CONSTRUCT VALIDITY OF THE HEALTH UTILITIES INDEX MARK 3 IN TYPE 2 DIABETES: EVIDENCE FROM A NATIONALLY REPRESENTATIVE SAMPLE OF CANADIANS

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ABSTRACT

Objective

To assess the cross-sectional construct validity of the Health Utilities Index Mark 3 (HUI3) in type 2 diabetes using population-health survey data.

Methods

This study used data from Cycle 1.1 (2000-2001) of the Canadian Community Health Survey (CCHS) were used. A total of 5,134 adult respondents were classified as having type 2 diabetes. Analyses of covariance were used to assess differences in overall and single attribute HUI3 scores between groups hypothesized, a priori, to differ in HRQL. We further evaluated the association between health care resource use (i.e., hospitalizations, physician and ER visits) and overall HUI3 scores using logistic regression models. Normalized sampling weights and bootstrap variance estimates were used in the analyses.

Results

For overall HUI3 scores, clinically important differences were observed between all groups anticipated to differ in HRQL. Clinically important differences in overall HUI3 scores were observed between respondents who had had diabetes for less than six years relative to those who had had diabetes for 13 years or longer. The HUI3 score of insulin users was lower than for non-users (-0.06, 95% CI: -0.09 to -0.03). Depression was the comorbidity associated with the largest deficit (-0.17; 95% CI: -0.22 to -0.12), followed by stroke (-0.15, 95% CI: -0.21 to -0.10) and heart disease (-0.08; 95% CI: -0.11 to -0.05). Insulin use and comorbidities were associated with clinically important deficits on the pain attribute. Overall HUI3 scores were significantly predictive of all three categories of health care resource use.

Conclusions

In this representative sample of the Canadian population, observed differences among groups for the overall and single attribute scores contribute further evidence of the construct validity of the HUI3 in type 2 diabetes.

BACKGROUND

Type 2 diabetes places a substantial burden on individuals with the disease. The burden arises from the condition itself, from complications or comorbidities associated with the disease and from its treatment (Ahroni 2000; Peyrot 1997; Jacobson 1994; Keinanen-Kiukaanniemi 1996; Anderson 1997; Glasgow 1997; Luscombe 2000). Diabetic complications such as retinopathy, nephropathy, neuropathy, cardiovascular disease, stroke and peripheral vascular disease result in significant morbidity and mortality (Ahroni 2000; Peyrot 1997; Jacobson 1994; Keinanen-Kiukaanniemi 1996; Anderson 1997; Glasgow 1997; Luscombe 2000; Meltzer 1998; U.K. Prospective Diabetes Study Group 1999). The morbidity burden of diabetes can be associated with impairment on many dimensions of health-related quality of life (HRQL), both physical and mental (Ahroni 2000; Aalto 1996; Wandell 1997; Anderson 2001; Bourdel-Marchasson 1997; Gafvels 1991). Self-reported health-related quality of life (HRQL) is an important outcome in diabetes because clinical parameters, such as glycosylated hemoglobin (A1c), may fail to capture the overall impact of the disease (Glasgow 1999; Weinberger 1994) despite poor glycemic control being associated with the development of microvascular complications. A combination of humanistic and clinical outcomes, therefore, would give a more complete understanding of the disease and its impact.

Health-related Quality of Life Measurement in Diabetes

Although HRQL in type 2 diabetes has been extensive, many questions remain about the most appropriate measures (Eiser 1993). General recommendations for assessments of HRQL suggest the concurrent use of several categories of measures (i.e., specific measures, generic health profiles and preference-based index measures) to capture a broad scope of health status (Canadian Coordinating Office for Health Technology Assessment 1997). Since a variety of HRQL measures are available, the choice may depend on a number of factors such as the purpose of the measurement, the attributes of health that are relevant to the target population, and the evidence of the construct validity of the measure in the target population. As well, it is important to minimize respondent burden by choosing measures that can also yield maximum data or information from relatively short questionnaires.

Much of the HRQL research in diabetes has focused on the development and application of diabetes-specific instruments (Shen 1999; The DCCT Research Group 1988). Specific HRQL measures bring into focus the impact on health and functioning arising directly from a condition or treatment and are intended to provide greater detail concerning outcomes associated with a condition (Guyatt 1993). In contrast, generic HRQL measures provide information on general functioning and well-being. Despite concerns of decreased sensitivity, generic measures of HRQL have an advantage over disease-specific measures in that they permit comparisons of the impact of various diseases on multiple dimensions of HRQL which may provide useful data for policy and resource allocation decisions (MacKeigan 1992). Generic measures of HRQL are appropriate and desirable for particular applications in diabetes. For example, diabetes-specific measures may not capture the additional HRQL deficits associated with comorbidities (de Visser 2002; Anderson 1997; Jacobson 1994) that make an important contribution to the disease burden in type 2 diabetes.

Generic measures can be classified into health status profiles and preference-based index measures (Guyatt 1993). Profile measures provide an array of scores representing various dimensions of health status or HRQL. Examples of profile measures are the SF-36 and the Nottingham Health Profile. Such measures provide multiple-outcome scores which may be useful to clinicians and researchers for monitoring or measuring differential effects of a condition or treatment.

Preference-based index measures are based on decision theory and economics and reflect preferences for alternative health outcomes (Guyatt 1993). An index produces a single overall score that reflects the value associated with a health state. Scores are often referred to as utility scores or utilities. Index scores are presented on a scale of 0 to 1, conventionally anchored as ‘dead’ and ‘full health’, respectively. There are two classes of preference-based index measures: direct measures and multi-attribute utility measures (indirect measures). Examples of direct measures include the standard gamble (SG) and the time trade off (TTO).

A multi-attribute utility measure describes health states on a set of attributes using a classification system. For example, the Health Utilities Index Mark 3 (HUI3) defines health on eight attributes: vision, hearing speech, ambulation, dexterity, emotion, cognition and pain. The

level of functioning for each attribute is determined by using a questionnaire. A multi-attribute utility function is then used to assign a valuation to a health state defined by the level of functioning on each attribute. The valuation is based upon community (i.e., societal) preferences for the health states described in the classification system. In addition to the overall index score, multi-attribute utility measures also provide information on specific attributes of health.

Construct Validity of Preference-based Index Measures in Diabetes

Construct validity has been defined as the degree to which an instrument measures the property or concept that it is intended to measure (Hays 1993). There are several approaches to assessing construct validity, of which one is referred to as the known or extreme groups approach. Using the known groups approach, individuals are divided into groups expected to differ in HRQL according to an external criteria. Clinically important differences in HRQL scores should be observed among known groups if the instrument does, indeed, have construct validity in the target population. Since the burden of diabetes has generally been attributed to disease-related factors, treatment burden and comorbidities and complications, it is reasonable that these factors have been used as known groups in previous studies assessing the construct validity of preference-based index measures in diabetes (Ragnarson 2000; Maddigan 2003a; Holmes 2000; Clarke 2002; Redekop 2002; Koopmanschap 2002; Tabaei 2004; U.K. Prospective Diabetes Study Group 1999; Hahl 2002; Coffey 2002; Hart 2004; Maddigan 2004a; Maddigan 2004b; Maddigan 2003b). The accumulation of such evidence in a variety of applications and contexts adds confidence that a measure is valid in those uses.

Past research applying preference-based index measures in diabetes is relatively limited, although recently several studies have used such measures (specifically the multi-attribute or indirect utility measures: EQ-5D or EuroQoL, QWB-SA, 15-D and the Health Utilities Index) and generated evidence to support their use in the condition (Ragnarson 2000; Holmes 2000; Clarke 2002; Redekop 2002; Koopmanschap 2002; Tabaei 2004; U.K. Prospective Diabetes Study Group 1999; Hahl 2002; Coffey 2002; Hart 2004; Maddigan 2004a; Maddigan 2004b; Maddigan 2003b; Maddigan 2003a). Other studies have used direct utility measures (standard gamble or time trade-off) to obtain utilities that reflect individuals' preferences for their own

health states (Brown 2002; Brown 2000) or direct measures of community preferences for health states associated with diabetes (Sullivan 2002; Landy 2002).

There is evidence of the cross-sectional construct validity of the EQ-5D or Euro-QuoL in type 2 diabetes (Holmes 2000; Clarke 2002; Redekop 2002; Ragnarson 2000; U.K. Prospective Diabetes Study Group 1999). Cross-sectional assessments of individuals with type 2 diabetes in the United Kingdom suggest that the EQ-5D is sensitive to the presence of macrovascular and microvascular complications in type 2 diabetes (Holmes 2000; U.K. Prospective Diabetes Study Group 1999; Clarke 2002). In a Dutch population with type 2 diabetes, the EQ-5D was sensitive to complications, duration of diabetes and treatment regimen (Redekop 2002). In a study of type 2 diabetes in five European countries, the EQ-5D was found to be sensitive to variations in HRQL by complications, treatment regimen and glycemic control (Koopmanschap 2002). A Swedish study that included individuals with type 1 or type 2 diabetes used the EQ-5D to specifically evaluate the impact of foot ulcers and amputations on HRQL (Ragnarson 2000). It found that both the EQ-5D index scores and VAS scores detected HRQL deficits associated with ulcer and amputation. The authors concluded that the EQ-5D was a useful instrument for exploring the impact of these complications (Ragnarson 2000). A longitudinal study of HRQL in type 1 diabetes found that yearly declines in EQ-5D index scores and VAS scores over a five-year period were statistically significant and that the rate of decline of the VAS for individuals with diabetes was greater than the estimated rate for the general population (Hart 2004). Cross-sectional analysis from the same study demonstrated that macrovascular and microvascular complications and comorbidities were associated with deficits on the index scores and the VAS (Hart 2004).

