Socioeconomic and Medical Characteristics Associated with Health-Related Quality of Life in North Carolina's Adults with Diabetes Mellitus

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Background:
In addition to the substantial mortality, medical morbidity, and disability among people in North Carolina and the US with diabetes mellitus, poor health-related quality of life is increasingly being documented among people with diabetes. As we consider interventions to improve health-related quality of life among people with diabetes, information about which subgroups have a poor quality of life may help target our resources and interventions more effectively.

Objective:
To determine which groups of people with diabetes in North Carolina have lower health-related quality of life.

Methods:
A Centers for Disease Control and Prevention (CDC) collaboration resulted in the creation of the Healthy Days measures, a set of four questions to assess general well-being that have been included in the core questions of the Behavior Risk Factor Surveillance System (BRFSS) in every state since 1993. The BRFSS, sponsored by the CDC, is a state-based, random-digit dialed telephone survey of civilian, non-institutionalized adults ≥ 18 years old. We used the North Carolina BRFSS from 1998-2001 to explore associations between HRQOL and sociodemographic and medical characteristics among adults with diabetes using the Healthy Days questions as outcomes. We hypothesized that age, sex, race, income, education, employment, insurance status, obesity, duration of diabetes, and insulin use would be associated with health-related quality of life among people with diabetes. We dichotomized the non-linear outcomes of physically unhealthy days, mentally unhealthy days, and functionally limited days into seven days or less and more than seven days since one week of unhealthy days is a clinically and socially significant outcome.

Statistical Analyses:
All analyses were conducted using Stata version 7.0. Descriptive analyses were conducted using tests of proportions and means with standard deviations. Relationships between sociodemographic and medical characteristics with the dichotomized Healthy Days measures were done using Pearson’s Chi-square. Results were considered statistically significant if the p-value was less than 0.05.

Results:
The majority of adults with diabetes in North Carolina were female, younger than 65 years, White, had a household income of greater than $20,000 per year, had a college education or greater, were not employed, had insurance, did not use insulin, were diagnosed less than 10 years ago, and were not disabled. An equal number of adults in North Carolina with diabetes rated their health as excellent, very good, or good (49%) compared to fair or poor (51%). The overall mean for physically unhealthy days was 9.3 per month, for mentally unhealthy days was 4.5 per month, and for functionally limited days was 5.7 per month.
People with diabetes in North Carolina were more likely to have a poor quality of life on all or most of the Healthy Days measures if they had a high school education or less,
lower household income, were unemployed, had no health insurance, had a longer duration of diabetes, and were using insulin. Race was the only sociodemographic characteristic with no relation to quality of life. Female sex was only related to more mentally unhealthy days. Younger age was associated with more mentally unhealthy days and older age was associated with a lower general health rating. Obesity was only associated with more functionally limited days, not the total number of mentally or physically unhealthy days.

Conclusions:
In this study of health-related quality of life among persons with diabetes in North Carolina, the greatest differences were between socioeconomic groups, with those of lower socioeconomic status having lower HRQOL. In addition, markers of more severe diabetes, including longer duration and use of insulin, are associated with a worse overall health-related quality of life. The significant degree of difference in the Healthy Days measures between various subgroups of people with diabetes based on the sociodemographic and medical characteristics we studied suggests that medical interventions could help reduce health disparities if targeted accordingly. The continual nature of the BRFSS will allow the NC DCP to track HRQOL over time and compare the results to other subgroups of the population. As the North Carolina Diabetes Control Program participates in efforts to increase the number of healthy years among people with diabetes, following the differences in HRQOL among subgroups will help direct resources and monitor the effectiveness of interventions.
**Background: the burden of diabetes mellitus**

Diabetes mellitus is a health challenge in North Carolina due to the large and increasing number of people affected, the shortened life expectancy, the associated complications and disability, and the high economic costs. Furthermore, in almost every study comparing people with diabetes to the general population, diabetes mellitus is associated with worse health-related quality of life (HRQOL) [1-9]. Health-related quality of life is defined by the Centers for Disease Control and Prevention (CDC) as “an individual’s or group’s perceived physical and mental health over time” [10]. Not only is quality of life an important health outcome as a measure of well-being, but people’s subjective perceptions of health are also related to more conventional health outcomes such as mortality and health care use [10, 11].

The prevalence of diagnosed diabetes in North Carolina’s adult population increased 42% in the last six years, from 4.5% in 1995 to 6.4% in 2000 [12]. This prevalence underestimates the total number of persons with diabetes since approximately one-third are undiagnosed [12]. The number of people affected with diabetes mellitus is expected to continue to rise due to an increased
prevalence of risk factors for diabetes such as obesity and older age. In North Carolina, the percentage of people who are obese increased in the last decade from 12.9% in 1990 to 21.8% in 2000 [13]. The number of elderly is also expected to rise from 991,000 on July 1, 2000 to 2,004,000 by July 1, 2025 [14].

Previous research has focused on the significant mortality and medical morbidity caused by diabetes. Diabetes mellitus is ranked the 4th most common cause of death among both Blacks and American Indians in North Carolina, and the 8th most common among both Whites and Hispanics [14]. These rankings of death are based only on the “underlying cause” listed on death certificates and do not reflect that diabetes is a major contributing factor to other top causes of death such as heart disease and stroke. Since diabetes is three times more likely to be recorded as a contributing cause of death than an underlying cause, these statistics likely underestimate the burden of diabetes [15]. Diabetes also contributes to substantial medical morbidity. Approximately 13,000 hospitalizations and 3,000 lower extremity amputations occur each year in North Carolina due to complications of diabetes [12]. Nationally, diabetes is the leading cause of both new cases of blindness and new cases of end-stage renal disease among adults [16].

