEALTH RELATED AND DIABETES SPECIFIC QUALITY OF LIFE IN INDIVIDUALS WITH TYPE-2 DIABETES AND HYPERTENSION AND/OR HYPERLIPIDEMIA.

Given that diabetes is a metabolic disorder that increases the risk of having a number of other co-morbid conditions, it is not usual for multiple conditions to develop concurrently in persons with diabetes. Wee and colleagues reported that subjects with diabetes reported lower HRQoL than subjects without diabetes. In previous studies, the presence of other chronic medical conditions in addition to diabetes resulted in even lower HRQoL (Wee et al., 2005). The primary finding for this specific aim in the current study was that the number of comorbidities was a significant predictor of HRQoL. The higher the number of comorbidities the lower HRQoL as measured by both the SF-36 and DQOL.

The number of study-specific comorbidities was significantly negatively related to all SF-36 subscale scores at a $p < .001$ level while the relationship was significant for only two of the four DQOL subscales (Impact and Diabetes Worry) and the total DQOL score. In the current study, the SF-36 was more sensitive to the effects of other diseases in addition to diabetes than the DQOL. The findings of the current study were similar to the findings of Jacobson and colleagues (1994) who reported that the DQOL Impact, Diabetes Worry and total scores were significantly related to the number diabetes complications (Jacobson, 1994). The reported association between the number of comorbidities and HRQoL is consistent with many studies (Ahroni & Boyko, 2000; R. M. Anderson et al., 1997; Boyer & Earp, 1997; Jacobson et al.,

1994; Maddigan et al., 2005; Stewart et al., 1989; Thommasen & Zhang, 2006b). One of the studies, conducted by Anderson and colleagues (1997), targeted the type-2 diabetes population. Similar to findings in the current study, they reported that the number of comorbidities was significantly negatively correlated with the six out of the nine SF-36 subscales (R. M. Anderson et al., 1997). Ahroni and Boyko (2000) examined the relationship between SF-36 subscale scores and diabetic complications in a sample of 331 diabetic veterans. They found that an increase of one diabetic complication was associated with an average loss of 7.2 to 11.8 points on six of the SF-36 subscales (Physical Functioning, Role-Physical, Bodily Pain, General Health, Vitality, and Social Functioning).

A high prevalence of chronic medical conditions among subjects with diabetes was reported in several studies (Dodson, 2002; Eaton, 2002; Maggio & Pi-Sunyer, 2003). The prevalence of comorbidities in this study was quite similar to a previous type-2 diabetes study (Rejeski et al., 2006), but higher than studies that included subjects with both type-1 and type-2 diabetes (Lloyd et al., 2001; Thommasen & Zhang, 2006b). The most common comorbidities among the subjects in this sample were hypertension (81.3%) and arthritis (50.8%). The prevalence of hypertension of this study was higher than that reported in the National Diabetes Fact Sheet of The United States (73% - CDC, 2005b) but similar to that reported by Rejeski and colleagues (80.6% - 2006). The prevalence of arthritis was consistent with the "Mobility and Mortality Weekly Report" that 50% of people 65 years of age have this chronic condition (CDC, 2006b).

Type-2 diabetes and hypertension often co-exist (Baba et al., 1985; Dodson, 2002) which increases the risk of developing other diseases such as coronary artery disease, renal failure and cerebral vascular disease. The presence of only diabetes and hypertension without other

complications has been reported to have little or no impact on HRQoL (Lloyd et al., 2001; Stewart et al., 1989; Thommasen & Zhang, 2006b). This may explain why hypertension is often under-diagnosed and under-treated in both the diabetic and general population (Nazimek-Siewniak, Moczulski, & Grzeszczak, 2002). This study's results are consistent with previous findings that only the Diabetes Related Worry subscale of the DQOL was significantly related to hypertension in a type-2 diabetes sample (DCCT Research Group, 1988; Jacobson, 1994).

In this study, arthritis had negative effects on the physical-related SF-36 subscales. Subjects with arthritis had lower scores on the Physical Functioning, Role-Physical and Bodily Pain subscales of the SF-36 when compared to patients without this condition. None of the DQOL scores were significantly related to arthritis. This is similar to previous reports that people with arthritis were more likely to report lower scores on physical functioning-related measures, which is thought to be related to pain (Maddigan et al., 2005; Thommasen & Zhang, 2006b). Patients with arthritis in the current study did not report significantly lower scores on the SF-36 mental health related subscales (Role-Emotional and Mental Health) than those without this condition which is, again, consistent with the findings in other studies (Adams & Speechley, 1996; Piccinni et al., 2006).

Coronary artery disease (CAD) was not significantly related to HRQoL as assessed by the SF-36 and DQOL. In contrast, Stewart and colleagues (1989) found a negative additive effect of CAD on HRQoL in individuals with other chronic conditions. The Stewart study did not, however, focus specifically on subjects with diabetes. Although all subjects in their study had CAD, Jette and Downing (1996) reported that there was no impact of disease severity on general HRQoL following cardiac rehabilitation.

The prevalence of a history of stroke/TIA among diabetes of the current study (12.15%) was higher than previously reported prevalence rates of 2 to 11% (Liebl et al., 2002; Nazimek-Siewniak et al., 2002; Sacco et al., 2001). Only SF-36 Bodily Pain subscale scores were significantly difference among subjects with and without a history of stroke or TIA. This finding is inconsistent with several previous studies that found that stroke was strongly correlated with poorer physical function (Haan & Weldon, 1996; Kuller, 1995; Ontiveros, Miller, Markides, & Espino, 1999; Otiniano et al., 2003; Worley et al., 1998). One possible reason for this inconsistency is that the CRCD Comorbidity questionnaire asked about the presence of a previous stroke or TIA and did not differentiate between the two conditions. It is possible that most of the subjects in the present study had a history of TIA and not stroke. Since the neurological deficit is transient with a TIA, one would not expect physical functioning to be affected.

The prevalence of Peripheral Vascular Disease (PVD) in the current study (20.87%) was also higher than that reported in previous studies (2.0 to 7.4 %) (Kanta Barman et al., 2004; Leavitt et al., 2004; Lloyd et al., 2001). PVD was associated with significantly lower scores on six of the eight SF-36 subscales (Physical Functioning, Role-Physical, Bodily Pain, Vitality, Social Functioning and Role-Emotional), but there was no effect on any of the DQOL scores. In contrast, Lloyd and colleagues (2001) found that the presence of PVD was associated with significantly lower scores only on the SF-36 Physical and Social Functioning subscales. This is the only other study identified that investigated HRQoL in patients with PVD. Currently, there is little research addressing HRQoL in this population.

Kidney disease was associated with lower scores on all four physical related subscales of SF-36 (Physical Functioning, Role-Physical, Bodily Pain, and General Health) relative to

subjects who did report having kidney disease. This finding was consistent the previous finding that the kidney disease was related to decrements in Physical Functioning, Role-Physical, and General Health SF-36 subscale scores (Ahroni & Boyko, 2000). In contrast to the current study, the Ahroni and Boyko reported that the subjects with kidney disease also had significantly lower scores on the Vitality and Social Functioning SF-36 subscales. The subjects in their study all had foot complications secondary to their diabetes which was not the case in the current study. Similar to the current study, Ahroni and Boyko did not find any differences in DQOL scores based on the presence of kidney disease. The prevalence of the kidney disease (13.71%) in the current study was consistent with ADA-reported prevalence rates (ADA, 2006a).

In the current study, more than 20% of the diabetic subjects experienced depressive symptoms, anxiety or other psychiatric problems. Lustman and colleagues (1997) noted that depression occurred in as many as 80% of diabetic cases, with major depression rates of 15% to 20%. Depression and anxiety often co-exist in the same patient (Belzer & Schneier, 2004). In the current study, patients with psychological problems (depression, anxiety and/or other psychiatric problems) reported significantly lower scores on all the SF-36 subscales except the Physical Functioning and Role-Physical subscales than those without psychological problems. In addition, DQOL total and subscale scores were significantly lower among subjects with psychological problems than those without these conditions. This is consistent with the findings of a number of other studies reporting lower HRQoL among subjects with mental health disorders (Brown et al., 2000; Chyun et al., 2006; Danieli et al., 2005; Peyrot & Rubin, 1997). These finding, combined with previous research, suggests that concurrent psychological comorbidities heighten the negative impact of diabetes on HRQoL.

In this study of individuals with type-2 diabetes, most comorbid conditions had a greater impact on general HRQoL than on diabetes specific quality of life. Although several studies suggested that the general HRQoL measures has poor discriminant validity related to specific medical problems (R. M. Anderson et al., 1997; Sureshkumar et al., 2002), in the current study the only disorders that were not associated with lower scores on one or more SF-36 subscales relative to those without the disorder were coronary artery disease and hypertension. In contrast, the only comorbid conditions associated with lower DQOL scores (relative to those without the condition) were hypertension (Diabetes Related Worry) and mental health disorders (total and all subscale scores).

5.4 SPECIFIC AIM #4

TO TEST REVISED WILSON AND CLEARY CONCEPTUAL MODEL IN THE TYPE-2 DIABETES POPULATION.

The revised Wilson and Cleary model contains seven factors (Ferrans et al., 2005; Wilson & Cleary, 1995). Given that the current study is a secondary analysis, one limitation was the availability of the data to adequately measure each factor. While SEM guidelines generally recommend at least three measured variables for each latent variable, in the current study two of the latent variables (general health perceptions and overall quality of life) had only two measured variables. The tested model was comprised of two exogenous variables (characteristics of the individual and characteristics of the environment) and five endogenous factors (biological & physiological factors, symptom status, functional status, general health perceptions and overall

quality of life). Twenty measured variables were arbitrarily loaded onto the model consistent with model guidelines (Davis, Holman, & Sousa, 2000; Ferrans et al., 2005; Wilson & Cleary, 1995). Each latent variable was measured by two to four measured variables.