The Quality of Well-Being Index (QWB-SA) and the 15-D have also been used in diabetes. The QWB-SA was sensitive to complications in individuals with either type 1 or type 2 diabetes (Tabaei 2004; Coffey 2002). In individuals with type 2 diabetes, treatment with oral agents or insulin was associated with slightly lower scores (Coffey 2002). As well, the QWB-SA detected the burden of episodes of hyperglycemia (Tabaei 2004). The 15-D detected differences between individuals with type 1 diabetes with or without renal, neurological, cardiovascular or cerebrovascular disease (Hahl 2002).

The Health Utilities Indexes (HUI) are a family of preference-based index measures that capture HRQL deficits associated with type 2 diabetes (Maddigan 2003b; Maddigan 2003a; Maddigan 2004a) and the burden associated with comorbidities in type 1 or type 2 diabetes (Maddigan 2004b). We found that the Health Utilities Index Mark 2 (HUI2) and Health Utilities Index Mark 3 (HUI3) detected impairments in overall HRQL and on specific attributes of HRQL according to severity of diabetes and unstable glycemic control (Maddigan 2003a; Maddigan 2004a). The HUI3 was more sensitive to the HRQL deficits associated with disease severity or advancement and with unstable glycemic control and, thus, may be preferred over the HUI2 (Maddigan 2003a). The greater range of possible scores on the HUI3, its enhanced ability to assess the utility of states worse than dead and its improved ability to discriminate moderate to severe impairment from mild or no impairment might favour the use of the HUI3 over the HUI2 for assessing HRQL in type 2 diabetes (Maddigan 2003a). Using the HUI2 produced higher utility scores than the HUI3 for individuals with moderate to severe impairment and, therefore, may underestimate the true HRQL deficits associated with type 2 diabetes (Maddigan 2003a).

There is initial evidence to support the use of multi-attribute utility measures in diabetes, including the HUI3. Evidence of the construct validity of the HUI3 has also been previously generated at the population level for arthritis and stroke (Grootendorst 2000). Given the body of evidence supporting the construct validity of the HUI3 in diabetes, stroke and arthritis, it would be reasonable to anticipate that the HUI3 would perform well at the population level in type 2 diabetes. We previously assessed the construct validity of the HUI3 in type 2 diabetes in a relatively small sample of rural Albertans, but were unable to assess the ability of HUI3 to detect differences between groups of individuals with and without specific comorbidities or complications (Maddigan 2003b; Maddigan 2003a; Maddigan 2004a). Therefore, we also assessed the relationship between HUI3 scores and comorbidities using Canadian National Population Health Survey (NPHS) data, but were limited in those analyses by the lack of data from the NPHS on treatment intensity, duration of diabetes and type of diabetes (Maddigan 2004b).

Health Care Resource Utilization and HRQL

Additional evidence of construct validity can be generated by examining the association between health care utilization use and HRQL scores. Past research has consistently demonstrated that poor self-rated health or scores on disease-specific, or generic, measures are associated with physician visits, use of emergency rooms and hospitalizations, even after controlling for demographic and clinical factors (Fan 2002; Brown 1994; Walter-Ginzburg 2001; Ethgen 2002; Wyke 2003; Jordan 2003; Rohrer 2000; Mapes 2003; Pearson 1999; Parkerson, Jr. 2000; Alla 2002; Spertus 2002; Kennedy 2001). This association has been observed both cross-sectionally and longitudinally.In a cross-sectional study of emergency department use in Ontario, self-rated health was one of the strongest determinants of emergency department use in the preceding 12 months (Brown 1994). In older adults, current self-ratings of health have been associated with emergency room utilization and hospitalizations in the previous year (Walter-Ginzburg 2001), as well as with physician visits in the previous month (Walter-Ginzburg 2001) or year (Rohrer 2000). The SF-36 has been shown to predict future health care resource utilization (physician visits, specialist visits, hospitalizations, health care worker visits and all procedures) in arthritis (Ethgen 2002) and high rates of physician consultation over a 24-month follow-up period in the general population (Jordan 2003).

A number of studies have assessed the ability of HRQL measures to predict future hospitalization and have found a significant association (Parkerson, Jr. 2000; Spertus 2002; Alla 2002; Fan 2002; Mapes 2003; Pearson 1999; Kennedy 2001). Much of this research has been carried out in specific populations, including individuals with end-stage renal disease (Parkerson, Jr. 2000) or those on dialysis (Mapes 2003), with heart failure (Alla 2002), coronary artery disease(Spertus 2002), obstructive lung disease (Fan 2002), or older adults (Pearson 1999; Kennedy 2001). Across these studies, health status predicted future hospitalization regardless of whether a disease-specific measure (Alla 2002; Spertus 2002; Fan 2002; Mapes 2003; Parkerson, Jr. 2000), a generic health profile (SF-36 (Mapes 2003; Pearson 1999), RAND-36 (Parkerson, Jr. 2000) or Duke Health Profile (Parkerson, Jr. 2000; Alla 2002) or self-rating of health (Kennedy 2001) was used.

In summary, health status is associated with utilization of health care resources in the general population and in specific disease groups. This relationship has been found across HRQL measures. It is interesting to note that a review of the literature did not produce any studies that used a multi-attribute utility measure to assess the relationship between health care resource utilization and HRQL or a study that did so in diabetes.

OBJECTIVES

Before the HUI3 is widely used in research or clinical applications in type 2 diabetes or health policy decisions are based upon data derived from its use, it is important that we can be reasonably confident in its performance in the disease. Providing evidence of construct validity of the HUI3 in diabetes may be of particular importance because this measure has been incorporated in all of Statistic Canada's population health surveys, as well as in the Ontario Population Health Survey. Thus, self-reported HRQL data derived from the HUI3 is available from a variety of sources and for representative samples of the Canadian population, making this line of research relevant to health policy in the Canadian context. The overall objective of this research, therefore, was to provide further evidence of the construct validity of the HUI3 in type 2 diabetes.

Specifically, the objectives were to generate evidence of construct validity of the HUI3 in type 2 diabetes using the following approaches:

1. The known groups approach – to assess the ability of the overall HUI3 scores and diabetes-relevant single-attribute scores to detect clinically important differences between groups anticipated to differ in their level of HRQL (i.e., according to duration of diabetes, comorbidities, treatment intensity and self-rated health).

2. Health care resource utilization – to assess the association between previous health care resource utilization (physician visits, emergency department use and hospitalization) and current overall HUI3 scores.

3. Convergent validity – to assess the interscale correlations between overall HUI3 scores, diabetes-relevant single-attribute scores and indicators of level of disability, depression and self-rated health.

METHODS

Survey Design

Data from the Canadian Community Health Survey (CCHS) Cycle 1.1 were used in this analysis. The CCHS is a cross-sectional survey of individuals aged 12 years and older across the 10 provinces and three territories of Canada (Beland 2002). Data are collected on utilization of health services, determinants of health and health status on a two-year cycle (Beland 2002). Cycle 1.1 involved a large sample (N=131, 535), sufficient in size to give reliable estimates at the level of the health region, whereas Cycle 1.2 involved a smaller sample size, designed to give provincial level estimates and focused on specific topics of concern (Beland 2002). The survey excludes individuals living on crown or reserve land, in institutions, members of the Canadian Armed Forces and. Even with these exclusions, the survey represents 98% of the Canadian population over 12 years of age (Beland 2002).

The survey design of the CCHS was complex in that it involved two different sampling frames, termed the *area frame* and *telephone frame*. For the area frame, the sample was drawn using a multistage stratified cluster design based on the sampling frame designed for the Canadian Labour Force Survey (Statistics Canada 1998). Approximately 83% of the sample was taken from the area frame; however, in some health regions, a telephone frame was also used, comprising the remaining 17% of the sample (Statistics Canada 2004). Within the area frame, one respondent was selected at random in approximately 82% of households to be surveyed by in-person interviews; but in the remaining 18% of households, two respondents were randomly selected to be surveyed. Two respondents were chosen in order to overrepresent individuals in the 12-to-19 age group (Beland 2002). For the telephone frame, the sample was selected randomly and only one respondent was surveyed per household.

Data for Cycle 1.1 were collected between September 2000 and November 2001 using computer-assisted interviewing. The full interview took approximately 45 minutes to complete. Overall, including both frames, 41.4% of respondents used in these analyses had telephone interviews, 56.7% had in-person interviews and 1.9% had a combination of techniques.

Proxy reporting was permitted for certain components of the interview, but many components were deemed only appropriate for self-response. Proxy reporting was permitted only

if the respondent selected for the survey would not be available for the entire period of data collection, was unable to respond due to physical or mental illness or to a language barrier (Statistics Canada 2004). For interviews that were completed by proxy, imputation using the "nearest neighbour" imputation method (i.e., hotdecking) was used to handle missing data for a pre-defined set of variables (Beland 2002). Imputation was not used for non-proxy respondents who declined to answer particular questions. We did not employ additional imputation methods for variables where it was found to be inappropriate by Statistics Canada or where it failed to provide quality estimated values (Beland 2002). At the end of Cycle 1.1, the overall response rate was 84.7% (Statistics Canada 2004).

Sample

Included in the analyses were CCHS respondents who self-identified as having had a diagnosis of diabetes by a health practitioner. An algorithm was used to categorize individuals as having type 1 or type 2 diabetes (Figure 1). The criteria of less than 30 years old and being placed on insulin immediately has been used previously to classify individuals as having type 1 diabetes (Hahl 2002). The use of oral agents to manage diabetes has been used previously to classify individuals as having type 2 diabetes (Johnson 2002; Eurich 2004). In the CCHS, 6361 respondents self-reported having received a diagnosis of diabetes, representing a weighted percentage of 4.1%; 5637 were categorized as having type 2 diabetes, representing a weighted percentage of the population of 90.1%. All analyses were restricted to individuals over the age of 18 (Figure 2). Without additional imputation, 5134 (91.2%) of the respondents over the age of 18 with type 2 diabetes had complete data to be included in this analysis (Figure 2).