The significant medical complications of diabetes contribute to the higher rates of disability among those with the disease. In the 1989 National Health Interview Survey, people with diabetes reported two to three times more activity limitations than those without diabetes [16]. A study in the Netherlands prospectively followed people aged 15 to 74 years with at least one of four
chronic diseases, and found that diabetes was associated with an increased risk of disability over six years [17]. One study of community-dwelling men and women 60 years or older found that those with diabetes had a 46-50% higher risk of disability than those without diabetes, even after controlling for age, ethnicity, education, body mass index, and a number of comorbid diseases [18]. Other studies among community-dwelling elderly also detected higher rates of disability, as measured both by self-report and physical performance tests, among people with diabetes compared to those without [5, 19-23].

The economic costs of diabetes are significant, owing to both direct medical expenses and the indirect costs of lost work. Using a model developed by the CDC, Kegler et al estimated the total cost of diabetes in North Carolina during 1990 to be approximately $1.2 billion, including $490 million for inpatient care, $84 million for outpatient care, and $664 million for indirect costs [15]. By 1998, the estimated hospitalization costs alone were more than $1.5 billion [12].

Using 1993 Medicare data, researchers determined that patients with diabetes were 76% more likely to be hospitalized than patients without diabetes, and hospitalization costs were almost 60% higher for those with diabetes [24]. Researchers have calculated substantial indirect costs of diabetes due to excess lost work and wages compared to persons without diabetes. Persons with type 2 diabetes mellitus in the 1989 National Health Interview Survey were less likely to be employed and more likely to report work loss days than those without diabetes [16]. Using claims records and population-based survey data, other researchers also observed that persons with diabetes were more likely to report both short-
term work absences and permanent disability [25-28]. Not only are persons with diabetes more likely to miss work compared to persons without diabetes, but one study found that persons with diabetes were significantly more likely to also lose work hours due to the failure to meet productivity standards while on the job [29].

In addition to the substantial mortality, medical morbidity, and disability among people in North Carolina and the US with diabetes mellitus, poor health-related quality of life is increasingly being documented among people with diabetes. Using general quality of life measures, people with diabetes consistently rate their health status worse than those without diabetes. Although some studies suggest that people with diabetes may have slightly better quality of life than those with other chronic conditions [6, 30], other studies observe that having diabetes is associated with a lower general health rating versus having other chronic conditions [1]. Most studies comparing people with diabetes to the general population find that both physical and mental health-related quality of life is worse among people with diabetes [1-5, 7-9].

The CDC and public health community are interested in measuring health-related quality of life as recognition of a broader definition of health other than traditional outcomes of morbidity and mortality associated with disease. As people live longer, clinicians, researchers, and policy-makers are acknowledging the importance of the quality of those years. The Division of Adult and Community Health in the CDC’s National Center for Chronic Disease Prevention and Health Promotion initiated a collaborative program in 1989 to develop a standard set of HRQOL measures that could be used for population health.
surveillance [10]. The collaboration resulted in the creation of the Healthy Days measures, a set of four questions to assess general well-being in a defined set of time [10]. The measures assess overall self-rated health, a global measure of physical health in the last 30 days, a global measure of mental health in the last 30 days, and a fourth question regarding functionally limited days in the last 30 days as a global indicator of "productivity and human capital" [10]. These four measures have been included in the core questions of the Behavior Risk Factor Surveillance System (BRFSS) in every state since 1993.

In addition to the importance of health-related quality of life as an outcome, other studies suggest that quality of life is associated with more traditional measures of health. Salas et al found that "costs, physician visits, and in-patient days were directly related to the patient’s self-perception of physical functioning" [24]. Mor et al also observed that improvement from a state of physical dependence to independence among the elderly lowered hospitalization rates [31]. Citing studies relating increased chronic diseases and mortality to worse self-perceptions of health, the CDC’s Division of Adult and Community Health concludes that "self-perceptions are...predictive of the future burden on the health care delivery system" [10]. Other research suggests that psychosocial factors in patients with diabetes are also "stronger predictors of medical outcomes such as hospitalization and mortality than are physiologic and metabolic measures (such as the presence of complications, BMI and HbA1c)" [11]. Health-related quality of life is also associated with the indirect costs of lost earnings. Yassin et al used cross-sectional data from the 1994 BRFSS to assess the annual cost
nationally among people with diabetes of functionally limited days, one of the
CDC's measures of quality of life [28]. They calculated that men and women
with diabetes were less likely to participate in the labor force than those without
diabetes. In addition, people with diabetes who did work had more functionally
limited days per month than those without diabetes. Using the value of annual
lost earnings in 1994 dollars, people with diabetes who dropped out of the labor
force contributed $76 million in economic loss. However, the greater economic
cost was days missed due to disability from perceived poor health among people
with diabetes who still worked, contributing another $9.2 billion of loss. As our
health care system and employers face increasing numbers of people with
diabetes mellitus, the substantial morbidity associated with diabetes becomes a
burden not only to those with the disease, but their families, employers, and
communities.