According to Wilson and Cleary (1995), biological and physiological factors focus on the function of cells, organs, and organ systems and include factors whose effects on health are principally mediated by changes in cell, organ, or organ system function and not variables that affect their function (Wilson & Cleary, 1995). Although some studies have used variables, such as age or the presence of comorbidities as bio-physiological factors (Orfila et al., 2006; Penckofer et al., 2005; Phaladze et al., 2005), this study elected to include only variables that reflected cellular, organ or organ system function. Since this investigation focused on the type-2 diabetes population with possible comorbidities, there were four available measured variables (HbA1c, fasting glucose, HDL to total cholesterol ratio and fasting insulin) from the parent study that were felt to be appropriate measures of biological and physiological factors. HbA1c measures how well individuals managed their blood sugar over the three months prior to the test while fasting glucose measures the amount of glucose in the blood at the time of the blood draw. Because these two variables represent similar metabolic information, using both variables in the model would induce an inadmissible solution due to multicollinearity. HDL to total cholesterol ratio was later excluded from the final analysis because it accounted for almost none of the variability in biological and physiological factors in this sample (R^2 was close to zero). Therefore, only HbA1c and fasting insulin were used as measured variables or indicators of biological and physiological factors.

Although Cosby et al. (2000) reported in their analysis that there were no meaningful relationships among any of the demographic variables (age, gender, or ethnicity) they examined

and any of the three dependent variables (symptom status, functional status, or general health perceptions) when they tested the Wilson and Cleary model in patients with AIDS, years of formal education and age were used as measured variables for characteristic of the individual in the current study along with the years since diabetes was diagnosed. Confirmatory factor analysis (CFA) was used to identify the possible relationships between exogenous (characteristics of the individual and characteristics of the environment) and endogenous (biological and physiological factors, symptom status, functional status, general health perceptions and overall quality of life) variables as well as the measured variables used represent each of the endogenous and exogenous variables.

Prior to testing a full conceptual model, the recommendation is to first test the measurement portion of the model, known as the two-step modeling method (J. C. Anderson & Gerbing, 1988; Kline, 2005). The CFA results indicated that the initial measurement model did not fit the data well and was not admissible ($\chi^2_M(149) = 504.938$, *CMIN/DF* = 3.389, CFI = 0.822, SRMR = 0.0776 and RMSEA = 0.087 with a 90% confidence interval of 0.078 to 0.095). Too many measured variables in the model were suspected to be the cause the inadmissibility of the solution. Therefore, the initial measurement model was modified based on the values of modification indices and R^2 values, in order to proceed to the next step of model testing, the fitting of a full structural equation model. Only 17 measured variables were included in the final test. The modifications to the measurement model were conducted in a *post-hoc* fashion based on modification indices rather than being hypothesis or theoretically driven a prior. However, suggested *post-hoc* modifications were only made if there was a theoretical basis or previous research to support them.

Unlike other studies applying the Wilson and Cleary model that attempted to improve the fit of the model by modifying the structural linear model (Arnold et al., 2005; Orfila et al., 2006; Sousa & Kwok, 2006), the current study improved the fit of the model by adding six correlational paths between residual covariances, which had no effect on the structural part of the model. These measurement error correlations represented the assumption that each two corresponding measured variables measure something in common that was not explicitly represented in the model (Kline, 2005, p. 168).

First, measurement error correlations were found between SF-36 Physical Functioning subscale scores and two other measured variables, the 6MWD and SF-36 Role Functioning. The 6-Minute Walking Distance and SF-36 Physical Functioning subscale are both measures of physical function so it is understandable that they have similarities in their measurement. In an attempt to reduce the number of variables in the model (given the limited sample size), the Role-Physical and Role-Emotional subscales of the SF-36 were combined into a Role Functioning subscale since they both are role functioning-related measures. Given that the combined scale measured the impact of physical health on function, one would expect it to be positively correlated with the Physical Functioning subscale. These assumptions were supported by Hamilton and Haennel (2000) who reported that 6-Minute Walk Distance, SF-36 Physical Functioning and SF-36 Role Physical Functioning scores were moderately correlated.

The third measurement error correlation was between the HbA1c value and duration of diabetes. Arnetz and colleagues' study (1982) has shown a significant positive correlation between the HbA1c and duration of diabetes while Kabadi (1988) found no significant relationship between HbA1c and duration of diabetes. In the current study, HbA1c was inverse transformed to induce univariate normality so that higher scores represent better levels. Inverse

transformed HbA1c was significantly negatively correlated (r = -0.207, p < .001) with the duration of diabetes and the correlation between their error terms was even stronger (r = -0.277). This indicated that a longer duration of diabetes was associated with worse HbA1c levels, which is consistent with Arnetz's findings.

The next measurement error correlation was between the SF-36 Social Functioning subscale and subjects' ages. Age was previously reported to have a significant negative relationship with SF-36 Social Functioning subscale scores among subjects with type-2 diabetes (Ibrahim, Beich, Sidorov, Gabbay, & Yu, 2002; Ware, 1993). In contrast, although the current study found that the bivariate correlation between these two variables was not significant (r = 0.105, p = .061), model fit indices indicated that their error terms were significantly correlated (r = 0.477, p < .001).

The fifth measurement error correlation was between the Spielberger's State Anxiety score and overall satisfaction with life. Subjects with higher anxiety scores reported being less satisfied with their overall life. This finding is consistent with studies in other populations that reported that anxiety was associated with less life satisfaction (Baroun, 2006; Eng, Coles, Heimberg, & Safren, 2005; Paolini, Yanez, & Kelly, 2006; Potasova & Prokopcakova, 2003).

The final measurement error correlation was between the SF-36 General Health subscale score and the derived weighted score for study focused symptoms. The finding indicated that their error terms were significantly negatively correlated (r = -0.199, p = .003), which means that people with lower weighted symptom scores (indicating few symptoms and/or that symptoms that were present had less impact of the quality of their lives) had higher SF-36 General Health subscale scores.

After modifications were made and a good-fit measurement model was obtained, the structural and measurement models were integrated into the revised Wilson and Cleary model. The final structural regression model resulted in a good-fit model ($\chi^2_M(98) = 203.986$, *CMIN/DF* = 2.081, CFI = 0.952, SRMR = 0.0549 and RMSEA = 0.058 with the 90% CI of 0.047 to 0.069). This result indicates that the revised Wilson and Cleary conceptual model loaded with the final 17 variables is suitable for explaining the data in this type-2 diabetes sample.

Fifty percent (50%) of the variance in the biological and physiological factors, as measured by HbA1c and fasting insulin, was explained by its predictors (individual and environment characteristics), mostly characteristics of the individual (measured by age and duration of diabetes, r = -0.703, p < **.**001). Environment characteristics, as measured by the ISEL Tangible and Belonging subscales, had a non-significant negative influence on biological and physiological factors (r = -0.059, p = **.**627).

Forty-six percent (46%) of the variance in symptom status (measured by the Beck Depression Index – II, Spielberger State-Trait Anxiety Inventory, and study-focused symptoms) was explained by its predictors: (1) biological and physiological factors (r = 0.631, p < **.**246), (2) characteristics of the individual (r = 0.376, p < **.**336) and (3) characteristics of the environment (r = -0.469, p < **.**001). However, both the latent variables of individual characteristics and biological and physiological factors had a positive, but not significant, influence on symptom status. This finding is consistent with the findings of previous research that uncomplicated diabetes is often asymptomatic and without other complications or comorbidities, a high proportion of patients with only hyperglycemia will not be diagnosed with diabetes unless specifically tested (Cathelineau et al., 1997; O'Connor et al., 2006; Singh et al., 1992). The findings in this study were supported by Wilson and Cleary (1995) who stated that in some

disorders biological or physiological factors may be unrelated to the symptom status. One of the possible explanations for the failure to find a significant association between biological and physiological factors and symptom status in the current study was that all of the measured variables available to represent biological and physiological factors reflected physiological changes while two of the three measures of symptom status measured psychological symptoms.

For many of subjects in the current study, functional status was explained by symptom status (r = -0.928, p < .001) and individual characteristics (r = -0.316, p < .001) (R^2= .84). The characteristics of the environment had non-significant effects on subjects' functional status (r = -0.078, p = .242). This may be related to the variables selected to represent these characteristics and the indirect associations between environment characteristics and functional status through symptom status. This finding suggests that impairments in functional status were related to a higher prevalence of symptoms and individual characteristics, but not to environmental factors. The strong relationship between symptom status and functional status is consistent with the Wilson and Cleary Model.

The variance in general health perceptions (97%) was largely explained by functional status (r = 0.882, p < .001) and individual characteristics (r = 0.571, p < .001). Characteristics of the environment had very little direct effect on general health perceptions (r = 0.114, p = .106). These findings, with the exception of no relationship between environmental characteristics and general health perceptions, are consistent with the Wilson and Cleary Model. The failure to find significant relationships between environmental characteristics and functional status and general health perceptions may reflect the environmental measures available from the parent study.

Overall quality of life, as measured by subjects' satisfaction with life and feeling full of life, was fundamentally explained by their general health perceptions (r = 0.962, p < .001). Individual and environment characteristics had minimal direct effects on subjects' overall quality of life. In the present study, the finding suggested that overall quality of life was mainly influence by other factors thru general health perceptions.

The current study utilized age and years since diabetes was diagnosed as measures of individual characteristics, and the Tangible and Belonging subscales of Interpersonal Support Evaluation List (ISEL) as environment characteristics. Years of formal education, numbers of adults living in household and gross household income were excluded from the model since they provided very little or no useful information for the tested model. Even though several of the individual and environmental characteristics originally identified to represent these exogenous variables (characteristics of the individual and environment) could not be used, those that were included were consistent with the guidelines of Wilson and Cleary (1995) and Ferrans et al. (2005). According the revised model specification, both individual and environment characteristics should impact symptom status, functional status, general health perceptions and overall quality of life factors. This was not the case in the current study and may be related to the measures used to represent these factors.