Measures

Health Utilities Index Mark 3 (HUI3)

HUI3 is a preference-based index measure of HRQL that uses a multiplicative utility function to assign valuations to different health states (Feeny 2002; Feeny 1995). Using the multi-attribute approach, health states are defined by a classification system that includes a set of dimensions or attributes of HRQL, with a number of different levels of functioning for each attribute. In the HUI3 system, eight attributes define health status: vision, hearing, speech,

ambulation, dexterity, emotion, cognition and pain. Each attribute has five or six levels, creating 972,000 unique HUI3 health states (Appendix 1) (Feeny 2002).

The overall utility function for the HUI3 was derived from visual analogue scale and standard gamble techniques and responses from random samples from the general population of Hamilton, Ontario, Canada (Feeny 2002). Overall scores on the HUI3 range from -0.36 to 1.0, with -0.36 representing the utility of the worst possible HUI3 health state, 0.0 representing dead and 1.0 representing perfect health (Feeny 2002). Differences of greater than 0.03 for HUI3 overall scores are considered to be clinically important (Horsman 2003). For the single attribute utilities, scores range from 0.0 to 1.0, with a score of 0.0 representing the lowest level of functioning on an attribute and a score of 1.0 representing full functional capacity on an attribute. A difference of 0.05 on a single attribute is considered to be clinically important (Horsman 2003).

Assessment of health status using the HUI3 can be based on current or usual health. In the versions of the questionnaire that assess current health status, a specific duration of recall is given: one, two or four weeks. Population survey applications of the HUI3 typically assess usual health status and no duration of recall is given (Horsman 2003). In the CCHS, the HUI3 was administered as a 31-item questionnaire with no specific recall period (i.e., "Are you usually able to…").

Objective One: Known Groups Construct Validity

Respondents were anticipated to differ in HRQL based on duration of diabetes (Redekop 2002; Maddigan 2004a; Koopmanschap 2002), treatment intensity (Redekop 2002; Koopmanschap 2002; Coffey 2002; Maddigan 2004a), presence and number of comorbidities (Holmes 2000; U.K. Prospective Diabetes Study Group 1999; Clarke 2002; Maddigan 2004b; Redekop 2002; Koopmanschap 2002; Hahl 2002) and self-rated health. The specific hypotheses for each known group are summarized in Appendix 2.

Duration of Diabetes: Duration of diabetes was determined from the respondents' age and self-reported age of diagnosis of diabetes. Respondents were then grouped into quartiles of duration of diabetes: less than 2 years, 2.0 to 5.9 years, 6.0 to 12.9 years and 13.0 years or more.

Treatment Intensity: Questions regarding insulin use were included in the core survey content and in the medication optional survey content. This made it possible to categorize almost all respondents as insulin users or non-users. Questions regarding the use of oral medications for the management of diabetes were optional content. For the subsample who resided in health regions that selected the medication optional content (n=1399), respondents were categorized as being managed by diet alone, oral medications, or insulin with or without oral medications.

Comorbidities: The CCHS includes data on several comorbidities that commonly occur in individuals with diabetes and adversely affect HRQL, such as heart disease (James 1997; Simpson 2003), stroke (James 1997), depression (Anderson 2001), and cataracts (Kato 2001; Rowe 2000). Of the approximately 25 chronic medical conditions reported in the CCHS, comorbidities were selected based on their relevance in diabetes and ability to test the performance of the single attributes of the HUI3. Stroke and heart disease were selected as they are common macrovascular complications (Simpson 2003; Lloyd 2001; de Visser 2002; James 1997) and are typically associated with significant HRQL deficits (Tengs 2003; Grootendorst 2000; de Visser 2002; Post 2001; Lloyd 2001). It was hypothesized that depression could be used to assess the performance of the emotion attribute since depression is associated with a significant additional HRQL burden in diabetes (Goldney 2004). Further, depression is a relevant comorbidity to include since diabetes is associated with an approximately two-fold increased risk of depression. (Anderson 2001). As cataracts may be associated with diabetes (Rowe 2000; Kato 2001), this comorbidity was used to assess the performance of the vision attribute since retinopathy was not assessed in the CCHS.

Diagnoses of heart disease, stroke and cataracts were based on self-report from a direct question in the CCHS which asks: "We are interested in long-term conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional. Do you have…," followed by a list of common chronic conditions. For depression, the Composite International Diagnostic Interview Short Form for Major Depression (CIDI-SFMD) was used to assess the probability of a major depressive disorder. A probability of 0.90 is considered consistent with a diagnosis of Major Depressive Disorder in accordance with the DSM-IV diagnostic criteria (Patten 2000). Respondents were categorized based on the presence or absence of stroke, heart disease, cataracts and depression. In addition to assessing the impact

of each comorbidity, the impact of the total number of comorbidities was assessed, with respondents categorized as having zero, one, two or three or more comorbidities.

Self-Rated Health: Respondents were asked to rate their overall health (including physical and mental health and social well-being) with response options of 'excellent', 'very good', 'good', 'fair' and 'poor'.

Objective Two: Utilization of Health Care Resources

Three markers were used to assess the association between health care resource utilization and HRQL: overnight hospitalizations, emergency room visits and physician visits. A hospitalization was defined as a self-reported overnight stay in a hospital, nursing home or convalescent home in the previous 12 months. Respondents were categorized as having no overnight hospital stays or one or more. An emergency room visit was defined as a last contact with a physician or nurse in the past 12 months in the hospital emergency room. Respondents were categorized as having used an emergency room or not. Physician visits were defined as the number of consultations with medical doctors over the previous 12 months and a median split (median = 5.0) was used to separate respondents into two groups. The median split was chosen in order to treat number of physician visits as dichotomous. Since the majority of respondents (95%) had one or more physician visit in the previous year, it was felt that the median spit would be preferable to a comparison of respondents who did and did not visit a physician.

Objective Three: Convergent Validity (Interscale Correlations)

To further assess construct validity, assessed the degree to which the overall HUI3 and diabetes-relevant single attributes correlated with measures of similar constructs (i.e., level of disability, depression and self-rated health) measured in the CCHS was assessed.

Level of Disability: Level of disability was assessed by the degree to which physical or mental health problems reduced the amount or kind of activity that could be performed at home, work or leisure. This variable had three possible categories (never, sometimes, and often) derived from responses to three questions. Disability was further assessed by the need for assistance with preparing meals, shopping, housework, heavy household tasks, moving about inside the house and personal care, up to a total of six tasks.

Depression Scale Short-Form Score: The 21 items from the CIDI-SFMD can be scored on a 0 to 8 scale with higher scores reflecting a greater number of depressive symptoms. A score of five or more symptoms is consistent with a DSM-IV diagnosis of depression (also reflecting a 0.90 probability of depression) (Patten 2000).

DATA ANALYSIS

Analysis of Cases with Missing Data

T-tests and Chi-Square were used, where appropriate, to compare the demographic characteristics of respondents who were excluded from the analysis because they were missing HUI3 scores (n=88). These respondents had complete data on all other variables of interest (Figure 1). As well, t-tests were used to compare overall HUI3 and single attribute scores of respondents who had complete data on the HUI3 scores (n=363) but were missing data on one or more demographic characteristic, thus excluding them from the models.

Objective One: Known Groups Comparisons

Unstandardized regression coefficients from Analysis of Covariance (ANCOVA) models were used to determine if clinically important and statistically significant differences on the overall HUI3 scores and diabetes relevant single attribute scores (i.e. vision, ambulation, dexterity, emotion, cognition and pain) existed among known groups. All models were adjusted for age in the quadratic form ($b_1 age + b_2 age^2$), education (less than high school; high school; some post secondary, college or trade school; or university), marital status, aboriginal status (yes or no) and for a number of medical conditions other than the four comorbidities. Age was operationalized in the quadratic form as a nonlinear relationship between age and HRQL that has been previously found in the Canadian population (Maddigan 2004b; Austin 2002).

In this sample, respondents with longer self-reported duration of diabetes were more likely to use insulin (P value <0.001) and were more likely to self-report having heart, stroke and cataracts (P value<0.001 for each). Respondents who used insulin were also more likely to report having heart disease (OR=1.69, 95% CI: 1.43 to 2.00), stroke (OR=2.43, 95% CI: 1.84 to 3.19) or cataracts (OR=1.63, 95% CI: 1.34 to 1.97). Since duration of diabetes was associated with insulin use and comorbidities, these variables were included in the models that assessed

differences in HUI3 between respondents above and below the median duration of diabetes. Similarly, duration of diabetes and comorbidities were included in the comparisons of HUI3 scores between respondents who did and did not use insulin. All comorbidities of interest were included in models in which differences in HRQL among known groups of respondents with and without each comorbidity were assessed. All comorbidities were included in order to control for the effects of multiple comorbidities on HRQL. Specific hypotheses for Objective One are listed in Appendix 2.

Objective Two: Health Care Resource Utilization

Logistic regression analyses were used to assess the association between overall HUI3 scores and physician visits (above or below the median), overnight hospitalization (yes or no) and last contact in the emergency department. In these analyses, overall HUI3 scores were grouped into three categories reflecting level of impairment: none/mild (0.89 to 1.00), moderate (0.70 to 0.88) and severe (less than 0.70) (Health Utilities Inc 2004). The models were adjusted for age in categories (18 to 44, 45 to 54, 55 to 64, 65 to 74 and 75 or greater), education (less than high school; high school; some post secondary, college or trade school; or university), marital status, aboriginal (yes or no), insulin use, stroke, heart disease, cataracts, depression and a number of medical conditions other than the four comorbidities.

Objective Three: Interscale Correlations

Interscale correlations were calculated to assess the convergent validity of the HUI3. Pearson's correlations were used to test the strength of association between the overall and single attribute utility scores of the HUI3 and the indicators of level of disability, the CIDI-SFMD and self-rated health. Correlations of greater than 0.50 were considered strong; between 0.30 and 0.49 were moderate; and less than 0.30 were considered to be weak (Cohen 1992). Hypothesized strength of relationships between the HUI3 and other measures are shown in Table 1.

Weighting and Variance Estimates

The multistage stratified cluster design used in the CCHS creates an unequal probability of being selected for inclusion into the survey. Unless accounted for, this can produce biased point estimates (e.g., of regression coefficients, means, etc.) and the variance can be underestimated.