**Can medical interventions improve health-related quality of life among
patients with diabetes?**

Most of the current interventions are designed to target people with
diabetes who have medical indicators of more severe disease, such as those with
higher mortality rates, higher diabetes complication rates, or higher disability
rates. However, to meet a goal of increasing the number of healthy years that
people with diabetes live, then we should also target those with a greater
perceived burden of disease and worse health-related quality of life. If quality of
life can be improved through specific interventions, then not only can the
subjective perceptions of health be enhanced, but people with diabetes may also
have better medical outcomes and increased functional days. Therefore, tracking health-related quality of life in people with diabetes is a valid outcome of interest only if clinicians and the public health community can implement medical care and community programs that improve HRQOL.

Researchers have discovered a few interventions directed towards individuals that improve health-related quality of life [11]. Some of the medical interventions that resulted in an enhanced HRQOL included intensified treatment with improved glycemic control, treatment of diabetic symptoms, and physical rehabilitation [11]. Most of the counseling or educational interventions were designed to enhance coping skills and resulted in improved emotional well-being [11]. Current research has not yet investigated whether public health interventions can affect quality of life among people with diabetes.

Indirect evidence suggests that by implementing treatments to decrease the number and severity of diabetes complications, we can improve the quality of life of people with diabetes. Studies looking at both type 1 and type 2 diabetes mellitus have shown that the microvascular complications of diabetes can be prevented with improved metabolic control and medical care [32, 33]. In addition, researchers have examined the cost-effectiveness of intensive therapy as practiced in effective clinical trials and found acceptable incremental costs for the decrease in morbidity and mortality [34, 35]. Since research links the number of complications inversely to health-related quality of life [8, 36-46], implementing proven diabetes treatment and monitoring regimens that decrease complications should improve HRQOL. Effective diabetes treatment may also decrease the
indirect costs of diabetes through improved work performance. One study compared patients with type 2 diabetes mellitus who were receiving glipizide versus those receiving placebo, and found that those receiving active therapy had higher retention of employment, greater retained productive capacity, and less absenteeism than those in the placebo group [47].

Health-related quality of life among patients with diabetes mellitus

Research has previously shown that people with diabetes have a lower health-related quality of life than the general population. As we consider interventions to improve health-related quality of life among people with diabetes, information about which subgroups have a poor quality of life may help target our resources and interventions more effectively. Tracking health-related quality of life specifically among people with diabetes also contributes to knowledge about health disparities and allows for comparisons between subgroups based on diabetes-specific complications and treatment not applicable to the general population.

Research by Glasgow et al is the most comprehensive and representative study of quality of life among people with diabetes in the United States [37]. Glasgow et al mailed adults with diabetes in the United States who were part of a marketing company sample the Medical Outcomes Study (MOS) Short-Form General Health Survey, the most widely used generic measure of quality of life in clinical research. Achieving a 73% response rate, the total sample size was 2056 adults of whom 86% were type 2, 62% were female, 53% had a high school
education or less, and 95% were White. The average age was 59. The researchers examined the association of a variety of socioeconomic, medical, diabetes-related and health-behavioral characteristics with social, physical, and mental health-related quality of life measures. In addition to comparing each characteristic with these three quality of life scores, the researchers also created prediction models of quality of life adjusting for all of the characteristics.

According to Glasgow et al's study results, multiple sociodemographic, medical, diabetes-related, and health behavioral characteristics are associated with quality of life. All of the sociodemographic characteristics were related to quality of life except race. Older age, female sex, lower income, high school education or less, living alone, and government health insurance were all associated with lower physical and social quality of life. Younger age, female sex, lower income, high school education or less, and government health insurance or no insurance were all also associated with lower mental quality of life. In addition to socioeconomic characteristics, Glasgow et al also examined medical and diabetes-related characteristics. Having two or more comorbid diseases and two or more diabetes microvascular complications were associated with the largest reductions in physical, social, and mental quality of life compared to the other characteristics. Persons with type 2 diabetes who used insulin also had worse physical and social quality of life than either persons with type 1 diabetes or those with type 2 diabetes not using insulin. Longer duration of diabetes was related to worse physical and social quality of life. Of the health behaviors, more frequent blood glucose testing and adhering to a diabetes diet were both associated with worse
mental quality of life whereas less physical activity was associated with worse physical, social, and mental quality of life. According to the results from the prediction models, quality of life was independently significantly related to most of the sociodemographic characteristics as well as the number of comorbidities, the number of complications, taking insulin or not, and exercise level. When adjusting for the other characteristics, a longer duration of diabetes was no longer associated with quality of life.

Although most of the other research on quality of life among people with diabetes only focused on a few characteristics, many of the observed associations are consistent with Glasgow et al. Sociodemographics, specifically increasing age [3, 9, 20, 29, 46, 48], female sex [3, 8, 39, 45, 46, 48, 49], and lower income [3, 39], were associated with worse health-related quality of life in the majority of the research. Studies also verify Glasgow et al’s findings that race is not associated with quality of life [37, 38, 45, 49, 50]. Of studies that investigated educational level, only one verified Glasgow et al’s finding that those with less than a high school education had lower health-related quality of life [39], whereas most found no difference [3, 20, 38, 50]. Glasgow et al found differences in quality of life between persons with diabetes who lived alone versus those who lived with someone, but other studies found no significant association when using similar outcomes for living status such as marital status or cohabitation [2, 3, 39, 50]. Employment status was only examined in one study of persons with diabetes, but those who were unemployed had lower HRQOL [3]. Studies that did not find associations between sociodemographics and quality of life usually had more
homogeneous populations of people with diabetes than the study by Glasgow et al [2, 38, 50, 51].