Wilson and Cleary conceptual model is comprised of three exogenous variables that influence other factors without being influenced by others: (1) biological and physiological factors, (2) characteristics of the individual, and (3) characteristics of the environment. Ferrans and colleagues (2005) purposed a modified to Wilson and Cleary model that added direct effects from characteristics of the individual and characteristics of the environment to biological and physiological factors leaving only two exogenous variables (characteristics of the individual and

characteristics of the environment). Based on Ferrans' suggested revisions to Wilson and Cleary Model, the last research question of this study examined the association between characteristics of the individual and characteristics of the environment. Individual characteristics were not significantly correlated with environment characteristics ($r = 0.069$, $p = .383$). Although these findings may in be related in part to the variables available in the parent study, they only partially support Ferrans' suggested revisions to the original Wilson and Cleary Model.

5.5 IMPLICATIONS

Results of this study provide further understanding of the process through which objective and subjective health determinants contribute to general health related and diabetes specific quality of life as measured by the SF-36 and DQOL. Some of the sociodemographic variables examined in the current study (e.g. age, gender, marital status, and level of education) have been examined thoroughly in previous studies. However, some variables have been overlooked and not often examined in studies. Those variables may contain valuable information related to quality of life. For example, in this study higher household income was found to be a significant predictor of better quality of life as measured by both diabetes specific and general health related quality of life measures. These data may not have been available in many previous studies due to actual or perceived unwillingness of participants to respond to questions about household income. The majority of subjects in the current study were willing to respond to questions asking about their income. Future research examining predictors of HRQoL should include measures of socioeconomic status. One possible alternative to direct questions about income is collecting data about subjects' zip codes. This variable may provide information regarding the possible

financial status of the participants and the social or medical services that are available to them, both of which can impact quality of life

The finding that although both quality of life measures were sensitive to the number of comorbidities, the SF-36 appeared to be more sensitive to other study-focused variables (most of demographic characteristics and the presence of specific study-focused comorbidities) than the DQOL supports the importance of including both a general and disease specific QoL measure in studies examining the impact chronic disorders. By design, that SF-36 is capable of assessing the impact of a board range of characteristics in relation to individuals' perceived health related quality of life while diabetes specific measures such as the DQOL are designed to evaluate the specific effects of diabetes and its treatment regimen on patients' quality of life. The recommendation to utilize a combination of general health-related and disease specific quality of life measures is supported by this study.

One noteworthy point is there is currently no gold standard for selecting the HRQoL measures to use in studies of type-2 diabetes. The concept of HRQoL remains vague and inadequately defined as evidenced by the large number of instruments that have been used to measure this concept (Polonsky, 2000). Without a good understanding of the instruments, many researchers in diabetes seem to follow one of three patterns: (1) use whatever everyone else using, (2) use instrument that assess some aspect of patients' psyche assuming that HRQoL and psychosocial status are synonymous, or (3) choose any questionnaire that has an appropriate name without examining the actual content, eg., selecting a questionnaire with quality of life and diabetes in its title (Polonsky, 2000). When such an arbitrary approach is used to select a quality of life instrument, it is not unexpected that the anticipated changes in HRQoL due to medical interventions are often not found (Polonsky, 2000). Investigators should examine the content of

instruments prior to using them to be sure that they are measuring the domains of interest in the study and are valid and reliable in the target population. More empirical studies are needed provide criteria for measurement selection. This study provided additional data on the psychometric properties on the SF-36 and DQOL in subjects with type-2 diabetes.

Lastly, this study provides a validation of the Revised Wilson and Cleary HRQoL conceptual model in a type-2 diabetes cohort by using SEM. Wilson and Cleary have contributed to better understanding of the determinants of quality of life by purposing a framework that explains its determinants (Wilson & Cleary, 1995). This comprehensive model includes a full range of variables typically included in HRQoL assessments from two different (biomedical and social science) paradigms. With better understanding of the phenomenon of HRQoL, interventions to improve patients' perceived HRQoL can be targeted to the underlying causes (Sullivan et al., 2000; Wilson & Cleary, 1995). Although the model has been validated in many population, until now there had been no empirical studies of this model in type-2 diabetes.

Seventeen variables were selected to test the model. Although Wilson and Cleary (1995) stated that the absence of arrows between nonadjacent levels does not imply that relationships do not exist, this study was not designed to modify to structure path of the model. Hence, as guided by the modification indices and the findings of previous studies, error terms correlations were allowed in order to obtain a better fit model. The finding of this analysis indicated that the relationships between selected variables as specified in the model and depicted in the Figure 4-4 were supported by the current data. In the good-fit model, all relationships and patterns conform to the purposed model despite a few non-significant relationships possibly due to the selected variables. This is an initial step toward a comprehensive validation of the revised Wilson and Cleary conceptual model in the type-2 diabetes population. The data about the relationships

among biological factors, symptoms, functional status, general health perceptions and overall quality of life can lead to a better understanding of the parameters that have the greatest impact on patients' quality of life and, consequently, facilitate the development of new clinical approaches to improve quality of life in patients with type-2 diabetes.

Based on the findings of the current study, future intervention studies designed to improve quality of life in patients with type-2 diabetes should focus on an individualized plan of symptom managements with the goal of improving patients' functional status.

Several study limitations need to be acknowledged. First, although the SEM technique is a remarkably reliable and flexible data analytical tool, SEM should only be used be used when there is a theoretical basis for testing the proposed relationships among variables (Kline, 2005). Use of SEM with the Revised Wilson and Cleary model increases the flexibility of the SEM due to the flexibility of the model. There is no rigorous guideline for variable selection for the model and the model developers allow the absence of relationships between nonadjacent levels to be added (Wilson & Cleary, 1995). Many studies have arbitrarily selected the variables based on their own understanding of the model or followed the previous selection used in other studies, which may lead to the selection of inappropriate variables to measure the latent variables of the model. Additionally, the flexibility to add a new relationship between the investigated variables may also induce false assumptions when there is no theoretical basic to support that relationship. The data available in the parent study constrained the measured variables that could be selected to test the model. While the 17 variables included in the final model were consistent with guidelines proposed by Wilson and Cleary (1995) and Ferrans and colleagues (2005), they may not have been the ideal variables to measure each of the model factors. This may have contributes to some of the non-significant relationships found in the study and suggest that there

may be better indicators for each model factor. One of the major limitations of this study is that it was a secondary data analysis and that the parent study was not designed to test this model. Future studies should be designed specifically test this model in individuals with type-2 diabetes.

Second, structural equation modeling is not capable of predicting the direction of relationships when used in cross-sectional studies even though it generates a directional model. Unless data are collected prospectively one cannot verify whether the different health variables in the model follow each other chronologically (Arnold et al., 2005). Future studies should be designed to investigate the relationships between these variables longitudinally and, preferably, include patients from the onset of their disease.

Third, since this is a secondary analysis study, the sample size was limited to subjects with complete baseline data from the parent study. The ratio of sample size per free parameters to be estimated in the final model was well below that recommended in the literature (6:1 versus 10 to 20:1). The result of an inadmissible solution in one model configuration may be a sign that the sample size was inadequate. Another possible cause of this inadmissible solution is that three latent variables in the model had fewer than the recommendation of three measured variables per a latent variable due to the limited variety of variables available from the parent study. Future study should strive to meet the model testing recommendations for SEM.

In an attempt to reduce the number of measurement variable for functional status, the Role-Physical and Role-Emotional subscales of the SF-36 were combined into a single Role Functioning subscale. When these subscales were combined it is likely that some information was lost. A larger sample would have permitted both measures to be included rather than combining them.

In an attempt to obtain good-fitting measurement and structural equation models, a number of modifications were needed (i.e., addition of correlated measurement errors, omission of several measured variables, and addition of new measured variables). Because modification indices suggested that there may be correlations between the measurement errors of indicators of nonadjacent latent variables in the proposed fully mediated model, future studies should examine the possibility of the partial mediation of the latent variables identified in the revised Wilson and Cleary Model as well as the use of alternate measured variables as indicators of the latent variables proposed in the model.

Finally, the data used in the current study were collected by self-administered questionnaires. It is know that using this method to collect data is less reliable and causes more missing data than the interview method since the interviewer can validate responses and correct mistakes at the time of interview (Guyatt et al., 1993). However, the use of interviews to collect study data is more costly. Using computer-based or web-based response-driven questionnaires might be a solution and should be compared to interview collected data in future studies.

BIBLIOGRAPHY

ADA. (2004a). Diagnosis and classification of diabetes mellitus. *Diabetes Care, 27 Suppl 1*, S5-S10.

ADA. (2004b). Standards of Medical Care in Diabetes. *Diabetes Care, 27*(1).

ADA. (2006a). Diabetes and Nephropathy (Kidney Complications). Retrieved December 22, 2006, from http://www.diabetes.org/diabetes-statistics/kidney-disease.jsp

ADA. (2006b). Diabetes Symptoms. Retrieved December 26, 2006, from http://www.diabetes.org/diabetes-symptoms.jsp

ADA. (2006c). Diabetic Neuropathy (Nerve Damage) and Diabetes. Retrieved December 26, 2006, from http://www.diabetes.org/type-1-diabetes/diabetic-neuropathy.jsp

Adams, P. C., & Speechley, M. (1996). The effect of arthritis on the quality of life in hereditary hemochromatosis. *Journal of Rheumatology, 23*(4), 707-710.

AHA. (2006). High Blood Pressure. Retrieved December 10, 2006, from http://www.americanheart.org/presenter.jhtml?identifier=2114

Ahroni, J. H., & Boyko, E. J. (2000). Responsiveness of the SF-36 among veterans with diabetes mellitus. *Journal of Diabetes & its Complications, 14*(1), 31-39.

Alonso, J., Ferrer, M., Gandek, B., Ware, J. E., Jr., Aaronson, N. K., Mosconi, P., et al. (2004). Health-related quality of life associated with chronic conditions in eight countries: Results from the International Quality of Life Assessment (IQOLA) Project. *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care & Rehabilitation, 13*(2), 283-298.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411-423.