Thus, normalized sampling weights were applied to the analysis in order to produce unbiased point estimates (Statistics Canada 2004). Normalized sampling weights adjust for the unequal selection probability but do not adjust for clustering or stratification (Statistics Canada 2004); thus, bootstrap variance estimates were used to estimate 95% confidence intervals for Objectives One and Two (Rust 1996). Consistent with Statistics Canada's policies for disclosure, data pertaining to any cell with a weighted or unweighted frequency of less than five were suppressed. All analyses were carried out with SPSS version 12.0 (SPSS Inc. Chicago IL).

RESULTS

Sample Characteristics

The average age of respondents included in the analysis was 61.7 ± 13.4, with just over one-half of respondents being male (52.3%)and 68.2% being married (Table 2). A large proportion of respondents did not complete high school (43.5%). As would be anticipated from the study design, Aboriginals were under-represented at 1.7%. The median duration of diabetes was 6.0 years (IQR: 2.0 to 13.0), and 15.6% of respondents used insulin. Heart disease and cataracts were the most commonly reported comorbidities, affecting 21.1% and 14.7% of respondents, respectively. The average number of medical conditions over the four comorbidities of interest was 3.24 ± 1.88.

The proportion of respondents who rated their health as excellent or very good was relatively small (22.8%) (Table 2). Consistent with this observation, the average overall HUI3 score was 0.76 ± 0.28, suggesting, on average, moderate impairment (Table 3). The average HUI3 score for the entire Canadian population was 0.88 ± 0.19. The largest deficit for the single-attribute utility scores was observed on the pain and discomfort attribute (mean = 0.85 ± 0.30) (Table 3). Across the eight single attributes, the majority of the sample was at Level 1 (no impairment) or Level 2 (mild impairment) functioning (Table 4).

Missing Data

HUI3 scores were compared for respondents who were excluded from the analyses due to missing data on covariates (n=363) (Figure 2) (Table 5). Respondents who were missing data had lower scores on the ambulation, emotion, cognition, and pain and discomfort attributes and

on overall HUI3 scores. With the exception of the ambulation attribute, these differences were clinically important.Respondents who had complete data on covariates but were missing data on the HUI3 (n=88) (Figure 2) differed from those respondents included in the analysis (n=5134) on a number of characteristics, including education, self-rated health and the two measures of disability (Table 6).

Objective One: Known Groups Comparisons

Duration of Diabetes

After adjusting for the covariates in the model (Appendix 3, Table 16), respondents in the lower two quartiles of duration of diabetes had significantly higher overall HUI3 scores compared to respondents who had diabetes for more than 13 years. The difference was clinically important and statistically significant for both quartiles. The burden on the single attributes was small after controlling for demographic characteristics, insulin use and comorbidities (Appendix 3, Tables 17 to 24), although respondents who had diabetes for more than 13 years had some impairment on the ambulation attribute relative to those in the other quartiles (Table 7).

Treatment Intensity

Insulin Use

The difference in overall HUI3 scores between respondents who did and did not use insulin was clinically important (-0.06. 95% CI: -0.09 to -0.03) (Table 8a) after adjusting for comorbidities, duration of diabetes and demographic characteristics (Appendix 3, Table 16). While differences between these groups were statistically significant for several single attributes (vision and ambulation), these differences were not necessarily sufficient in magnitude to be considered clinically important after controlling for the covariates in the model (Appendix 3, Tables 17 to 23). The exception was the pain attribute, where a large deficit was observed (-0.07, 95% CI: -0.11 to -0.04).

Diet, Oral Medications versus Insulin

Respondents who answered the optional content module were categorized according to whether they were managed by diet (23.7%), oral agents (57.7%), or insulin with or without oral

agents (18.7%). Respondents who lived in health regions that selected the medication optional content module did not differ from respondents who resided in health regions that did not select this module with respect to overall HUI3 score, disability, duration of diabetes, number of medical conditions, presence of the comorbidities of interest, marital status, sex and age. They did, however, have a larger number of physician visits and were more likely to have been hospitalized in the previous year. As well, those who completed the mediation module optional content were more likely to have finished high school, to use insulin and to rate their health as 'excellent' or 'very good' (P value <0.01 for all).

Overall or single attribute utility scores of respondents whose diabetes was managed with oral agents did not differ from respondents whose diabetes was managed by diet alone. No clinically important or statistically significant differences were noted between these groups (Table 8b). HRQL deficits associated with the use of insulin (with or without oral agents) (Table 8b) were similar to those associated with insulin use observed in the core content sample (Table 8a). The overall HRQL deficit associated with insulin use in the optional content analysis was -0.06 (95% CI: -0.11 to -0.0003), which was consistent the deficit found in the core content. A clinically important deficit was also observed on the pain attribute, but this difference failed to reach statistical significance (-0.06, 95% CI: -0.12 to 0.00) (Table 8b). The deficit on the ambulation attribute (-0.04) associated with insulin use was the same in the core and optional content samples.

Comorbidities

Specific Comorbidities

All of the comorbidities of interest were associated with clinically important deficits on the overall HUI3 after adjusting for demographic and clinical characteristics (Appendix 3, Table 25). Of the four comorbidities, the deficit associated with cataracts was smallest in magnitude and failed to reach statistical significance (Table 9). Differences in overall HUI3 scores between respondents with and without depression (-0.17, 95% CI: -0.22 to -0.12) and stroke (-0.15, 95% CI: -0.21 to -0.09) were the largest in magnitude (Table 9).

The impact of cataracts on the vision attribute was small and would not be considered clinically important (-0.02, 95% CI: -0.04 to -0.003). Heart disease, stroke and depression were all associated with clinically important deficits on the pain attribute. Stroke was the only comorbidity associated with clinically important deficits on the ambulation attribute (-0.12, 95% CI: -0.17 to -0.07), whereas both stroke and depression were associated with deficits on the cognition attribute. As anticipated, the difference in scores on the emotion attribute between respondents with and without depression was clinically important (-0.14, 95% CI: -0.17 to -0.10). These differences were all adjusted for demographic and clinical characteristics (Appendix 3, Tables 26 to 33).

Total Number of Comorbidities

Respondents with fewer comorbidities had significantly higher overall HUI3 scores (Table 10; Appendix 3, Table 34) after adjusting for the covariates in the model. As hypothesized, respondents with fewer comorbidities experienced less burden than those with three or four comorbidities. The difference between scores of respondents with three or four comorbidities of interest and those without any of these comorbidities was ten times the clinically important difference for overall scores (0.30; 95% CI: 0.16 to 0.44). The difference in overall HUI3 scores between respondents with one comorbidity and three or four comorbidities was about seven times that clinically important difference (0.22; 95% CI: 0.08 to 0.36).

Clinically important differences were observed between respondents with three or four comorbidities and respondents with no comorbidities on the vision, ambulation, dexterity, emotion, cognition and pain attributes (Table 10; Appendix 3, Tables 35 to 42). Respondents who had one comorbidity had significantly higher scores on the ambulation, dexterity, emotion, cognition and pain attributes than respondents with three or four comorbidities (Table 10).

Self-rated Health

A decline in overall HUI3 scores was seen across 'good', 'fair' and 'poor' health (Table 11), after controlling for other covariates in the model (Appendix 3, Table 43). When moving from 'good' to 'poor' self-rated health, the deficit associated with each category was three times that of the previous category (Table 11). Respondents who rated their health as 'excellent' and 'very good' had similar overall HUI3 scores, with a difference between groups of -0.01 (95% CI: -0.03 to 0.02).

Deficits were observed on the ambulation, emotion, cognition and pain attributes for respondents who rated their health as 'poor' relative to those who rated their health as 'excellent' (Table 11; Appendix 3, Table 44 to Table 51). The largest deficit was seen on the pain attribute for respondents who rated their health as 'poor' (-0.30, 95% CI: -0.24 to -0.35). Respondents who rated their health as 'fair' had clinically important deficits on the ambulation (-0.05, 95% CI: -0.07 to -0.02) and pain (-0.08, 95% CI: -0.06 to -0.11) attributes. As with the overall HUI3 scores, single attribute scores of respondents who rated their health as 'excellent' or 'very good' were almost identical (Table 11).

Objective Two: Utilization of Health Care Resources

Severity of impairment on overall HUI3 scores was associated with all categories of health care utilization after adjusting for the covariates in the models (Tables 12 to14). Relative to respondents whose overall HUI3 scores indicated severe impairment, respondents with no or mild impairment (OR=0.59, 95% CI: 0.48 to 0.74) or moderate impairment (OR=0.66, 95% CI: 0.51 to 0.86) had a lower probability of exceeding the median number of physician visits (Table 12). The probability of having an overnight hospitalization in the previous year (OR=0.67, 95% CI: 0.51 to 0.89) (Table 13) or last contact with a physician or nurse in the emergency room (OR=0.46, 95% CI: 0.24 to 0.86) (Table 14) was significantly reduced for those respondents whose overall HUI3 scores indicated no or mild impairment relative to those with severe impairment. Comorbidities, duration of diabetes, and insulin use were also associated with utilization of health care resources (Tables 12 – 14).

Objective Three: Interscale Correlations

The hypothesized strength of correlation between overall HUI3 scores, diabetes-relevant single attributes and other measures were correct for one-third of relationships (Table 15). For all incorrect hypotheses, disagreement was by one category and, in almost all cases, the observed strength of association was less than what was hypothesized. The exception to this was the relationships between the two measures of disability (impact and assistance with activities) and overall HUI3 score; we hypothesized that these relationships would be moderate in magnitude, whereas the observed relationships were strong (Table 15).