Researchers investigating the association of other chronic diseases and health-related quality of life among patients with diabetes have found that all chronic diseases decrease quality of life and increase disability. Rather than investigating the effects of the number of comorbidities, most researchers specifically examined individual diseases. Chronic diseases negatively affecting quality of life among patients with diabetes include: cardiovascular disease [2, 6, 46], arthritis [6, 50], obesity [2], chronic lung disease [6], and depression [38, 50, 52, 53].

Researchers have also focused on the associations between different diabetes-related characteristics and health-related quality of life. Studies investigating complications of diabetes, duration of diabetes, and insulin use, discovered similar results as Glasgow et al. Complications of diabetes, both microvascular and macrovascular, were consistently associated with worse quality of life [8, 36, 38-46]. In one study of patients with type 2 diabetes who were less than 65 years old, low visual acuity, neuropathy, and microalbuminuria did not affect HRQOL after adjusting for obesity and coronary heart disease [2]. However, results from another study of patients with diabetes suggest that the severity of microvascular complications is more important than the number of complications [54]. The relationship between duration of diabetes and HRQOL depended on whether adjustments were made for the confounding of other socioeconomic and medical characteristics. When unadjusted for the number of
diabetes complications, most studies observed that longer duration of diabetes was associated with worse health-related quality of life [48-50]. However, the association was not significant in other studies, especially after adjusting for additional characteristics [2, 8, 38, 39, 41, 45, 51]. Researchers also observed that insulin use in patients with type 2 diabetes was associated with worse quality of life [8, 38, 49]. However, one study found that the sex of the person with diabetes may interact with the association of insulin use and quality of life. In that study, women using insulin had worse quality of life compared to women using diet and/or pills, but men using insulin had less anxiety than men using diet and/or pills [55].

In addition to the diabetes-related characteristics investigated in the study by Glasgow et al, other studies also examined the association between diabetes-treatment related factors such as glycemic control, treatment intensity, and glycemia-related symptoms with quality of life. Overall, hyperglycemia symptoms and perhaps poor metabolic control contribute to decreased quality of life. Symptoms due to diabetes were consistently associated with a lower quality of life [39, 40, 46, 50, 56]. Poor glycemic control was associated with a lower health-related quality of life in some studies [39, 46, 47, 56], but other studies found no relation [2, 4, 8, 36]. Studies that looked at the intensity of treatment found no difference in quality of life between intensively treated versus conventionally treated patients in both type 1 patients [51] and type 2 patients [40]. However, some research showed that better glycemic control was related to
improved health-related quality of life, especially if symptoms were decreased [47, 50, 56].

Less evidence exists regarding the association between health behavioral factors such as smoking, alcohol, and exercise with quality of life among those with diabetes. One study specifically examined general health-related quality of life and found that smoking was associated with worse scores on all the Medical Outcomes Study measures in primary care patients with diabetes [46]. However, most studies only investigated the association between smoking and disability with inconsistent results [17, 18, 20, 57]. All of the studies examining levels of physical activity have found that high levels of activity were associated with better quality of life and less disability whereas sedentary lifestyles were associated with worse quality of life and more disability [20, 46, 57-59]. However, physical activity is a similar measure as the physical health-related quality of life scales. In addition, none of these studies were able to look at either physical activity prior to the onset of disability or the association between changes in physical activity with changes in disability status and quality of life.

Limitations of previous research on HRQOL among people with diabetes

Previous research on quality of life among people with diabetes is difficult to synthesize and generalize to a state population for multiple reasons. Although the study by Glasgow et al was a representative and comprehensive study of the quality of life among adults with diabetes in the United States, the participants were selected based on a marketing sample and may be different than the general
population of people with diabetes in North Carolina. Many of the population-based studies of people with diabetes were done in Europe where population characteristics differ significantly from the United States and health care is universal [2-4, 8, 9, 39, 48, 49, 53]. Most of the other studies of quality of life among people with diabetes were done using a select group of clinic patients, including patients seen at diabetes clinics [6, 38, 41, 45, 46, 50, 52, 56, 59, 60], patients with specific diabetes complications [36, 42-44], and patients who participated in clinical trials [40, 47, 51]. Some of the researchers also focused on a subgroup of the general population such as the elderly, white women, Mexican Americans, or African Americans. Comparisons of the results are also limited since many of the studies were specifically looking at the difference in quality of life between two subgroups of people with diabetes such as the difference between males and females, between intensively controlled and conventionally treated, or between patients with various diabetes complications and those without, rather than investigating associations between multiple characteristics with health-related quality of life.

The variety of quality of life scales used also makes comparison of research results difficult. Most studies used general quality of life scales rather than diabetes-specific scales to measure health related quality of life. Although diabetes-specific scales allow for focus on problems posed by diabetes such as hypoglycemia, hyperglycemia, self-monitoring of blood glucose, dietary restrictions, and fear of complications, the generic scales allow for better comparison between groups of individuals with different diseases. Generic
measures used include the Medical Outcomes Study Short-Form General Health Survey, including the Swedish translation, the Nottingham Health Profile, and the Sickness Impact Profile [11]. Diabetes-specific measures include the Diabetes Quality of Life measure, developed for use in the Diabetes Control and Complications Trial; the Diabetes-39 instrument; and the Problem Areas in Diabetes survey [11].