Anderson, R. J., Freedland, K. E., Clouse, R. E., & Lustman, P. J. (2001). The prevalence of comorbid depression in adults with diabetes: a meta-analysis. *Diabetes Care, 24*(6), 1069-1078.

Anderson, R. M., Fitzgerald, J. T., Wisdom, K., Davis, W. K., & Hiss, R. G. (1997). A comparison of global versus disease-specific quality-of-life measures in patients with NIDDM. *Diabetes Care, 20*(3), 299-305.

Anderson, T. W. (1957). Maximum likelihood estimates for the multivariate normal distributions when some observations are missing. *J. Amer. Statist. Assoc., 52*, 200-203.

Angel, R., & Cleary, P. D. (1984). The effects of social structure and culture on self-reports of health among Mexican Americans. *Social Science Quarterly, 65*, 814-828.

Anonymous. (1995). Quality of life and clinical trials. *Lancet, 346*(8966), 1-2.

Arnetz, B. B., Kallner, A., & Theorell, T. (1982). The influence of aging on hemoglobin A1c (HbA1c). *J Gerontol, 37*(6), 648-650.

Arnold, R., Ranchor, A. V., Koeter, G. H., de Jongste, M. J. L., & Sanderman, R. (2005). Consequences of chronic obstructive pulmonary disease and chronic heart failure: the relationship between objective and subjective health. *Social Science & Medicine, 61*(10), 2144-2154.

ATS. (2002). ATS Statement: Guidelines for the Six-minute Walk Test. *American Journal of Respiratory & Critical Care Medicine, 166*(1), 111-117.

Baba, T., Murabayashi, S., Aoyagi, K., Sasaki, K., Imamura, K., Kudo, M., et al. (1985). Prevalence of hypertension in diabetes mellitus--its relation to diabetic nephropathy. *Tohoku J Exp Med, 145*(2), 167-173.

Balke, B. (1963). A Simple Field Test for the Assessment of Physical Fitness. Rep 63-6. *CARI Report, 53*, 1-8.

Barnes, L. L. B., Harp, D., & Jung, W. S. (2002). Reliability Generalization of Scores on the Spielberger State-Trait Anxiety Inventory. *Educational and Psychological Measurement, 62*(4), 603-618.

Baroun, K. A. (2006). Relations among religiosity, health, happiness, and anxiety for Kuwaiti adolescents. *Psychological Reports, 99*(3), 717-722.

Barr, J. T. (1995). The outcomes movement and health status measures. *Journal of Allied Health, 24*(1), 13-28.

Barsky, A. J., Cleary, P. D., & Klerman, G. L. (1992). Determinants of perceived health status of medical outpatients. *Social Science & Medicine, 34*(10), 1147-1154.

Barsky, A. J., Cleary, P. D., Sarnie, M. K., & Klerman, G. L. (1993). The course of transient hypochondriasis. *American Journal of Psychiatry, 150*(3), 484-488.

Beaser, R. S., Garbus, S. B., & Jacobson, A. M. (1996). Diabetes Mellitus. In B. Spilker (Ed.), *Quality of life and pharmacoeconomics in clinical trials* (2nd ed., pp. 983-992). Philadelphia: Lippincott-Raven.

Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. (1996). Comparison of Beck Depression Inventories -IA and -II in psychiatric outpatients. *J Pers Assess, 67*(3), 588-597.

Bell, D. S. (1994). Stroke in the diabetic patient. *Diabetes Care, 17*(3), 213-219.

Belzer, K., & Schneier, F. R. (2004). Comorbidity of anxiety and depressive disorders: issues in conceptualization, assessment, and treatment. *J Psychiatr Pract, 10*(5), 296-306.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238-246.

Bergner, M. (1985). Measurement of health status. *Medical Care, 23*(5), 696-704.

Bergner, M., Bobbitt, R. A., Carter, W. B., & Gilson, B. S. (1981). The Sickness Impact Profile: development and final revision of a health status measure. *Medical Care, 19*(8), 787-805.

Boers, M., Nurmohamed, M. T., Doelman, C. J. A., Lard, L. R., Verhoeven, A. C., Voskuyl, A. E., et al. (2003). Influence of glucocorticoids and disease activity on total and high density lipoprotein cholesterol in patients with rheumatoid arthritis. *Annals of the Rheumatic Diseases, 62*(9), 842-845.

Bollen, K. A. (1989). *Structural equations with latent variables*. New York: Wiley.

Bott, U., Muhlhauser, I., Overmann, H., & Berger, M. (1996). Validation of a Diabetes Quality-of-Life Measure. *Diabetes, 45(2S)*(Supplement), 111A.

Bott, U., Muhlhauser, I., Overmann, H., & Berger, M. (1998). Validation of a diabetes-specific quality-of-life scale for patients with type 1 diabetes. *Diabetes Care, 21*(5), 757-769.

Bowling, A. (1997). *Measuring health : a review of quality of life measurement scales* (2nd ed.). Buckingham ; Philadelphia: Open University Press.

Boyer, J. G., & Earp, J. A. (1997). The development of an instrument for assessing the quality of life of people with diabetes. Diabetes-39. *Medical Care, 35*(5), 440-453.

Bradley, C. (1996). Measuring quality of life in diabetes. In S. M. Marshall, P. D. Home & R. A. Rizza (Eds.), *The Diabetes Annual 10*. Amsterdam ; New York: Elsevier Science.

Bradley, C. (2001). Importance of differentiating health status from quality of life. *Lancet, 357*(9249), 7-8.

Bradley, C., Todd, C., Gorton, T., Symonds, E., Martin, A., & Plowright, R. (1999). The development of an individualized questionnaire measure of perceived impact of diabetes on quality of life: the ADDQoL. *SO - Quality of Life Research, 8*(1-2), 79-91.

Brown, G. C., Brown, M. M., Sharma, S., Brown, H., Gozum, M., & Denton, P. (2000). Quality of life associated with diabetes mellitus in an adult population. *Journal of Diabetes & its Complications, 14*(1), 18-24.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162). Newburyk Park: Sage Publications.

Bryant, F. B. (2000). Accessing the validity of measurement. In L. G. Grimm & P. R. Yarnold (Eds.), *Reading and understanding more multivariate statistics* (1st ed., pp. 99-146). Washington, DC: American Psychological Association.

Butland, R. J., Pang, J., Gross, E. R., Woodcock, A. A., & Geddes, D. M. (1982). Two-, six-, and 12-minute walking tests in respiratory disease. *British Medical Journal Clinical Research Ed., 284*(6329), 1607-1608.

Byrne, B. M. (2001). *Structural equation modeling with AMOS : basic concepts, applications, and programming*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Camacho, F., Anderson, R. T., Bell, R. A., Goff, D. C., Jr., Duren-Winfield, V., Doss, D. D., et al. (2002). Investigating correlates of health related quality of life in a low-income sample of patients with diabetes. *Quality of Life Research, 11*(8), 783-796.

Carmines, E. G., & McIver, J. P. (1981). Analyzing models with unobserved variables. In G. W. Bohrnstedt & E. F. Borgatta (Eds.), *Social measurement : current issues* (pp. 254 p.). Beverly Hills: Sage Publications, Inc.

Cathelineau, G., de Champvallins, M., Bouallouche, A., & Lesobre, B. (1997). Management of newly diagnosed non-insulin-dependent diabetes mellitus in the primary care setting: effects of 2 years of gliclazide treatment--the Diadem Study. *Metabolism: Clinical & Experimental, 46*(12 Suppl 1), 31-34.

CDC. (2003). Self-reported heart disease and stroke among adults with and without diabetes--United States, 1999-2001. *MMWR - Morbidity & Mortality Weekly Report, 52*(44), 1065-1070.

CDC. (2005a). Diabetes: A Serious Public Health Problem. *Chronic Disease* Retrieved March 17, 2005, from http://www.cdc.gov/nccdphp/bb_diabetes/index.htm

CDC. (2005b). *National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2005*. Atlanta, GA U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2005.

CDC. (2005c). Preventing Diabetes and Its Complications. *Chronic Disease* Retrieved April 22, 2005, from http://www.cdc.gov/nccdphp/publications/factsheets/Prevention/diabetes.htm

CDC. (2006a). Diabetes: Disabling, Deadly, and on the Rise At A Glance 2006. *Chronic Disease* Retrieved May 5, 2006, from http://www.cdc.gov/nccdphp/publications/aag/ddt.htm

CDC. (2006b). Prevalence of doctor-diagnosed arthritis and arthritis-attributable activity limitation--United States, 2003-2005. *MMWR - Morbidity & Mortality Weekly Report, 55*(40), 1089-1092.

CDC. (2007). Arthritis At A Glance 2007. *Chronic Disease* Retrieved March 8, 2007, from http://www.cdc.gov/arthritis/

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases, 40*(5), 373-383.

Cheng, A. Y., Tsui, E. Y., Hanley, A. J., & Zinman, B. (1999). Developing a quality of life measure for Chinese patients with diabetes. *Diabetes Research & Clinical Practice, 46*(3), 259-267.

Chyun, D. A., Melkus, G. D., Katten, D. M., Price, W. J., Davey, J. A., Grey, N., et al. (2006). The association of psychological factors, physical activity, neuropathy, and quality of life in type 2 diabetes. *Biological Research for Nursing, 7*(4), 279-288.

Cleary, P. D., Greenfield, S., & McNeil, B. J. (1991). Assessing quality of life after surgery. *Control Clin Trials, 12*(4 Suppl), 189S-203S.

Cohen, S., & Hoberman, H. M. (1983). Positive events and social supports as buffers of life change stress. *Journal of Applied Social Psychology, 13*(2), 99-125.

Cohen, S., Mermelstein, R., Kamarck, T., & Hoberman, H. M. (1985). Measuring the functional components of social support. In I. G. Sarason & B. R. Sarason (Eds.), *Social support: Theory, research and application* (pp. 73-94).