DISCUSSION

Type 2 diabetes is a chronic medical condition that can be associated with impairments on multiple dimensions of HRQL. A valid measure of HRQL in diabetes should differentiate between individuals expected to differ in their illness burden. As hypothesized, we observed respondents with greater disease burden (based upon duration of disease, treatment intensity, comorbidities and self-rated health) had lower overall scores on the HUI3 and some deficits on the single attributes. The evidence generated from these analyses (both known groups comparisons and the association between overall HUI3 scores and health care resource utilization) provides additional evidence of the cross-sectional construct validity of the HUI3 in type 2 diabetes at the population level.

Clinically important differences in overall HUI3 scores were found between respondents below the median duration of diabetes (i.e., in either of the lower two quartiles) and respondents in the fourth quartile. In a sample of rural Albertans with type 2 diabetes, we used duration of diabetes to form known groups based on a median split (with the median being 5.0 years) (Maddigan 2004a) rather than quartiles. In this analysis, a similar result was obtained, with the difference between groups (i.e., those above and below the median) being 0.07. The similar result is interesting given that the sample was not necessarily representative of individuals with type 2 diabetes and was not selected at random. As well, that difference was not adjusted for comorbidities, insulin use or demographic characteristics (Maddigan 2004a).

Insulin use was associated with deficits on the overall HUI3 score after adjusting for duration of diabetes, comorbidities and a number of demographic characteristics. This relationship was

found for analyses performed for both core content and optional content samples. We had previously surmised that the burden associated with insulin may be the result of confounding with disease duration, comorbidities or demographic characteristics such as age (Maddigan 2003b; Maddigan 2003a; Maddigan 2004a). In this analysis, we adjusted for these factors and found that this relationship persisted which suggests that the HUI3 does detect the burden associated with insulin use. Alternatively, insulin use could remain a marker for some further unexplained variance in HRQL such as microvascular complications. Unfortunately, we were limited to controlling for those comorbidities assessed in the CCHS, so complications such as peripheral vascular disease and nephropathy remained potential confounders. A number of these complications are related to duration of diabetes, so by adjusting for duration of diabetes we may have controlled, in part, for differences due to confounding by these variables.

Analysis of the optional content data revealed that, relative to respondents managed with diet, oral agents were not associated with HRQL deficits. This finding contrasts our previous research where we found that the difference in overall HUI3 scores between individuals whose diabetes was managed by diet versus oral medications was 0.03 (i.e., the clinically important difference) (Maddigan 2003b). One important point to note, however, was that the difference observed in our previous research was not adjusted for duration of diabetes or comorbidities so it may have been confounded, in part, by these variables. Thus, on average, the treatment burden associated with oral agents may not generally be clinically important, as measured with the HUI3.

The hypothesized relationships between overall HUI3 scores and comorbidities were consistently supported in these analyses. The overall HUI3 scores clearly distinguished between respondents with and without the comorbidities of interest, suggesting that comorbidities make an important contribution to the disease burden in type 2 diabetes. The ability to distinguish between individuals with and without comorbidities or complications is a criterion that has been used to validate other utility measures in diabetes (Clarke 2002; U.K. Prospective Diabetes Study Group 1999; Holmes 2000; Hart 2004; Redekop 2002; Koopmanschap 2002; Tabaei 2004; Coffey 2002; Hahl 2002). Thus, the ability of the overall HUI3 to discriminate between respondents with and without comorbidities in this sample is consistent with previous research carried out with other utility measures.

In addition to distinguishing between respondents with and without specific comorbidities, the overall HUI3 also distinguished between respondents who differed in their number of comorbidities. Respondents with three or four comorbidities had overall HUI3 scores that, on average, indicated severe impairment. The overall scores for respondents with no comorbidities or one comorbidity indicated moderate impairment. Thus, the overall HUI3 performed as expected, providing evidence of construct validity. Although the magnitude of the difference between respondents with two comorbidities compared to three or four comorbidities was large, scores for both groups indicated severe impairment. Thus, the nature of the comorbidity, not only the number of comorbidities, had an important impact on HRQL. Regardless, it was evident that any comorbidity and the accumulation of comorbidities had detrimental effects on overall HRQL in type 2 diabetes, with some comorbidities having a greater impact than others.

The results for self-rated health were particularly interesting as there was little difference in overall HUI3 scores between respondents who rated their health as 'excellent' or 'very good'. There were three-fold deficits in HRQL scores for the remaining categories. For example, the deficit associated with having 'good' health was -0.04, whereas the deficit associated with having 'fair' health was -0.12 and 'poor' health was -0.36. These data suggest a nonlinear gradient of preferences for health states that respondents rated as 'excellent', 'very good', 'good', 'fair' or 'poor'.

It is reasonable to expect respondents with poorer HRQL scores to have higher rates of health care utilization, particularly in a publicly funded healthcare system where there are few financial barriers to access. The association between health care resource utilization and HRQL is an approach to assessing the construct validity of the HUI3 that had not been previously explored. Consistent with past research using health profiles or disease specific measures of HRQL (Brown 1994; Walter-Ginzburg 2001; Wyke 2003; Jordan 2003; Parkerson, Jr. 2000; Pearson 1999; Kennedy 2001), we did find that respondents with higher overall HUI3 scores consumed fewer health care resources. As the majority of the evidence to support the use of the HUI3 in type 2 diabetes has been previously generated from known groups comparisons, we felt that it was important to generate evidence using a different approach. Our confidence in the HUI3's construct validity in type 2 diabetes would have been weakened if those individuals who had poor health status were not more likely to consume health care resources. Thus, the observed

relationship with health care resource utilization successfully triangulated the results from the known groups comparisons.

Convergent validity was the third manner in which the validity of the overall HUI3 was assessed. However, none of the hypothesized correlations between overall HUI3 and other measures were correct. For two of the four relationships (i.e., the relationships between HUI3 and the measures of disability), the strength of the correlation was stronger than hypothesized. The correlation between overall HUI3 and self-rated health was 0.49, which approached the threshold of a strong correlation (0.50). Thus, while the strength of the correlations was not as hypothesized, the evidence did not suggest that the overall HUI3 lacked validity in this population.

We sought to generate evidence to support the overall HUI3 in type 2 diabetes from three sources: known groups comparisons, health care resource utilization and interscale correlations. The evidence from known groups was generally consistent with our previous research and with work that has been carried out with other utility measures. The evidence generated from the association between health care utilization and overall HUI3 scores provided additional evidence of the validity of the overall HUI3 in type 2 diabetes. While the interscale correlations were not as hypothesized, the observed correlations were not radically different than anticipated.

Evidence of construct validity of the single attributes was not as compelling as the evidence generated for the overall HUI3. Hypotheses for the pain attribute were most consistently supported. Clinically important differences between groups were detected according to insulin use, number of complications, heart disease, depression, stroke and self-rated health. The ambulation attribute also performed reasonably well in that clinically important differences were noted between groups according to number of complications, self-rating of health and heart disease. The ambulation attribute did not discriminate between groups of respondents according to treatment or duration of diabetes, as we had hypothesized based on previous research (Maddigan 2003b; Maddigan 2004a).

The emotion attribute performed well in discriminating between respondents whose scores on the CIDI-SFMD did and did not suggest depression. The difference between groups was almost three times the clinically important difference, providing strong evidence of the validity

of the emotion attribute in this population. Differences on the emotion attribute according to treatment regimen or duration were not statistically significant after controlling for comorbidities and other covariates. Previously, we had found that the difference on the emotion attribute between respondents on insulin and those controlled by diet alone was clinically important, even after controlling for demographics and duration of diabetes (Maddigan 2003b). We had felt that the burden associated with insulin use contributed to these differences. It is now apparent that, after controlling for other comorbidities, the strength of this association is weakened. A small gradient in emotion attribute scores was seen across respondents with zero, one or two comorbidities, but scores in all of these groups were much higher than the scores of respondents with three or four comorbidities. This suggests that an accumulation of comorbidities results in impairments in emotional health in individuals with diabetes.

The gradient across self-rated health categories and scores on the emotion attribute was somewhat weaker than anticipated. For self-rated health, clinically important differences on the emotion attribute were only found between respondents who rated their health as poor compared to excellent. This could perhaps suggest that when faced with this question the majority of subjects may have focused on physical health which left little distinction amongthe four top categories. This assertion is supported by the relatively weak correlation between self-rated health and the emotion attribute.

Vision and dexterity were the two attributes for which the fewest hypotheses were supported. Cataracts were associated with a statistically significant, but nonclinically important deficit on the vision attribute (-0.02, 95% CI: -0.04, -0.003). The relationship between visual impairment and cataracts may have been attenuated if respondents had had their cataracts removed before they caused visual impairment. As well, the ability of the vision and dexterity attributes to distinguish between known groups may have been limited by the lack of variability on level of functioning on these attributes in the general population. On the vision attribute and dexterity attributes, 95.0% and 98.9% of the population were at level 1 or level 2 functioning, respectively. The only known groups comparisons for which the hypotheses for the dexterity and vision attributes were supported were the comparisons made between respondents with no comorbidities versus those with three or more comorbidities. This finding highlights how severely burdened on multiple dimensions of HRQL respondents with three or four

comorbidities were. In our previous research, the proportion of respondents at level 1 or level 2 of the vision or dexterity attributes was lower (78.7 and 87.9%, respectively) and, thus, the variability was greater (Maddigan 2003a). Using these data, we had found that vision scores did differ with disease duration and insulin use, but, similarly, differences on the dexterity attribute did not reach clinical importance in our previous research (Maddigan 2004a).

Similar to results for the interscale correlations for the overall scores, the majority of the hypothesized relationships for the single attributes were not supported. The vision and dexterity attributes had weak correlations with all other measures and were correctly predicted for one-half of the hypotheses. In general, hypotheses of discriminant validity were more successful than hypotheses of convergent validity (i.e., we were more often correct in making inferences regarding weak correlations than moderate or strong ones). The failure to find as strong an association as anticipated could be attributed, in part, to the lack of variance in functioning on the single attributes in this sample. Somewhat surprising was the weak association between the CIDI-SFMD and the pain attribute, given that pain and depression are often associated (Fishbain 1997).