The benefits of using the BRFSS Healthy Days measures of HRQOL

The most common general health-related quality of life scale used in previous studies was the Medical Outcomes Study Short-Form General Health Survey with physical, social, and role functioning scales as well as measures of mental health, perceptions of overall health, and pain intensity. Although extensively used and validated, the length of the MOS form is impractical to use for population surveillance and does not quantify the effects of a poor quality of life in a manner relevant to policy makers. Therefore, the CDC developed a scale using four basic questions regarding self-rated health and the number of unhealthy days that would be both shorter and relevant to policy makers. Healthy Days measures ask about a person’s self-rated health, physical health, and mental health by assessing the number of unhealthy days and the number of days when a person had activity limitations due to poor health in the past month. Analyses of the Behavior Risk Factor Surveillance Survey core Healthy Days questions in representative surveys of adults have found the measures to be internally consistent, to identify known or suspected population groups with poor quality of
life, and to have concurrent validity when compared with responses of the self-rated health measure for all adults [10]. In a nationwide follow-up study of Norwegian adults by the University of Oslo, researchers found that “the Healthy Days measures had good internal consistency reliability and that response changes on the follow-up survey were indicative of actual changes in respondent health status” [10]. Another study by the Columbia University School of Public Health found the measures had acceptable construct validity [10].

The Behavioral Risk Factor Surveillance Survey (BRFSS) monitors state and national populations on an annual basis and is “an important public domain resource for continuous, comparable data about population health” [10]. By including measures of HRQOL, the BRFSS now allows researchers and public health officials to track whether we are meeting the Healthy People 2010 goals of increasing the quality and years of healthy life and eliminating health disparities. The Healthy Days outcomes measure health-related quality of life according to both current approaches, including level of function and perception of health [61]. The quantification of unhealthy days measures the ‘absolute’ level of functioning in relation to the general population whereas the general health rating measures the individuals’ perception of their health status. Calculating the number of days that are limited due to poor health-related quality of life also allows researchers and policy makers to calculate the economic and social cost of poor health.
Research objectives for HRQOL among people with diabetes in North Carolina

The North Carolina Diabetes Control Program (NC DCP) is involved with several efforts throughout the state to improve the care of people with diabetes mellitus. Previous work for people with diabetes has focused on improving short-term medical outcomes. However, an additional important method of assessing the status of people with diabetes in our state includes measuring health-related quality of life. Subjective perceptions of health are an important component of well-being and are related to medical and possibly economic outcomes.

The NC DCP is interested in determining if there are subgroups of people with diabetes and a poor HRQOL who can then be targeted for interventions designed to improve quality of life. Although researchers have used the Healthy Days measures asked in the BRFSS to compare patients with diabetes mellitus to the general population, no study has looked for identifiable subgroups of patients with diabetes who are at risk for poor quality of life using Healthy Days. Even though important medical and diabetes-related characteristics such as other chronic diseases and diabetes complications are not asked about in the Behavior Risk Factor Surveillance Survey, using a population-based HRQOL measure with the ability to translate available information into economic and social costs is beneficial to a public health agency. In addition, the continual nature of the survey will allow the NC DCP to track HRQOL over time and compare the results to other subgroups of the population.
Methods

In order to better understand which groups of people with diabetes in North Carolina have poor health-related quality of life vs. which groups are doing relatively well, we used the NC BRFSS data and Healthy Days measures to explore associations between HRQOL and sociodemographic and medical characteristics. The BRFSS, sponsored by the Centers for Disease Control and Prevention, is a state-based, random-digit dialed telephone survey of civilian, non-institutionalized adults ≥ 18 years old. The true response rate is difficult to calculate since many of the phone numbers are not household phone numbers. In 1999, for example, although only 18.5% of all telephone numbers contacted completed the interview, the refusal rate was only 6.1%, termination during the interview was 0.1%, language barrier prevented the interview in 0.4%, and a physical or mental impairment prevented the interview in 0.3% [62]. The majority of noncompleted interviews were due to non-working telephone numbers (45.9%) and business numbers (16.8%), plus multiple times of no answer or a busy line (7.7%) and the respondent not being available during the required time (3.6%) [62]. The final BRFSS sample data is weighted to adjust for unequal probabilities of selection as a result of the disproportionate sampling method, people living in households with different numbers of telephones and different numbers of adults, and the unequal non-response rates among different demographic groups [62].

After reviewing the literature, we hypothesized that age, sex, race, income, education, employment, and insurance status would be associated with health-
related quality of life among people with diabetes. Many studies, including the research by Glasgow et al, observed associations between sociodemographic characteristics and health-related quality of life, except for race. We included race in our analyses since research among the general population using the Healthy Days measures found that both Blacks and Hispanics had lower quality of life than Whites [1]. In addition, minorities have higher rates of some diabetes complications that are associated with lower quality of life. We included only obesity as a comorbid disease due to survey differences each year and inconsistent collection of the presence of other conditions such as cardiovascular disease. We included the diabetes-related risk factors of duration of the disease and use of insulin since the BRFSS does not ask about specific diabetes complications. Despite previous research findings that physical activity is related to quality of life, we did not include activity level due to the previous mentioned limitations in a cross-sectional study of using a variable that is a similar measure as the outcome.

Our protocol was assessed by the North Carolina Public Health Institutional Review Board and was determined to be exempt from review. Adults with diabetes were identified by yes responses to the question “have you ever been told by your doctor that you have diabetes?” Females with a history of gestational diabetes only are not included in the analyses. Due to the relatively small number of adults with diabetes per year, we combined data from years 1998-2001. We used the separate outcomes of general health rating, physically unhealthy days, mentally unhealthy days, and number of days with functional
limitations due to poor physical or mental health. All respondents were asked 1) “Would you say that in general your health is excellent, very good, good, fair, or poor?”; 2) “Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?”; 3) “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?”; and 4) “During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?”