Cohen, S., & Syme, S. L. (1985). *Social support and health*. Orlando: Academic Press.

Cosby, C., Holzemer, W. L., Henry, S. B., & Portillo, C. J. (2000). Hematological complications and quality of life in hospitalized AIDS patients. *AIDS Patient Care & Stds, 14*(5), 269-279.

Cox, D. J., & Gonder-Frederick, L. (1992). Major developments in behavioral diabetes research. *Journal of Consulting & Clinical Psychology, 60*(4), 628-638.

Criqui, M. H., Fronek, A., Barrett-Connor, E., Klauber, M. R., Gabriel, S., & Goodman, D. (1985). The prevalence of peripheral arterial disease in a defined population. *Circulation, 71*(3), 510-515.

Danieli, E., Airo, P., Bettoni, L., Cinquini, M., Antonioli, C. M., Cavazzana, I., et al. (2005). Health-related quality of life measured by the Short Form 36 (SF-36) in systemic sclerosis: correlations with indexes of disease activity and severity, disability, and depressive symptoms. *Clinical Rheumatology, 24*(1), 48-54.

Davis, A. L., Holman, E. J., & Sousa, K. H. (2000). Documentation of care outcomes in an academic nursing clinic: an assessment. *Journal of the American Academy of Nurse Practitioners, 12*(12), 497-502.

DCCT Research Group. (1988). Reliability and validity of a diabetes quality-of-life measure for the diabetes control and complications trial (DCCT). *Diabetes Care, 11*(9), 725-732.

DCCT Research Group. (1993). The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. . *New England Journal of Medicine, 329*(14), 977-986.

DCCT Research Group. (1996). Influence of intensive diabetes treatment on quality-of-life outcomes in the diabetes control and complications trial. *Diabetes Care, 19*(3), 195-203.

De Berardis, G., Pellegrini, F., Franciosi, M., Belfiglio, M., Di Nardo, B., Greenfield, S., et al. (2005). Longitudinal assessment of quality of life in patients with type 2 diabetes and self-reported erectile dysfunction. *Diabetes Care, 28*(11), 2637-2643.

De Leon, O. A. (1995). Development, reliability and validation of the Diabetes Emotional Adjustment Scale in Spanish: preliminary findings. *International Journal of Psychiatry in Medicine, 25*(1), 81-92.

DeCarlo, L. T. (1997). On the meaning and use of kurtosis. *Psychological Methods, 2*(3), 292-307.

DeFronzo, R. A. (1997). Insulin resistance: a multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidaemia and atherosclerosis. *Netherlands Journal of Medicine, 50*(5), 191-197.

Diener, E. (1984). Subjective well-being. *Psychol Bull, 95*(3), 542-575.

Dodson, P. M. (2002). Hypertension and diabetes. *Curr Med Res Opin, 18 Suppl 1*, s48-57.

Dunbar-Jacob, J., Erlen, J., Schlenk, E., Sereika, S., & Doswell, W. (1998). Expanding Research on Patient Quality of Life Outcomes [Electronic Version]. *Medical Outcomes Trust*, *3*. Retrieved August 29, 2006 from http://www.outcomes-trust.org/monitor/nov98/5.html.

Eaton, W. W. (2002). Epidemiologic evidence on the comorbidity of depression and diabetes. *Journal of Psychosomatic Research, 53*(4), 903-906.

EDIC Research Group. (1999). Epidemiology of Diabetes Interventions and Complications (EDIC). Design, implementation, and preliminary results of a long-term follow-up of the Diabetes Control and Complications Trial cohort. *Diabetes Care, 22*(1), 99-111.

Eiser, C., & Tooke, J. E. (1993). Quality-of-life evaluation in diabetes. *Pharmacoeconomics, 4*(85).

Eng, W., Coles, M. E., Heimberg, R. G., & Safren, S. A. (2005). Domains of life satisfaction in social anxiety disorder: relation to symptoms and response to cognitive-behavioral therapy. *Journal of Anxiety Disorders, 19*(2), 143-156.

Fawcett, J. (1999). *The relationship of theory and research* (3rd ed.). Philadelphia, Pa.: F.A. Davis.

Ferrans, C. E., Zerwic, J. J., Wilbur, J. E., & Larson, J. L. (2005). Conceptual Model of Health-Related Quality of Life. *Journal of Nursing Scholarship, 37*(4), 336-342.

Fisher, E. B., Jr., Delamater, A. M., Bertelson, A. D., & Kirkley, B. G. (1982). Psychological factors in diabetes and its treatment. *Journal of Consulting & Clinical Psychology, 50*(6), 993-1003.

Fitzgerald, J. T., Davis, W. K., Connell, C. M., Hess, G. E., Funnell, M. M., & Hiss, R. G. (1996). Development and validation of the Diabetes Care Profile. *Evaluation & the Health Professions, 19*(2), 208-230.

Gale Research, C. (2002). Glycosylated hemoglobin test. In J. L. Longe & D. S. Blanchfield (Eds.), *The Gale encyclopedia of medicine*: Detroit : Gale Group, c2002.

Garratt, A. M., Schmidt, L., & Fitzpatrick, R. (2002). Patient-assessed health outcome measures for diabetes: a structured review. *Diabetic Medicine, 19*(1), 1-11.

Garson, G. D. (2006a). SPSS Regression Output. *PA 765* Retrieved March 15, 2007, from http://www2.chass.ncsu.edu/garson/pa765/regressa.htm

Garson, G. D. (2006b). Structural Equation Modeling. *PA 765* Retrieved June 14, 2006, from http://www2.chass.ncsu.edu/garson/pa765/structur.htm

Garson, G. D. (2006c). Testing of Assumptions. *PA 765* Retrieved June 14, 2006, from http://www2.chass.ncsu.edu/garson/pa765/assumpt.htm

Gavard, J. A., Lustman, P. J., & Clouse, R. E. (1993). Prevalence of depression in adults with diabetes. An epidemiological evaluation. *Diabetes Care, 16*(8), 1167-1178.

Genuth, S., Alberti, K. G. M. M., Bennett, P., Buse, J., Defronzo, R., Kahn, R., et al. (2003). Follow-up report on the diagnosis of diabetes mellitus.[see comment]. *Diabetes Care, 26*(11), 3160-3167.

Gill, T. M. M. D., & Feinstein, A. R. M. D. (1994). A Critical Appraisal of the Quality Of Quality-of-Life Measurements. *JAMA, 272*(8), 619-626.

Gillis, A. J., & Jackson, W. (2002). *Research for nurses : methods and interpretation*. Philadelphia, PA: F.A. Davis Co.

Glasgow, R. E., Ruggiero, L., Eakin, E. G., Dryfoos, J., & Chobanian, L. (1997). Quality of life and associated characteristics in a large national sample of adults with diabetes. *Diabetes Care, 20*(4), 562-567.

Goldney, R. D., Phillips, P. J., Fisher, L. J., & Wilson, D. H. (2004). Diabetes, depression, and quality of life: a population study. *Diabetes Care, 27*(5), 1066-1070.

Graue, M., Wentzel-Larsen, T., Hanestad, B. R., Batsvik, B., & Sovik, O. (2003). Measuring self-reported, health-related, quality of life in adolescents with type 1 diabetes using both generic and disease-specific instruments. *Acta Paediatr, 92*(10), 1190-1196.

Gregg, E. W., Sorlie, P., Paulose-Ram, R., Gu, Q., Eberhardt, M. S., Wolz, M., et al. (2004). Prevalence of lower-extremity disease in the US adult population >=40 years of age with and without diabetes: 1999-2000 national health and nutrition examination survey. *Diabetes Care, 27*(7), 1591-1597.

Guttmacher, A. E., & Collins, F. S. (2002). Genomic medicine--a primer. *New England Journal of Medicine, 347*(19), 1512-1520.

Guyatt, G. H., Feeny, D. H., & Patrick, D. L. (1993). Measuring health-related quality of life. *Annals of Internal Medicine, 118*(8), 622-629.

Haan, M. N., & Weldon, M. (1996). The influence of diabetes, hypertension, and stroke on ethnic differences in physical and cognitive functioning in an ethnically diverse older population. *Annals of Epidemiology, 6*(5), 392-398.

Hamilton, D. M., & Haennel, R. G. (2000). Validity and reliability of the 6-minute walk test in a cardiac rehabilitation population. *Journal of Cardiopulmonary Rehabilitation, 20*(3), 156-164.

Hanestad, B. R. (1993). Self-reported quality of life and the effect of different clinical and demographic characteristics in people with type 1 diabetes. *Diabetes Res Clin Pract, 19*(2), 139-149.

Hanestad, B. R., & Albrektsen, G. (1991). Quality of life, perceived difficulties in adherence to a diabetes regimen, and blood glucose control. *Diabetic Medicine, 8*(8), 759-764.

Hanninen, J. A., Takala, J. K., & Keinanen-Kiukaanniemi, S. M. (1999). Depression in subjects with type 2 diabetes. Predictive factors and relation to quality of life. *Diabetes Care, 22*(6), 997-998.

Hill-Briggs, F., Gary, T. L., Hill, M. N., Bone, L. R., & Brancati, F. L. (2002). Health-related quality of life in urban African Americans with type 2 diabetes. *Journal of General Internal Medicine, 17*(6), 412-419.

Hill, M., & SPSS Inc. (1997). *SPSS Missing Value Analysis™ 7.5*. Chicago, IL: SPSS Inc.

Hiltunen, L., Keinanen-Kiukaanniemi, S., Laara, E., & Kivela, S. L. (1996). Self-perceived health and symptoms of elderly persons with diabetes and impaired glucose tolerance. *Age & Ageing, 25*(1), 59-66.

HIPPEL, P. T. v. (2004). Biases in SPSS 12.0 Missing Value Analysis. *The American Statistician, 58*(2).