Relative to other utility measures that have been applied in diabetes, the HUI3 seems to be a reasonable choice in that its overall scores detected the disease burden associated with diabetes, duration of disease, treatment and comorbidities. The ability of the overall scores to distinguish between these groups is consistent with what has been found for other utility measures such as the EQ-5D (Holmes 2000; U.K. Prospective Diabetes Study Group 1999; Clarke 2002; Redekop 2002; Ragnarson 2000), the QWB-SA (Tabaei 2004; Coffey 2002), and the 15-D (Hahl 2002). The HUI3 has some unique advantages over the other utility measures that are important to note. One important feature of the HUI3 is that, in addition to the overall index score, single-attribute utility scores can be obtained and these scores provide additional information about health and functioning. This is not possible with the EQ-5D or QWB-SA. There was evidence to support the use of the single attributes of the HUI3 in type 2 diabetes, in particular pain and ambulation, at the population level. Thus, this is an important feature of the HUI3.

A further advantage of the HUI3 is that the larger number of dimensions and levels of the HUI3 create a larger number of health states (972,000) compared to the EQ-5D (243) or the

QWB-SA (1215). Further, the larger number of levels per attribute of the HUI3 (five or six) allows for better discrimination of level of functioning relative to the EQ-5D and QWB-SA which have three levels of functioning per attribute. One possible limitation of the HUI3 is that it does not include social interaction as a domain or attribute; that is, it is restricted to 'within the skin' in its attributes. While this is a limitation, it should be noted that general recommendations for measuring HRQL suggest using a preference-based measure, a generic health profile and a disease-specific measure. Thus, information on social interaction could be captured using an additional instrument that provides complementary information.

Generating population level of evidence to support the use of the HUI3 was important given that the HUI3 has been incorporated into a number of Statistics Canada's Surveys, for example the CCHS, the National Population Health Survey and the General Social Survey. These surveys are the basis for much research and tracking of health trends in Canada; thus, there is the potential for resource-allocation decisions to be made from their data. It is important to society that health-policy decisions are based on data derived from methodologically sound sources; for instance, that data are measured with valid instruments. The results of this study can increase confidence that data reflecting the burden of type 2 diabetes generated with the HUI3 at the population level will be suitable for resource allocation decisions.

From a research perspective, it was important to generate evidence of construct validity of the HUI3 in type 2 diabetes as it is sometimes questioned whether generic HRQL measures, regardless of whether they are preference-based index measures or generic health profiles, are appropriate to use in the disease. Consequently, when study outcomes are measured with a generic measure, it may be questioned whether disease burden in type 2 diabetes was truly reflected, given the broad nature of the health dimensions contained in the measure. Having previous evidence of construct validity, such as the evidence generated by this study, helps to clarify this question. From a research perspective, the results of this study are important in that the application of the HUI3 in type 2 diabetes was furthered beyond a clinical study population (Maddigan 2004a) to the population level. Given the wealth of data available from Canadian population health surveys and the potential for research in type 2 diabetes with these surveys, this population-based assessment of the construct validity of the HUI3 is useful methodological background work which can be drawn upon.

In carrying out these analyses, a number of limitations became apparent. One issue with the analysis was the use of a previously unvalidated algorithm to distinguish between respondents with type 1 and type 2 diabetes. A number of the criteria in the algorithm have been used previously (Hahl 2002; Johnson 2002; Eurich 2004), but the algorithm as a whole has not. While this algorithm is considered the typical clinical presentation of type 2 diabetes, some individuals included in the analysis may have had type 1 diabetes. It is important to point out that for those respondents that could be classified (99%), the split between type 1 and type 2 diabetes was 10% and 90%, which is generally recognized as the distribution of type 1 and type 2 diabetes in Canada (Centre for Chronic Disease Prevention and Control 2002). Thus, we were confident in the ability of the algorithm to accurately classify respondents as having type 1 or type 2 diabetes.

Another potential limitation was related to the accuracy of self-reported medical conditions and health care utilization. Although the questions regarding medical conditions specified that the conditions have been diagnosed by a health professional, there remained potential for individuals to over- or under-report any medical condition. According to data collected from the National Diabetes Surveillance System (NDSS), the prevalence of diabetes in Canada is 5.1% in people aged 20 and over (Health Canada 2003). In the CCHS, 4.7% of respondents over the age of 20 self-reported having a diagnosis of diabetes; thus, the self-reporting of diabetes was likely accurate. Health care resource utilization data were based on self-report over the previous year. While the ability to recall whether a last contact with a physician or nurse was in an emergency room or whether an overnight hospitalization had occurred in the previous year may be less prone to recall bias, the accuracy of self-reporting the number of physician visits over a full year is questionable.

The CCHS sample is representative of 98% of the community-dwelling population in Canada; however, the exclusion of individuals who live on reserve lands was somewhat problematic in that only 1.7% of the sample was Aboriginal. We still felt that it was important to adjust the analyses for this covariate, but the standard errors associated with this variable were large as a result of the small sample. Further, the degree to which this sample was representative of Aboriginals with diabetes in Canada was questionable as there have been systematic differences between Aboriginals who live on and off reserves (Health Canada 1999; Health

Canada 2000). Analyses were performed with and without this variable and we found that it made little difference; we opted to retain it in the analyses.

A number of respondents were missing data on covariates and the variables used to separate respondents into known groups. These respondents tended to have worse HRQL. We do believe it was important, however, to adjust the known groups for these covariates and did retain over 90% of respondents over the age of 18 with type 2 diabetes. Generalizability of these results to the respondents with missing data may be limited due to the observed differences between responders and non-responders.

Despite these limitations, we feel that this study provided evidence of the construct validity of the HUI3 and did so in a large, representative sample of the majority of the Canadian population.

A further strength of this study was that the known groups were adjusted for multiple covariates known to affect health. For example, the analysis comparing insulin users to non-users was adjusted for demographic characteristics, in addition to duration of diabetes and comorbidities. Thus, the deficit associated with insulin use was not observed simply because insulin users would likely have a longer duration of diabetes and a greater likelihood of having developed heart disease or stroke, as these factors were adjusted for in the analysis. With the approach we used in this analysis, we were reasonably confident that the deficits we observed were, indeed, related to the factors used to separate respondents into known groups since we adjusted for covariates. This is an improvement over our previous research where we did not have data on both comorbidities and treatments. It is possible that some of the burden we previously observed on the single attributes and had attributed to treatment burden or duration was related to comorbidities.

CONCLUSION

Type 2 diabetes is a chronic medical condition in which the HRQL burden is generally attributed to the disease itself, its treatment burden and the comorbidities or complications associated with the disease. In these analyses we found that the overall HUI3, the pain and discomfort, emotion and ambulation attributes distinguished between respondents anticipated to differ in their level of HRQL when grouped according to the factors thought to impact HRQL in

diabetes. As anticipated, level of impairment on the HUI3 was associated with utilization of health care resources. This research lends further evidence to support the use of the HUI3 in individuals with type 2 diabetes, aged 18 and over, at the population level.

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Figure 1: Algorithm for Differentiating between Individuals with Type 1 and Type 2 Diabetes