**Statistical Analyses**

All analyses were conducted using Stata version 7.0. The data set was first analyzed to assess the range of data, the effect of missing data, and the linearity of the outcome measures. Descriptive analyses were conducted using tests of proportions and means with standard deviations. Relationships between sociodemographic and medical characteristics with the dichotomized Healthy Days measures were done using Pearson’s Chi-square. Results were considered statistically significant if the p-value was less than 0.05. Our analyses accounted for the complex weighting of the survey. In the course of our analyses, we encountered strata with only one primary sampling unit (PSU). According to the methods of Korn and Graubard, strata with single-sampled PSU’s were collapsed with a neighboring stratum in order to perform design-based variance estimators for multistage sampling [63]. Future analyses will include a predictive model of
characteristics independently associated with a higher number of functionally limited days among adults with diabetes. We will first test for interactions and collinearity between the sociodemographic and medical characteristics. A logistic regression model will then be used to identify variables that were independently associated with the outcome after controlling for potential confounders.

Results

Descriptive Data

Table 1 describes the characteristics of the population of adults with diabetes in North Carolina. The majority were female, younger than 65 years, White, had a household income of greater than $20,000 per year, had a college education or greater, were not employed, had insurance, did not use insulin, were diagnosed less than 10 years ago, and were not disabled. Most of the measures had good response rates with less than 5% refusing to answer each question. However, almost 25% did not tell their household income. Those who were older than 65 and unemployed were more likely to refuse to answer their income level.

General health rating was dichotomized into those who rated their health as excellent, very good, or good compared to those who rated their health as fair or poor. Overall, an equal number of adults in North Carolina with diabetes rated their health as excellent, very good, or good (49%) compared to fair or poor (51%). The overall mean for physically unhealthy days was 9.3 per month, for mentally unhealthy days was 4.5 per month, and for functionally limited days was 5.7 per month (Table 2). However, the unhealthy days outcomes were all greatly skewed with the median number for each zero or one days per month. We
therefore dichotomized the outcomes of physically unhealthy days, mentally unhealthy days, and functionally limited days into seven days or less and more than seven days since one week of unhealthy days is a clinically and socially significant outcome.

**Relationship of sociodemographic and medical characteristics to quality of life**

Table 3 describes the differences in quality of life by the various independent variables. Race was not associated with any of the quality of life measures. People with diabetes were more likely to have a poor quality of life on all of the measures if they had less household income, were unemployed, and had no health insurance. They were also more likely to rate their health as fair or poor and have both physically and functionally limited days if they had a high school education or less. Older age was associated only with a higher likelihood of rating their general health as fair or poor; however, younger age was related to more than one week of mentally unhealthy days. Females were more likely to have mentally unhealthy days than males, but there was no difference by gender for physically unhealthy or functionally limited days. Obesity was only associated with more than one week of functionally limited days, not with the likelihood of physically or mentally unhealthy days. A longer duration of diabetes was associated with a lower general health rating and more physically unhealthy days whereas taking insulin was associated with all of the quality of life measures.

We are still conducting statistical analyses to determine the independent association of the characteristics with health-related quality of life. We chose
functionally limited days as the model’s outcome due to the economic and social significance to policy makers of lost work days. Our next step is to determine if there are any statistically significant correlations or interactions between the characteristics before we can determine the independent associations between each characteristic and functionally limited days.

Conclusions

In this study of health-related quality of life among persons with diabetes in North Carolina, the greatest differences were between socioeconomic groups, with those of lower socioeconomic status having lower HRQOL. A study among the general population found similar results when using the Healthy Days measures for quality of life [1]. The relationships between lower incomes and less education to a lower HRQOL are consistent with the results of Glasgow et al on a representative national sample of people with diabetes. Our results are also similar to Glasgow et al’s in that younger age and female sex were related to worse mental quality of life. However, unlike Glasgow et al, this study did not find relationships between older age or female sex and worse physical quality of life.

We were unable to measure the association between diabetes complications and health-related quality of life due to the limitations of the survey questions. Both duration of diabetes and insulin use may be associated with the presence of complications (which is likely associated with quality of life); interestingly, duration of diabetes was only associated with worse general health
rating and more than one week of physically unhealthy days, whereas insulin use was associated with all of the Healthy Days measures. These results suggest that insulin use may be more closely related to the number of complications than duration of disease. Despite diabetes complications such as end-stage renal disease and diabetes deaths being more common among most Non-whites compared to Whites, race was not related to quality of life. Investigating the reasons for the similar health-related quality of life may help better define how minorities adjust to diabetes complications.

In addition to interventions aimed at decreasing complications, our results suggest that other medical interventions may be needed, especially for certain subgroups of people with diabetes. Those who are obese have a similar number of physically and mentally unhealthy days but may be more likely to miss work on those days since they have more functionally limited days than those who are not obese. Helping people with diabetes lose weight may not only prevent the progression of their disease but may also decrease the number of days limited by poor health. In addition, some important differences were seen in the associations between age and sex with mentally unhealthy days. More than one week of mentally unhealthy days was associated with younger age and female sex. These results suggest that mental health screening and interventions should be targeted towards younger adults and women in addition to the lower socioeconomic groups.