Hofer, S., Benzer, W., Alber, H., Ruttmann, E., Kopp, M., Schussler, G., et al. (2005). Determinants of health-related quality of life in coronary artery disease patients: a prospective study generating a structural equation model. *Psychosomatics, 46*(3), 212-223.

Holmes, D. M. (1986). The person and diabetes in psychosocial context. *Diabetes Care, 9*(2), 194-206.

HP. (2000). Diabetes. *Healthy People 2010, Volume I: Understanding and Improving Health* Retrieved March 22, 2005, from http://www.healthypeople.gov/Document/HTML/Volume1/05Diabetes.htm

Hu, L.-t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55.

Hunt, S. M., McKenna, S. P., McEwen, J., Williams, J., & Papp, E. (1981). The Nottingham Health Profile: subjective health status and medical consultations. *Social Science & Medicine - Part A, Medical Sociology, 15*(3 Pt 1), 221-229.

Ibrahim, I. A., Beich, J., Sidorov, J., Gabbay, R., & Yu, L. (2002). Measuring outcomes of type 2 diabetes disease management program in an HMO setting. *Southern Medical Journal, 95*(1), 78-87.

Idler, E. L., & Kasl, S. (1991). Health perceptions and survival: do global evaluations of health status really predict mortality? *J Gerontol, 46*(2), S55-65.

Information Technology Services. (2004, January 27). Handling non-normal data in structural equation modeling (SEM). *General FAQ* Retrieved November 27, 2006, from http://www.utexas.edu/its/rc/answers/general/gen33.html

Jacobs, J. R. (2000). *Health-related quality of life in adolescents with diabetes mellitus.* Jacobs, Jenifer R : U Florida, US.

Jacobson, A. M. (1994). The Diabetes Quality of Life measure. In C. Bradley (Ed.), *Handbook of psychology and diabetes : a guide to psychological measurement in diabetes research and practice* (pp. 65-88). Switzerland ; [Langhorne, Pa.], USA: Harwood Academic Publishers.

Jacobson, A. M. (1997). Quality of Life in Patients With Diabetes Mellitus. *Semin Clin Neuropsychiatry, 2*(1), 82-93.

Jacobson, A. M., de Groot, M., & Samson, J. (1995). Quality of Life Research in Patients With Diabetes Mellitus. In J. E. Dimsdale & A. Baum (Eds.), *Quality of life in behavioral medicine research* (pp. 241-262). Hillsdale, N.J.: Lawrence Erlbaum Associates.

Jacobson, A. M., de Groot, M., & Samson, J. A. (1994). The evaluation of two measures of quality of life in patients with type I and type II diabetes. *Diabetes Care, 17*(4), 267-274.

Jacobson, A. M., de Groot, M., & Samson, J. A. (1997). The effects of psychiatric disorders and symptoms on quality of life in patients with type I and type II diabetes mellitus. *Quality of Life Research, 6*(1), 11-20.

Jacobson, A. M., & The DCCT Research Group. (1994). The Diabetes Quality of Life Measure. In C. Bradley (Ed.), *Handbook of psychology and diabetes : a guide to psychological measurement in diabetes research and practice* (pp. 65-87). Switzerland ; [Langhorne, Pa.], USA: Harwood Academic Publishers.

Janz, N. K., Janevic, M. R., Dodge, J. A., Fingerlin, T. E., Schork, M. A., Mosca, L. J., et al. (2001). Factors influencing quality of life in older women with heart disease. *Medical Care, 39*(6), 588-598.

Jette, A. M., Davies, A. R., Cleary, P. D., Calkins, D. R., Rubenstein, L. V., Fink, A., et al. (1986). The Functional Status Questionnaire: reliability and validity when used in primary care. *J Gen Intern Med, 1*(3), 143-149.

Jette, D. U., & Downing, J. (1996). The relationship of cardiovascular and psychological impairments to the health status of patients enrolled in cardiac rehabilitation programs. *Physical Therapy, 76*(2), 130-139; discussion 140-138.

Johnson, R. J., & Wolinsky, F. D. (1993). The structure of health status among older adults: Disease, disability, functional limitation, and perceived health. *Journal of Health and Social Behavior, 34*(2), 105-121.

Jöreskog, K. G., & Sörbom, D. (1984). *LISREL-VI user's guide* (3rd ed.). Mooresville, IN: Scientific Software.

Kabadi, U. M. (1988). Glycosylation of proteins. Lack of influence of aging. *Diabetes Care, 11*(5), 429-432.

Kaholokula, J. K. a., Haynes, S. N., Grandinetti, A., & Chang, H. K. (2006). Ethnic differences in the relationship between depressive symptoms and health-related quality of life in people with type 2 diabetes. *Ethnicity & Health, 11*(1), 59-80.

Kanta Barman, K., Padmanabhan, M., Premalatha, G., Deepa, R., Rema, M., & Mohan, V. (2004). Prevalence of diabetic complications in fibrocalculous pancreatic diabetic patients and type 2 diabetic patients: a cross-sectional comparative study. *Journal of Diabetes & its Complications, 18*(5), 264-270.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed. ed.). New York: Guilford Press.

Koenig, H. G., George, L. K., Peterson, B. L., & Pieper, C. F. (1997). Depression in medically ill hospitalized older adults: prevalence, characteristics, and course of symptoms according to six diagnostic schemes. *Am J Psychiatry, 154*(10), 1376-1383.

Kolawole, B. A., Abodunde, O., Ikem, R. T., & Fabiyi, A. K. (2004). A test of the reliability and validity of a diabetes specific quality of life scale in a Nigerian hospital. *Quality of Life Research, 13*(7), 1287-1295.

Kopp, J. (1988). Counseling patients who have diabetes and psychological problems (continuing education credit). *Diabetes Educator, 14*(6), 539-545.

Kovacs, M., Iyengar, S., Goldston, D., Stewart, J., Obrosky, D. S., & Marsh, J. (1990). Psychological functioning of children with insulin-dependent diabetes mellitus: a longitudinal study. *Journal of Pediatric Psychology, 15*(5), 619-632.

Kuller, L. H. (1995). Stroke and diabetes. In National Diabetes Data Group (U.S.) (Ed.), *Diabetes in America* (2nd ed., pp. 449-456). Bethesda, Md.: National Institutes of Health National Institute of Diabetes and Digestive and Kidney Diseases.

Leavitt, B. J., Sheppard, L., Maloney, C., Clough, R. A., Braxton, J. H., Charlesworth, D. C., et al. (2004). Effect of Diabetes and Associated Conditions on Long-Term Survival After Coronary Artery Bypass Graft Surgery. *Circulation, 110*(11_suppl_1), II-41-44.

Liebl, A., Neiss, A., Spannheimer, A., Reitberger, U., Wieseler, B., Stammer, H., et al. (2002). Complications, co-morbidity, and blood glucose control in type 2 diabetes mellitus patients in Germany--results from the CODE-2 study. *Experimental & Clinical Endocrinology & Diabetes, 110*(1), 10-16.

Lipkin, M. J. (1990). *Functional status measurement in primary care*. New York: Springer-Verlag.

Lloyd, A., Sawyer, W., & Hopkinson, P. (2001). Impact of long-term complications on quality of life in patients with type 2 diabetes not using insulin. *Value in Health, 4*(5), 392-400.

Lustman, P. J., Griffith, L. S., & Clouse, R. E. (1997). Depression in Adults with Diabetes. *Semin Clin Neuropsychiatry, 2*(1), 15-23.

Lyness, J. M., King, D. A., Cox, C., Yoediono, Z., & Caine, E. D. (1999). The importance of subsyndromal depression in older primary care patients: prevalence and associated functional disability. *J Am Geriatr Soc, 47*(6), 647-652.

Maciejewski, M. L. (2006). Generic measures. In R. L. Kane (Ed.), *Understanding health care outcomes research* (2nd ed., pp. 123-164). Sudbury, Mass.: Jones and Bartlett.

Maddigan, S. L., Feeny, D. H., & Johnson, J. A. (2005). Health-related quality of life deficits associated with diabetes and comorbidities in a Canadian National Population Health Survey. *Quality of Life Research, 14*(5), 1311-1320.

Maggio, C. A., & Pi-Sunyer, F. X. (2003). Obesity and type 2 diabetes. *Endocrinol Metab Clin North Am, 32*(4), 805-822, viii.

Marsh, H. W., & Hocevar, D. (1985). Application of confirmatory factor analysis to the study of self-concept: First- and higher order factor models and their invariance across groups. *Psychological Bulletin, 97*(3), 562-582.

Mayou, R., Bryant, B., & Turner, R. (1990). Quality of life in non-insulin-dependent diabetes and a comparison with insulin-dependent diabetes. *Journal of Psychosomatic Research, 34*(1), 1-11.

McColl, E., Steen, I. N., Meadows, K. A., Hutchinson, A., Eccles, M. P., Hewison, J., et al. (1995). Developing outcome measures for ambulatory care--an application to asthma and diabetes. *Social Science & Medicine, 41*(10), 1339-1348.

McHorney, C. A., Ware, J. E., Jr., Lu, J. F., & Sherbourne, C. D. (1994). The MOS 36-item Short-Form Health Survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. *Medical Care, 32*(1), 40-66.

McHorney, C. A., Ware, J. E., Jr., & Raczek, A. E. (1993). The MOS 36-Item Short-Form Health Survey (SF-36): II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. *Medical Care, 31*(3), 247-263.

Meadows, K., Steen, N., McColl, E., Eccles, M., & et al. (1996). The Diabetes Health Profile (DHP): A new instrument for assessing the psychosocial profile of insulin requiring patients: Development and psychometric evaluation. *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care & Rehabilitation, 5*(2), 242-254.

Meadows, K. A., Abrams, C., & Sandbaek, A. (2000). Adaptation of the Diabetes Health Profile (DHP-1) for use with patients with Type 2 diabetes mellitus: psychometric evaluation and cross-cultural comparison. *Diabetic Medicine, 17*(8), 572-580.