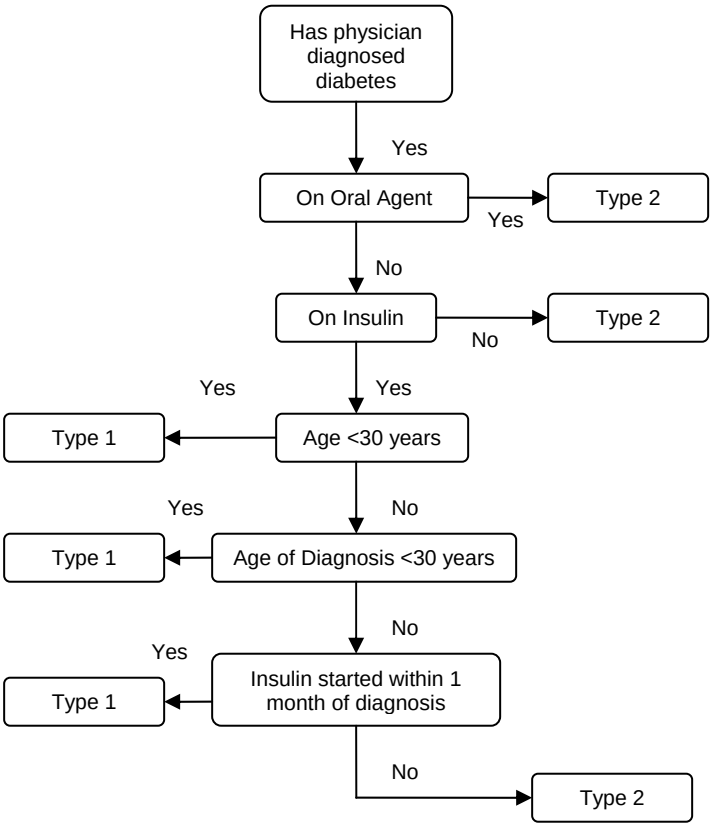

Figure 2: Survey Sample, Analysis Sample and Missing Data

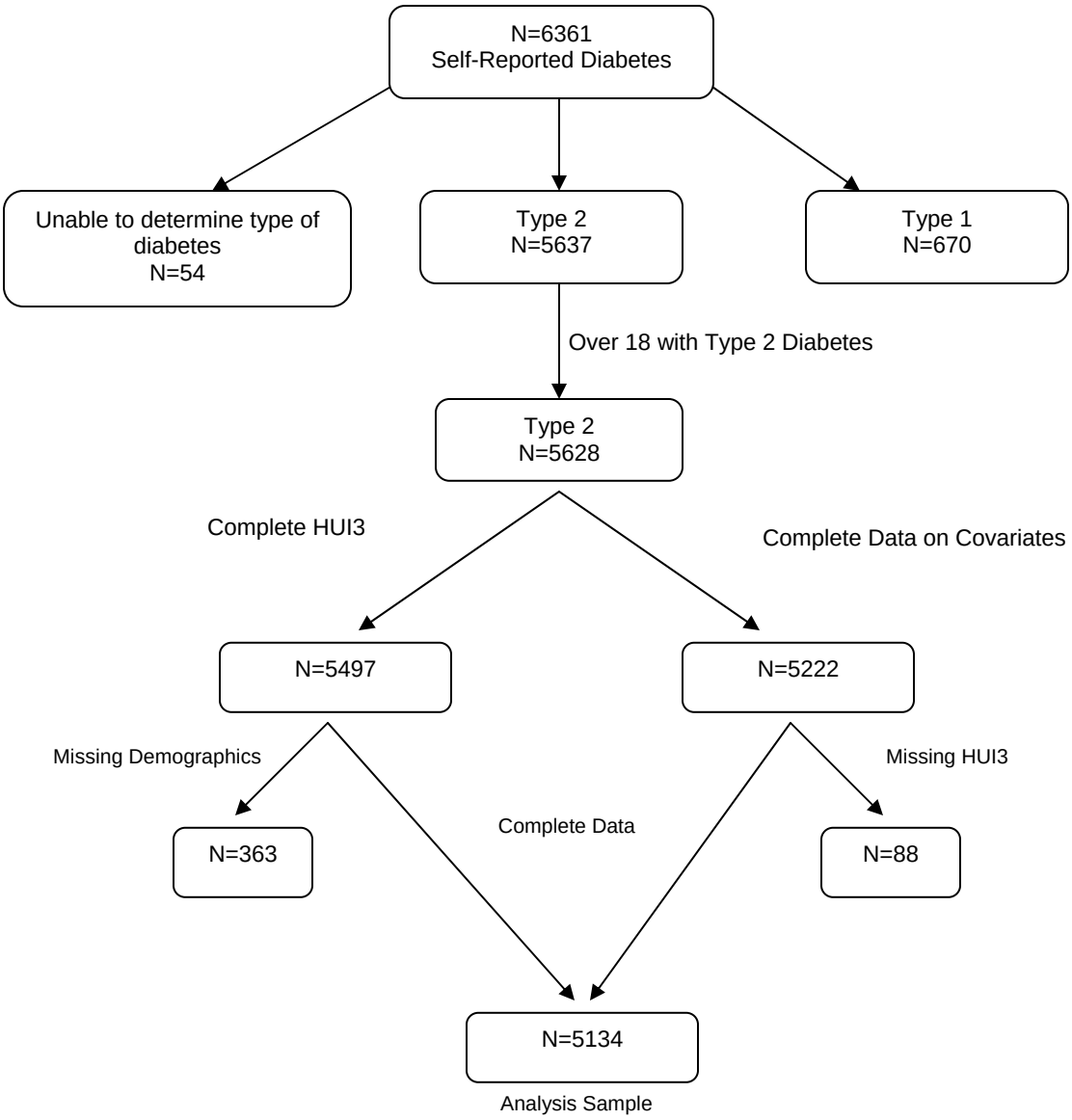

Table 1: Hypothesized Strength of Interscale Correlations

	General Health	Probability of Depression	Disability	Assistance with Activities
Overall HUI3	strong	moderate	moderate	moderate
Emotion	moderate	strong	moderate	moderate
Pain	moderate	moderate	strong	strong
Dexterity	small	small	moderate	moderate
Ambulation	moderate	small	strong	strong
Vision	small	small	moderate	moderate

Table 2: Demographic Characteristics of Respondents with Type 2 Diabetes

	N=5134
Age – Mean (SD)	61.69 (13.44)
Median (Interquartile Range)	63.00 (52.00-72..00)
Age Categories - %	
18 - 44	11.4
45 - 54	17.9
55 - 64	25.0
65 - 74	27.6
75 or older	18.1
Sex – (% Male)	52.3
Level of Education - %	
Less than secondary	43.5
Secondary graduation	16.6
Some post-secondary, college, trade school	28.2
University degree	11.2
Marital Status – (% Married)	68.2
Duration of Diabetes – Mean (SD)	9.41 (9.91)
Median (Interquartile Range)	6.00 (2.00-13.00)
Proxy Completion – (% Proxy)	5.0
Aboriginal Status – (% Yes)	1.7
Number of Medical Conditions[A]	
Mean (SD)	3.24 (1.88)
Median (Interquartile Range)	3.00 (2.00-4.00)
Has Cataracts (% Yes)	14.7
Suffers the Effects of Stroke (% Yes)	5.2
Has Heart Disease (% Yes)	21.1
Predicted Probability of Depression > 0.90 - %	7.2
Overnight Hospitalization (% Yes)	17.5
Last Contact with Physician or Nurse in ER (% Yes)	3.0
Number of Physician Visits in Previous 12 Months –	
Mean (SD)	8.50 (14.93)
Median (Interquartile Range)	5.00 (3.00-11.00)
Uses Insulin (% Yes)	15.6
Total Number of Sentinel Comorbidities	
Zero	62.1
One	29.0
Two	7.4
Three or Four	1.5
Self-Rated Health	
Excellent	4.5
Very Good	18.3
Good	35.2
Fair	28.4
Poor	13.6
Impact of Health Problems	
Never	54.0
Sometimes	19.6
Often	26.4
Total Number of Activities Requiring Assistance	
Zero	62.3
One	17.5
Two	6.5
Three	4.8
Four	4.0
Five	2.2
Six	2.6

A Number of medical conditions other than stroke, heart disease, cataract or depression

Table 3: Descriptive Statistics for Overall and Single Attribute Utility Scores for Respondents with Type 2 Diabetes (N=5134)

	Mean (SD)	Median (IQR)
Overall HUI3 Score	0.76 (0.28)	0.91 (0.66 – 0.97)
Vision	0.94 (0.10)	0.95 (0.95 – 0.95)
Hearing	0.97 (0.11)	1.00 (1.00 – 1.00)
Speech	1.00 (0.04)	1.00 (1.00 – 1.00)
Ambulation	0.93 (0.20)	1.00 (1.00 – 1.00)
Dexterity	0.99 (0.07)	1.00 (1.00 – 1.00)
Emotion	0.95 (0.12)	1.00 (0.91 – 1.00)
Cognition	0.94 (0.14)	1.00 (0.92 – 1.00)
Pain and Discomfort	0.85 (0.30)	1.00 (0.77 – 1.00)

Table 4: Distribution of Respondents with Type 2 Diabetes on Single Attributes of the HUI3 (N=5134)

	Vision		Hearing		Speech		Ambulation		Dexterity		Emotion		Cognition		Pain	
	Utility	%	Utility	%	Utility	%	Utility	%	Utility	%	Utility	%	Utility	%	Utility	%
Level 1	1.0	20.8	1.0	90.8	1.0	99.1	1.0	86.5	1.0	97.9	1.0	69.5	1.0	68.7	1.0	68.8
Level 2	0.95	74.2	0.86	4.3	0.82	0.6	0.83	2.3	0.88	1.0	0.91	23.3	0.86	18.5	0.92	5.9
Level 3	0.73	1.3	0.71	2.0	0.67	suppressed	0.67	6.4	0.73	suppressed	0.73	5.2	0.92	2.6	0.77	8.6
Level 4	0.59	1.9	0.48	2.2	0.41	0.2	0.36	0.5	0.45	0.6	0.33	1.5	0.70	7.2	0.48	7.7
Level 5	0.38	1.5	0.32	0.4	0.0	suppressed	0.16	3.5	0.20	0.2	0.0	0.5	0.32	2.7	0.0	9.0
Level 6	0.0	0.3	0.0	0.3	-	-	0.0	0.9	0.0	suppressed	-	-	0.0	0.3	-	-

Table 5: Comparison of Mean (S.D.) HUI3 Scores of Respondents Included in and Excluded from Analyses due to Missing Data on Covariates

HUI3 Attribute	Complete Data on Covariates (n=5134)	Missing Data on Covariates (n=363)	Mean Difference (95% CI)[A,B]
Overall	0.76 (0.28)	0.60 (0.34)	**0.16 (0.11, 0.21)**
Vision	0.94 (0.10)	0.94 (0.12)	0.01 (-0.01, 0.02)
Hearing	0.97 (0.11)	0.95 (0.15)	0.02 (-0.00, 0.04)
Speech	1.00 (0.04)	0.99 (0.05)	0.01 (-0.00, 0.01)
Ambulation	0.93 (0.20)	0.89 (0.24)	**0.04 (0.01, 0.08)**
Dexterity	0.99 (0.07)	0.99 (0.08)	0.00 (-0.01, 0.01)
Emotion	0.95 (0.12)	0.89 (0.21)	**0.06 (0.02, 0.09)**
Cognition	0.94 (0.14)	0.86 (0.22)	**0.08 (0.04, 0.11)**
Pain and Discomfort	0.85 (0.30)	0.74 (0.38)	**0.11 (0.05, 0.16)**

A. Calculation of 95% Confidence Intervals were based on bootstrap variance estimate.
B. Bold entries indicate statistically significant differences (P Value<0.05)

Table 6: Comparison of Demographics of Respondents with Complete and Missing HUI3 Scores[a]

	Complete Data on Covariates and HUI3 Scores (N=5134)	Complete Data on Covariates, Missing HUI3 Scores (N=88)
Age – Mean (SD)	61.69 (13.44)	65.71 (13.70)
Sex – (% Male)	52.3	60.0
Level of Education - % Less than secondary	43.5	59.4*
Marital Status – (% Married)	68.2	62.3
Duration of Diabetes – Mean (SD)	9.41 (9.91)	8.42 (7.68)
Proxy Completion – (% Proxy)	7.0	18.8
Aboriginal Status – (% Yes)	1.7	Suppressed[B]
Number of Medical Conditions[C]		
Mean (SD)	3.24 (1.88)	3.73 (1.88)
Cataracts – (% Yes)	14.7	15.9
Stroke – (% Yes)	5.2	Suppressed[B]
Heart Disease – (% Yes)	21.1	21.7
Depression – (% Yes)	7.2	7.2
Overnight Hospitalization – (% Yes)	17.5	22.9
Last Contact with Physician or Nurse in ER – (% Yes)	3.0	Suppressed[B]
Median Split on Physician Visits – (% above Median)	48.2	76.8*
Uses Insulin – (% Yes)	15.6	18.8
Total Number of Sentinel Comorbidities – (% Zero)	62.1	55.1
Self-Rated Health	2.72 (1.05)	2.09 (0.91)*
Impact of Health Problems – (% Often)	26.4	50.0*
Total Number of Activities Requiring Assistance	0.88 (1.50)	1.69 (1.81)*

* Difference between groups was statistically significant at the P value <0.05 level, using t-tests or χ^2 tests as appropriate.