The results of this study are strengthened by the use of a random, population-based state survey, the relatively good response rate, and the reliability
and validity of the quality of life outcome measures. Cross-sectional studies are better for chronic, relatively common diseases with low mortality or a prolonged course such as diabetes. However, cross-sectional population-based studies can only describe associations by stating prevalence odds ratios. This study is not designed to prove that any of these characteristics are a cause of poor quality of life. People with diabetes who have a poor quality of life may be less likely to continue school or get a job. In addition, those with a poor quality of life may be more likely to gain weight, to develop diabetes earlier, or to have poor glycemic control leading to the need for insulin and more diabetes complications. A number of comorbid illnesses related to HRQOL such as depression, cardiovascular disease, arthritis, and lung disease were not asked about in the BRFSS in North Carolina every year and could not be included as potential associated factors. The microvascular complications of diabetes mellitus are also not asked about in the survey and could not be assessed for the relationship with the Healthy Days measures. Future research needs to include other chronic diseases and complications of diabetes when assessing the independent association of sociodemographic and medical characteristics since previous studies determined that both are strongly related to quality of life among people with diabetes.

Some limitations exist due to the methods of the BRFSS. The BRFSS only includes households with telephones; therefore, there is the potential for excluding a portion of the population with a low SES and a higher risk for poor HRQOL. The survey may also under-represent severely impaired adults since
functional capacity is required to take the survey and the institutionalized are not included. In addition, some of the variation in HRQOL by different sociodemographic groups may reflect differences in interpretation of questions. For example, researchers have suggested that women are more likely to report symptoms and men are more likely “to deny the seriousness of their problems” [61]. The data collected through the BRFSS also relies on self-report. However, researchers have found a high agreement between the self-report and the medical report of common medical conditions in the elderly [64], and between self-report and medical report of diabetes and heart disease in other population groups [65]. In addition, some of the results of the study may have been statistically significant because of multiple testing. The results also may have been affected by the substantial number of people who did not respond to the question about income and the small numbers of people who were employed and were uninsured.

The significant degree of difference in the Healthy Days measures between various subgroups of people with diabetes based on the sociodemographic and medical characteristics we studied suggests that medical interventions could help reduce health disparities if targeted accordingly. The subgroup of people with diabetes who have a higher number of unhealthy mental and physical days can be said to suffer in their general quality of life compared to the general population. However, the core Healthy Days measures do not assess specific causes for poor health-related quality of life. In order to more accurately direct medical and public health interventions to improve quality of life, future studies will need to measure specific aspects of health-related quality of life such
as pain, depression, anxiety, sleeplessness, and vitality. The CDC added an optional 10-item set of questions in 1995 for the BRFSS to further assess health-related quality of life. These questions should be added to future surveys in North Carolina so that the data can be used to design interventions for those individuals with the highest burden from diabetes.

This study provides additional support that among people with diabetes, lower socioeconomic status and markers of more severe diabetes, including longer duration and use of insulin, are associated with a worse health-related quality of life. In order to track HRQOL among adults with diabetes in North Carolina, future surveillance using the BRFSS should include important predictor variables such as questions regarding chronic disease diagnoses and diabetes complications on an annual basis. As the NC DCP participates in efforts to eliminate health disparities and increase the number of healthy years among people with diabetes, tracking the significant differences in HRQOL among subgroups will help target resources and monitor the effectiveness of interventions.
Table 1: Characteristics of the sample (Unweighted number: 1035)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unweighted number</th>
<th>Weighted percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>594</td>
<td>60</td>
</tr>
<tr>
<td>≥65</td>
<td>429</td>
<td>40</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>373</td>
<td>44</td>
</tr>
<tr>
<td>Female</td>
<td>662</td>
<td>56</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>665</td>
<td>68</td>
</tr>
<tr>
<td>Non-White</td>
<td>358</td>
<td>32</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ high school</td>
<td>396</td>
<td>39</td>
</tr>
<tr>
<td>≥ college</td>
<td>635</td>
<td>61</td>
</tr>
<tr>
<td>Annual income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$20,000</td>
<td>332</td>
<td>38</td>
</tr>
<tr>
<td>&gt;$20,000</td>
<td>459</td>
<td>62</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>347</td>
<td>36</td>
</tr>
<tr>
<td>Unemployed</td>
<td>685</td>
<td>64</td>
</tr>
<tr>
<td>Health care coverage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>930</td>
<td>89</td>
</tr>
<tr>
<td>No</td>
<td>102</td>
<td>11</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI &lt; 30 kg/m²</td>
<td>423</td>
<td>44</td>
</tr>
<tr>
<td>BMI ≥30 kg/m²</td>
<td>544</td>
<td>56</td>
</tr>
<tr>
<td>Duration of Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 years</td>
<td>444</td>
<td>59</td>
</tr>
<tr>
<td>≥ 10 years</td>
<td>287</td>
<td>41</td>
</tr>
<tr>
<td>Type of treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No insulin</td>
<td>532</td>
<td>68</td>
</tr>
<tr>
<td>Insulin</td>
<td>233</td>
<td>32</td>
</tr>
<tr>
<td>Disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>383</td>
<td>37</td>
</tr>
<tr>
<td>No</td>
<td>595</td>
<td>63</td>
</tr>
</tbody>
</table>