Merkus, M. P., Jager, K. J., Dekker, F. W., Boeschoten, E. W., Stevens, P., & Krediet, R. T. (1997). Quality of life in patients on chronic dialysis: self-assessment 3 months after the start of treatment. The Necosad Study Group. *American Journal of Kidney Diseases, 29*(4), 584-592.

Merkus, M. P., Jager, K. J., Dekker, F. W., de Haan, R. J., Boeschoten, E. W., & Krediet, R. T. (1999). Physical symptoms and quality of life in patients on chronic dialysis: results of

The Netherlands Cooperative Study on Adequacy of Dialysis (NECOSAD)[see comment]. *Nephrology Dialysis Transplantation, 14*(5), 1163-1170.

Moore, W. V., Fredrickson, D., Brenner, A., Childs, B., Tatpati, O., Hoffman, J. M., et al. (1998). Prevalence of hypertension in patients with type II diabetes in referral versus primary care clinics. *Journal of Diabetes & its Complications, 12*(6), 302-306.

Mulaik, S. A., & Millsap, R. E. (2000). Doing the four-step right. *Structural Equation Modeling, 7*(1), 36-73.

Nagi, S. (1965). Some conceptual issues in disability and rehabilitation. In M. B. Sussman (Ed.), *Sociology and rehabilitation*. Cleveland, Ohio: American Sociological Association.

Nazimek-Siewniak, B., Moczulski, D., & Grzeszczak, W. (2002). Risk of macrovascular and microvascular complications in Type 2 diabetes: results of longitudinal study design. *Journal of Diabetes & its Complications, 16*(4), 271-276.

Nerenz, D. R., Repasky, D. P., Whitehouse, F. W., & Kahkonen, D. M. (1992). Ongoing assessment of health status in patients with diabetes mellitus. *Medical Care, 30*(5 Suppl), MS112-124.

NIDDK. (2005a). *Diabetes, Heart Disease, and Stroke* (No. 06-5094). Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, 2005.

NIDDK. (2005b). *National Diabetes Statistics* (No. 06–3892). Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, 2005.

NIDDK. (2006). *Kidney Disease of Diabetes* (No. 07–3925). Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, 2007.

Nokes, K. M., Holzemer, W. L., Corless, I. B., Bakken, S., Brown, M.-A., Powell-Cope, G. M., et al. (2000). Health-related quality of life in persons younger and older than 50 who are living with HIV/AIDS. *Research on Aging, 22*(3), 290-310.

Nordenson, N. J. (2006, 11/10/2006). Glycosylated hemoglobin test. Retrieved 11/10, 2006, from http://www.healthatoz.com/healthatoz/Atoz/ency/glycosylated_hemoglobin_test.jsp

O'Connor, P. J., Gregg, E., Rush, W. A., Cherney, L. M., Stiffman, M. N., & Engelgau, M. M. (2006). Diabetes: How Are We Diagnosing and Initially Managing It? *Ann Fam Med, 4*(1), 15-22.

Ontiveros, J., Miller, T. Q., Markides, K. S., & Espino, D. V. (1999). Physical and psychosocial consequences of stroke in elderly Mexican Americans. *Ethnicity & Disease, 9*(2), 212-217.

Orfila, F., Ferrer, M., Lamarca, R., Tebe, C., Domingo-Salvany, A., & Alonso, J. (2006). Gender differences in health-related quality of life among the elderly: the role of objective

functional capacity and chronic conditions. *Social Science & Medicine, 63*(9), 2367-2380.

Otiniano, M. E., Du, X. L., Ottenbacher, K., & Markides, K. S. (2003). The effect of diabetes combined with stroke on disability, self-rated health, and mortality in older Mexican Americans: results from the Hispanic EPESE. *Archives of Physical Medicine & Rehabilitation, 84*(5), 725-730.

Palumbo, P. J., & Melton III, J. (1995). Peripheral Vascular Disease and Diabetes. In National Diabetes Data Group (U.S.) (Ed.), *Diabetes in America* (2nd ed., pp. 401-408). Bethesda, Md.: National Institutes of Health National Institute of Diabetes and Digestive and Kidney Diseases.

Paolini, L., Yanez, A. P., & Kelly, W. E. (2006). An Examination of Worry and Life Satisfaction Among College Students. *Individual Differences Research, 4*(5), 331-339.

Parkerson, G. R., Jr., Broadhead, W. E., & Tse, C. K. (1991). Development of the 17-item Duke Health Profile. *Family Practice, 8*(4), 396-401.

Parkerson, G. R., Jr., Connis, R. T., Broadhead, W. E., Patrick, D. L., Taylor, T. R., & Tse, C. K. (1993). Disease-specific versus generic measurement of health-related quality of life in insulin-dependent diabetic patients. *Medical Care, 31*(7), 629-639.

Paschalides, C., Wearden, A. J., Dunkerley, R., Bundy, C., Davies, R., & Dickens, C. M. (2004). The associations of anxiety, depression and personal illness representations with glycaemic control and health-related quality of life in patients with type 2 diabetes mellitus. *Journal of Psychosomatic Research, 57*(6), 557-564.

Patrick, D. L., & Bergner, M. (1990). Measurement of health status in the 1990s. *Annual Review of Public Health, 11*, 165-183.

Patrick, D. L., Danis, M., Southerland, L. I., & Hong, G. (1988). Quality of life following intensive care. *J Gen Intern Med, 3*(3), 218-223.

Patrick, D. L., & Deyo, R. A. (1989). Generic and disease-specific measures in assessing health status and quality of life. *Medical Care, 27*(3 Suppl), S217-232.

Patrick, D. L., & Deyo, R. A. (1994). Generic and disease-specific measures in assessing health status and the quality of life. In J. E. Mezzich & M. R. Jorge (Eds.), *Psychiatric epidemiology: Assessment concepts and methods* (pp. 452-474). Baltimore, MD: Johns Hopkins University Press.

Patrick, D. L., & Erickson, P. (1993). Health status and health policy : quality of life in health care evaluation and resource allocation. In (pp. 20). New York: Oxford University Press.

Penckofer, S., Ferrans, C. E., Fink, N., Barrett, M. L., & Holm, K. (2005). Quality of Life in Women Following Coronary Artery Bypass Graft Surgery. *Nurs Sci Q, 18*(2), 176-183.

Perlman, R. L., Finkelstein, F. O., Liu, L., Roys, E., Kiser, M., Eisele, G., et al. (2005). Quality of life in chronic kidney disease (CKD): a cross-sectional analysis in the Renal Research Institute-CKD study. *American Journal of Kidney Diseases, 45*(4), 658-666.

Peyrot, M., & Rubin, R. R. (1997). Levels and risks of depression and anxiety symptomatology among diabetic adults.[see comment]. *Diabetes Care, 20*(4), 585-590.

Phaladze, N. A., Human, S., Dlamini, S. B., Hulela, E. B., Hadebe, I. M., Sukati, N. A., et al. (2005). Quality of life and the concept of "living well" with HIV/AIDS in sub-Saharan Africa. *Journal of Nursing Scholarship, 37*(2), 120-126.

Piccinni, A., Maser, J. D., Bazzichi, L., Rucci, P., Vivarelli, L., Del Debbio, A., et al. (2006). Clinical significance of lifetime mood and panic-agoraphobic spectrum symptoms on quality of life of patients with rheumatoid arthritis. *Comprehensive Psychiatry, 47*(3), 201-208.

Polonsky, W. H. (2000). Understanding and Assessing Diabetes-Specific Quality of Life. *Diabetes Spectrum, 13*, 36.

Potasova, A., & Prokopcakova, A. (2003). Life satisfaction and affectivity (A research probe). *Studia Psychologica, 45*(3), 203-210.

Read, J. L., Quinn, R. J., & Hoefer, M. A. (1987). Measuring overall health: an evaluation of three important approaches. *Journal of Chronic Diseases, 40 Suppl 1*, 7S-26S.

Redelmeier, D. A., Bayoumi, A. M., Goldstein, R. S., & Guyatt, G. H. (1997). Interpreting small differences in functional status: the Six Minute Walk test in chronic lung disease patients. *American Journal of Respiratory & Critical Care Medicine, 155*(4), 1278-1282.

Rejeski, W. J., Lang, W., Neiberg, R. H., Van Dorsten, B., Foster, G. D., Maciejewski, M. L., et al. (2006). Correlates of health-related quality of life in overweight and obese adults with type 2 diabetes. *Obesity, 14*(5), 870-883.

Rocco, M. V., Gassman, J. J., Wang, S. R., & Kaplan, R. M. (1997). Cross-sectional study of quality of life and symptoms in chronic renal disease patients: the Modification of Diet in Renal Disease Study. *American Journal of Kidney Diseases, 29*(6), 888-896.

Rubin, R. R., & Peyrot, M. (1999). Quality of life and diabetes. *Diabetes/Metabolism Research Reviews, 15*(3), 205-218.

Sacco, R. L., Boden-Albala, B., Abel, G., Lin, I. F., Elkind, M., Hauser, W. A., et al. (2001). Race-ethnic disparities in the impact of stroke risk factors: the northern Manhattan stroke study. *Stroke, 32*(8), 1725-1731.

Schipper, H., Clinch, J., & Olweny, C. L. M. (1996). Quality of life studies: definitions and conceptual issues. In B. Spilker (Ed.), *Quality of life and pharmacoeconomics in clinical trials* (2nd ed., pp. 11-24). Philadelphia: Lippincott-Raven.

Schwartz, C. E., Sprangers, M. A. G., Carey, A., & Reed, G. (2004). Exploring response shift in longitudinal data. *Psychology & Health, 19*(1), 51 - 69.

Sereika, S., & Engberg, S. (2006). *Development of Standardized Sociodemographic and Co-Morbidity Questionnaires*. Paper presented at the The 17th International Nursing Research Congress Focusing on Evidence-Based Practice. Retrieved August 10, 2006, from http://stti.confex.com/stti/congrs06/techprogram/paper_30321.htm.

Shen, W. P., Kotsanos, J. G. M. D., Huster, W. J. P., Mathias, S. D. M. P. H., Andrejasich, C. M. M. S., & Patrick, D. L. P. (1999). Development and Validation of the Diabetes Quality of Life Clinical Trial Questionnaire. *Medical Care, 37(4) LILLY*(SUPPLEMENT), AS45-AS66.

Shobhana, R., Rama Rao, P., Lavanya, A., Padma, C., Vijay, V., & Ramachandran, A. (2003). Quality of life and diabetes integration among subjects with type 2 diabetes. *Journal of the Association of Physicians of India, 51*, 363-365.

Shumaker, S. A., & Naughton, M. J. (1995). The international assessment of health-related quality of life: A theoretical perspective. In S. A. Shumaker & R. A. Berzon (Eds.), *The international assessment of health-related quality of life : theory, translation, measurement and analysis* (pp. vi, 275 p.). Oxford ; New York: Rapid Communications.

Singh, B. M., Jackson, D. M., Wills, R., Davies, J., & Wise, P. H. (1992). Delayed diagnosis in non-insulin dependent diabetes mellitus. *BMJ, 304*(6835), 1154-1155.

Smith, K. W., Avis, N. E., & Assmann, S. F. (1999). Distinguishing between quality of life and health status in quality of life research: A meta-analysis. *Quality of Life Research, 8*(5), 447-459.

Solway, S., Brooks, D., Lacasse, Y., & Thomas, S. (2001). A qualitative systematic overview of the measurement properties of functional walk tests used in the cardiorespiratory domain. *Chest, 119*(1), 256-270.

Sousa, K., & Kwok, O. (2006). Putting Wilson and Cleary to the Test: Analysis of a HRQOL Conceptual Model using Structural Equation Modeling. *Quality of Life Research, 15*, 725-737.

Speight, J. (2002). Assessing the impact of diabetes screening on quality of life or quality of health? *Diabetes Care, 25*(10), 1893-1894.

Spielberger, C. D. (1972). *Anxiety: current trends in theory and research*. New York,: Academic Press.

Spielberger, C. D., & Gorsuch, R. L. (1983). *State-trait anxiety inventory for adults : sampler set : manual, test, scoring key*. Redwood City, Calif.: Mind Garden.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

SPSS Inc. (2004). SPSS version 13.0 for Windows (Version 13.0 for Windows). Chicago, IL: SPSS Inc.

SPSS Inc. (2005). AMOS version 6.0 for Windows (Version 6.0 for Windows). Chicago, IL: SPSS Inc.

Stern, S. E., Williams, K., Ferrannini, E., DeFronzo, R. A., Bogardus, C., & Stern, M. P. (2005). Identification of individuals with insulin resistance using routine clinical measurements. *Diabetes, 54*(2), 333-339.

Stevens, J. (1996). *Applied multivariate statistics for the social sciences* (3rd ed. ed.). Mahwah, N.J.: Lawrence Erlbaum Associates.

Stewart, A. L., Greenfield, S., Hays, R. D., Wells, K., Rogers, W. H., Berry, S. D., et al. (1989). Functional status and well-being of patients with chronic conditions. Results from the Medical Outcomes Study. *JAMA, 262*(7), 907-913.

Sullivan, M. D., Kempen, G. I., Van Sonderen, E., & Ormel, J. (2000). Models of health-related quality of life in a population of community-dwelling Dutch elderly. *Quality of Life Research, 9*(7), 801-810.

Sureshkumar, K. K., Mubin, T., Mikhael, N., Kashif, M. A., Nghiem, D. D., & Marcus, R. J. (2002). Assessment of quality of life after simultaneous pancreas-kidney transplantation. *American Journal of Kidney Diseases, 39*(6), 1300-1306.

Tabachnick, B. G., & Fidell, L. S. (2000). *Using Multivariate Statistics* (4th ed.). Needham Heights, MA 02494: Allyn & Bacon.

Testa, M. A., & Simonson, D. C. (1996). Assessment of quality of life outcomes. *New England Journal of Medicine, 334*(13), 835-840.

Thommasen, H. V., & Zhang, W. (2006a). Health-related quality of life and type 2 diabetes: A study of people living in the Bella Coola Valley. *BC Med J, 48*(6), 272-278.

Thommasen, H. V., & Zhang, W. (2006b). Impact of chronic disease on quality of life in the Bella Coola Valley. *Rural & Remote Health, 6*(2), 528.

Trief, P. M., Wade, M. J., Pine, D., & Weinstock, R. S. (2003). A comparison of health-related quality of life of elderly and younger insulin-treated adults with diabetes. *Age & Ageing, 32*(6), 613-618.

Troosters, T., Gosselink, R., & Decramer, M. (1999). Six minute walking distance in healthy elderly subjects.[see comment]. *European Respiratory Journal, 14*(2), 270-274.

US. Census Bureau. (2005). Poverty Thresholds 2005 (Publication. Retrieved 11/04/2006, from U.S. Census Bureau: http://www.census.gov/hhes/www/poverty/threshld/thresh05.html

vanden Bos, G., & Limburg, L. (1995). Public health and chronic diseases. *European Journal of Public Health, 5*, 1-2.

Verbrugge, L. M. (1991). Physical and social disability in adults. In H. Hibbard, P. A. Nutting, M. L. Grady, United States. Agency for Health Care Policy and Research. & United States. Health Resources and Services Administration. (Eds.), *Primary care research, theory and methods : conference proceedings* (pp. 31-53). Rockville, MD: U.S. Department of Health and Human Services Public Health Service Agency for Health Care Policy and Research.

Viinamaki, H., Niskanen, L., & Uusitupa, M. (1995). Mental well-being in people with non-insulin-dependent diabetes. *Acta Psychiatrica Scandinavica, 92*(5), 392-397.

Walters, B. A. J., Hays, R. D., Spritzer, K. L., Fridman, M., & Carter, W. B. (2002). Health-related quality of life, depressive symptoms, anemia, and malnutrition at hemodialysis initiation. *American Journal of Kidney Diseases, 40*(6), 1185-1194.

Wan, T. T. (1976). Predicting self-assessed health status: a multivariate approach. *Health Serv Res, 11*(4), 464-477.

Wang, L.-s., Sun, Z.-q., Cai, T.-s., & Zhou, Z.-g. (2005). Development and evaluation of quality of life scale for patients with type 2 diabetes mellitus. *Zhong Nan da Xue Xue Bao, Yi Xue Ban = Journal of Central South University. Medical Sciences. 30*(1), 21-27.

Ward, J., Lin, M., Heron, G., & Lajoie, V. (1997). Comprehensive audit of quality-of-care and quality-of-life for patients with diabetes. *Journal of Quality in Clinical Practice, 17*(2), 91-100; discussion 101-102.

Ware, J. E., Jr. (1976). Scales for measuring general health perceptions. *Health Services Research, 11*(4), 396-415.

Ware, J. E., Jr. (1987). Standards for validating health measures: definition and content. *J Chronic Dis, 40*(6), 473-480.

Ware, J. E., Jr. (1993). *SF-36 health survey : manual and interpretation guide*. Boston, Mass.: The Health Institute, New England Medical Center.

Ware, J. E., Jr., Brook, R. H., Davies, A. R., & Lohr, K. N. (1981). Choosing measures of health status for individuals in general populations. *Am J Public Health, 71*(6), 620-625.

Ware, J. E., Jr., Kosinski, M., & Dewey, J. E. (2000). *How to Score Version 2 of the SF-36® Health Survey (Standard & Acute Forms)*. Lincoln, RI: QualityMatric Incorporated.

Ware, J. E., Jr., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Medical Care, 30*(6), 473-483.

Watkins, K., & Connell, C. M. (2004). Measurement of Health-Related QOL in Diabetes Mellitus. *Pharmacoeconomics, 22*(17), 1109-1126.

Wee, H.-L., Cheung, Y.-B., Li, S.-C., Fong, K.-Y., & Thumboo, J. (2005). The impact of diabetes mellitus and other chronic medical conditions on health-related Quality of Life: is the whole greater than the sum of its parts? *Health & Quality of Life Outcomes, 3*, 2.

Weinberger, M., Kirkman, M., Samsa, G. P., Cowper, P. A., & et al. (1994). The relationship between glycemic control and health-related quality of life in patients with non-insulin-dependent diabetes mellitus. *Medical Care, 32*(12), 1173-1181.

Wells, K. B., Stewart, A., Hays, R. D., Burnam, M. A., Rogers, W., Daniels, M., et al. (1989). The functioning and well-being of depressed patients. Results from the Medical Outcomes Study.[see comment]. *JAMA, 262*(7), 914-919.

Whisman, M. A., Perez, J. E., & Ramel, W. (2000). Factor structure of the Beck Depression Inventory - Second Edition (BDI-ii) in a student sample. *Journal of Clinical Psychology, 56*(4), 545-551.

WHO. (1946). Constitution of the World Health Organization. *American Journal of Public Health, 46*(11), 1315-1323.

Wilson, I. B., & Cleary, P. D. (1995). Linking Clinical Variables With Health-Related Quality of Life: A Conceptual Model of Patient Outcomes. *JAMA, 273*(1), 59-65.

Wilson, I. B., & Cleary, P. D. (1997). Clinical predictors of declines in physical functioning in persons with AIDS: results of a longitudinal study. *Journal of Acquired Immune Deficiency Syndromes & Human Retrovirology, 16*(5), 343-349.

Woodcock, A. J., Julious, S. A., Kinmonth, A. L., & Campbell, M. J. (2001). Problems with the performance of the SF-36 among people with type 2 diabetes in general practice. *Quality of Life Research, 10*(8), 661-670.

Worley, K. L., Lalonde, D. R., Kerr, D. R., Benavente, O., & Hart, R. G. (1998). Survey of the causes of stroke among Mexican Americans in South Texas. *Texas Medicine, 94*(5), 62-67.