Table 2: Average scores for HRQOL among adults with diabetes in NC

<table>
<thead>
<tr>
<th>Measure</th>
<th>% or Mean</th>
<th>Median</th>
<th>% ≤ 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported health status</td>
<td>51%</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>fair or poor</td>
<td>51%</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>excellent, very good or good</td>
<td>51%</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td># days during the past 30 days that physical health was not good</td>
<td>9.3</td>
<td>1.0</td>
<td>66%</td>
</tr>
<tr>
<td># days during the past 30 days that mental health was not good</td>
<td>4.5</td>
<td>0</td>
<td>84%</td>
</tr>
<tr>
<td># days during the past 30 days that poor physical or mental health restricted activities</td>
<td>5.7</td>
<td>0</td>
<td>77%</td>
</tr>
</tbody>
</table>
Table 3: Relationship between HRQOL and each risk factor

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Fair or poor general health</th>
<th>&gt;7 physically unhealthy days</th>
<th>&gt;7 mentally unhealthy days</th>
<th>&gt;7 functionally limited days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N % p value</td>
<td>N % p value</td>
<td>N % p value</td>
<td>N % p value</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>285 47.8 0.02</td>
<td>186 33.4 0.78</td>
<td>122 19.2 0.006</td>
<td>131 23.3 0.30</td>
</tr>
<tr>
<td>&gt;65</td>
<td>251 57.2</td>
<td>154 34.5 0.78</td>
<td>57 11.6 0.006</td>
<td>92 22.3 0.30</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>177 48.1 0.14</td>
<td>103 29.6 0.06</td>
<td>50 12.3 0.02</td>
<td>72 21.7 0.62</td>
</tr>
<tr>
<td>Female</td>
<td>363 54.1</td>
<td>240 36.9 0.06</td>
<td>130 19.2 0.02</td>
<td>152 23.4 0.22</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>336 49.7</td>
<td>229 34.6 0.96</td>
<td>118 16.0 0.92</td>
<td>140 21.2 0.22</td>
</tr>
<tr>
<td>Non-white or Hispanic</td>
<td>197 54.9</td>
<td>109 43.6 0.96</td>
<td>61 16.3 0.92</td>
<td>82 25.6 0.22</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ high school</td>
<td>396 61.7 0.000</td>
<td>256 41.2 0.000</td>
<td>117 18.2 0.000</td>
<td>168 28.4 0.000</td>
</tr>
<tr>
<td>&gt; college</td>
<td>142 35.4 &lt;0.000</td>
<td>86 22.5 0.000</td>
<td>63 13.2 0.09</td>
<td>55 14.0 &lt;0.000</td>
</tr>
<tr>
<td>Annual income</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$20,000</td>
<td>241 73.4 0.000</td>
<td>162 52.8 &lt;0.000</td>
<td>81 22.1 0.001</td>
<td>101 34.8 0.000</td>
</tr>
<tr>
<td>&gt;$20,000</td>
<td>167 36.9 &lt;0.000</td>
<td>96 21.4 &lt;0.000</td>
<td>58 11.2 0.001</td>
<td>57 12.3 &lt;0.000</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>105 30.7</td>
<td>48 16.0 0.000</td>
<td>38 9.4 0.000</td>
<td>19 7.5 0.000</td>
</tr>
<tr>
<td>Unemployed</td>
<td>434 63.2 &lt;0.000</td>
<td>295 44.1 &lt;0.000</td>
<td>142 20.0 0.001</td>
<td>205 31.4 &lt;0.000</td>
</tr>
<tr>
<td>Health insurance</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>474 49.9 0.04</td>
<td>293 31.3 &lt;0.002</td>
<td>150 14.5 0.001</td>
<td>191 20.9 0.004</td>
</tr>
<tr>
<td>No</td>
<td>63 63.3</td>
<td>49 51.2 0.002</td>
<td>30 30.0 0.001</td>
<td>32 36.4 0.004</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>234 55.1 0.20</td>
<td>147 37.1 0.15</td>
<td>71 14.6 0.45</td>
<td>105 28.2 0.005</td>
</tr>
<tr>
<td>No</td>
<td>274 49.9</td>
<td>168 31.3 0.15</td>
<td>97 16.8 0.45</td>
<td>102 18.8 0.005</td>
</tr>
<tr>
<td>Duration of Diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 years</td>
<td>210 45.5 0.002</td>
<td>123 29.3 0.005</td>
<td>67 14.3 0.05</td>
<td>84 20.4 0.05</td>
</tr>
<tr>
<td>≥ 10 years</td>
<td>166 59.1</td>
<td>121 42.0 0.005</td>
<td>61 19.3 0.13</td>
<td>76 28.2 0.05</td>
</tr>
<tr>
<td>Insulin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>151 66.0</td>
<td>111 46.9 0.000</td>
<td>55 22.2 0.01</td>
<td>68 29.6 0.03</td>
</tr>
<tr>
<td>No</td>
<td>241 44.4 &lt;0.000</td>
<td>142 28.2 &lt;0.000</td>
<td>77 13.4 0.01</td>
<td>97 20.3 0.03</td>
</tr>
</tbody>
</table>

Predictive Model:
LogitP(>avg. functionally limited days) = α + β1(age) + β2(sex) + β3(race) + β4(education) + β5(annual income) + β6(employment) + β7(geography) + β8(insurance) + β9(obesity) + β10(duration) + β11(insulin)


10. Centers for Disease Control and Prevention, Measuring Healthy Days. 2000, CDC: Atlanta, Georgia.


13. Centers for Disease Control and Prevention, Behavior Risk Factor Surveillance Survey, trend data.


40. UK Prospective Diabetes Study Group, *Quality of life in type 2 diabetic patients is affected by complications but not by intensive policies to improve blood glucose or blood pressure control.* Diabetes Care, 1999. 22(7): p. 1125-1136.