A P-values for continuous variables were based on Bootstrap variance estimates.

B Consistent with Statistics Canada's guidelines for data release, cells with frequencies of less than 5 were suppressed. Release guidelines do not preclude data analysis. χ^2 tests were performed and indicated there were no statistically significant differences between respondents with and without complete HUI3 scores where data were suppressed.

C Number of medical conditions other than stroke, heart disease, cataract or depression

Table 7: Adjusted[a] Mean Difference (95% CI) in Overall and Single Attribute Utility Scores according to Quartiles of Duration of Diabetes

	Mean (95% CI) of Reference Quartile (≥ 13 years)	<2 years relative to ≥ 13 years[b]	2 to 6 years relative to ≥ 13 years[b]	6 to 13 years relative to ≥ 13 years[b]
Overall HUI3	0.55 (0.52, 0.58)	**0.04 (0.01, 0.06)***	**0.06 (0.03, 0.08)***	0.02 (-0.01, 0.05)
Vision	0.91 (0.89, 0.92)	0.00 (-0.02 , 0.01)	0.01 (-0.01, 0.02)	0.01 (0.00, 0.02)
Hearing	0.96 (0.95, 0.98)	0.00 (-0.01, 0.02)	0.00 (-0.01, 0.01)	-0.01 (-0.03, 0.01)
Speech	0.99 (0.99, 1.00)	0.01 (0.00, 0.01)	0.01 (0.00, 0.01)	0.00 (0.00, 0.01)
Ambulation	0.84 (0.81, 0.86)	**0.03 (0.01, 0.06)***	**0.04 (0.01, 0.06)***	**0.04 (0.01, 0.06)***
Dexterity	0.97 (0.96, 0.98)	0.01 (0.00, 0.01)	0.01 (0.00, 0.02)	**0.01 (0.01, 0.02)***
Emotion	0.89 (0.87, 0.90)	0.00 (-0.01, 0.02)	0.01 (0.00, 0.02)	-0.02 (-0.02, 0.01)
Cognition	0.87 (0.85, 0.88)	0.02 (0.00, 0.03)	0.02 (0.00, 0.03)	0.01 (-0.01, 0.02)
Pain	0.69 (0.65, 0.73)	0.02 (-0.01, 0.05)	**0.03 (0.01, 0.06)***	0.00 (-0.03, 0.03)

a Adjusted for Age as a Quadratic, Sex, Education, Marital Status, Race, Depression, Stroke, Heart Disease, Cataracts, Number of Other Medical Conditions, Insulin Use

b 95% Confidence Interval based on the Bootstrap Variance Estimate

*P value <0.05 for between groups difference after adjusting for covariates

Table 8a: Adjusted[a] Mean (95% CI) Difference in Overall and Single Attribute Utility Scores according to Insulin Use

	Respondents who do not use Insulin	Impact of Insulin on HRQL: Mean (95% CI)[b] Difference[c]
Overall	0.61 (0.58, 0.64)	**-0.06 (-0.09, -0.03)***
Vision	0.92 (0.91, 0.94)	**-0.02 (-0.03, - 0.003)***
Hearing	0.96 (0.95, 0.97)	0.00 (-0.02, -0.02)
Speech	0.99 (0.99, 1.00)	0.00 (0.00, 0.01)
Ambulation	0.88 (0.86, 0.91)	**-0.04 (-0.07, -0.01)***
Dexterity	0.98 (0.97, 0.99)	**-0.01 (-0.02, -0.001)***
Emotion	0.89 (0.88, 0.91)	0.00 (-0.02, 0.01)
Cognition	0.87 (0.86, 0.89)	0.00 (-0.01, 0.02)
Pain	0.74 (0.71, 0.78)	**-0.07 (-0.11, -0.04)***

a. Adjusted for Age, Sex, Education, Marital Status, Race, Depression, Stroke, Heart Disease, Cataracts, Number of Other Medical Conditions, and Duration of Diabetes
b. 95% Confidence Interval based on the Bootstrap Variance Estimate
c. Adjusted mean utility score for respondents who use insulin minus adjusted mean utility score for respondents who do not. A negative score indicates lower utility scores for the group who uses insulin (i.e., a HRQL deficit).
*P value <0.05 for between groups difference after adjusting for covariates

Table 8b: Adjusted[a] Mean (95% CI) Difference in Overall and Single Attribute Utility Scores according to Treatment Intensity

	Diet Controlled	Impact of Oral Agents on HRQL: Mean (95% CI)[b] Difference[c]	Impact of Insulin on HRQL: Mean (95% CI)[b] Difference[c]
Overall	0.58 (0.52, 0.65)	0.00 (-0.04, 0.04)	**-0.06* (-0.11, -0.003)**
Vision	0.89 (0.86, 0.93)	0.02 (-0.01, 0.04)	-0.01 (-0.04, 0.02)
Hearing	0.93 (0.89, 0.97)	0.02 (-0.01, 0.05)	0.01 (-0.04, 0.05)
Speech	1.00 (0.99, 1.01)	0.00 (0.00, 0.00)	0.00 (-0.01, 0.01)
Ambulation	0.87 (0.81, 0.92)	-0.02 (-0.04, 0.01)	-0.04 (-0.09, 0.00)
Dexterity	1.00 (0.99, 1.02)	0.00 (-0.01, 0.01)	-0.01 (-0.03, 0.00)
Emotion	0.90 (0.86, 0.93)	0.00 (-0.02, 0.02)	-0.01 (-0.04, 0.02)
Cognition	0.89 (0.85, 0.92)	0.00 (-0.02, 0.01)	-0.01 (-0.03, 0.02)
Pain	0.72 (0.64, 0.80)	-0.01 (-0.05, 0.03)	-0.06 (-0.12, 0.00)

a. Adjusted for Age as a Quadratic, Sex, Education, Marital Status, Race, Depression, Stroke, Heart Disease, Cataracts, Number of Other Medical Conditions, and Duration of Diabetes
b. 95% Confidence Interval based on the Bootstrap Variance Estimate
c. Adjusted mean utility score for respondents who use insulin minus adjusted mean utility score for respondents who do not. A negative score indicates lower utility scores for the group who uses insulin (i.e., a HRQL deficit).
*P value <0.05 for between groups difference after adjusting for covariates

Table 9: Adjusted[a] Mean (95% CI) Difference in Overall and Single Attribute Utility Scores according to Comorbidities

	Cataracts		Heart Disease		Stroke		Depression	
	Respondents without Cataracts	Impact of Cataracts on HRQL: Mean (95% CI)[b] Difference[c]	Respondents without Heart Disease	Impact of Heart Disease on HQL: Mean (95% CI)[b] Difference[c]	Respondents without Stroke	Impact of Stroke on HRQL: Mean (95% CI)[b] Difference[c]	Respondents without Depression	Impact of Depression on HRQL: Mean (95% CI)[b] Difference[c]
Overall	0.61 (0.58, 0.64)	-0.03 (-0.06, 0.01)	0.63 (0.60, 0.67)	**-0.08* (-0.11, -0.05)**	0.67 (0.64, 0.70)	**-0.15* (-0.21, -0.10)**	0.68 (0.65, 0.71)	**-0.17* (-0.22, -0.12)**
Vision	0.93 (0.91,0.94)	**-0.02* (-0.04, -0.003)**	0.92 (0.90, 0.93)	0.00 (-0.01, 0.01)	0.93 (0.91, 0.94)	-0.02 (-0.04, 0.01)	0.93 (0.91, 0.94)	**-0.02* (-0.04, -0.003)**
Hearing	0.96 (0.94, 0.97)	0.00 (-0.01, 0.02)	0.96 (0.95, 0.98)	0.00 (-0.02, 0.01)	0.97 (0.96, 0.98)	-0.02 (-0.04, 0.01)	0.97 (0.95, 0.98)	-0.01 (-0.03, 0.01)
Speech	1.00 (0.99, 1.00)	-0.01 (-0.01, 0.00)	1.00 (0.99, 1.00)	0.00 (-0.01, 0.00)	1.00 (0.99, 1.00)	-0.01 (-0.01, 0.00)	0.99 (0.99, 1.00)	0.00 (0.00, 0.01)
Ambulation	0.88 (0.86, 0.91)	-0.02 (-0.05, 0.02)	0.89 (0.85, 0.89)	-0.02 (-0.04, 0.00)	0.94 (0.90, 0.95)	**-0.12* (-0.17, - 0.07)**	0.89 (0.85, 0.90)	-0.02 (-0.05, 0.01)
Dexterity	0.98 (0.97, 0.99)	-0.01 (-0.02, 0.01)	0.98 (0.97, 0.99)	**-0.01* (-0.02, -0.001)**	1.00 (0.99, 1.00)	-0.04 (-0.08, 0.01)	0.98 (0.97, 0.99)	0.00 (-0.01, 0.01)
Emotion	0.88 (0.87, 0.90)	0.00 (-0.01, 0.02)	0.90 (0.88, 0.91)	**-0.01* (-0.02, -0.002)**	0.91 (0.89, 0.92)	**-0.03* (-0.06, -0.01)**	0.96 (0.94, 0.97)	**-0.14* (-0.17, -0.10)**
Cognition	0.87 (0.85, 0.89)	0.01 (-0.01, 0.02)	0.89 (0.87, 0.91)	**-0.03* (-0.05, -0.01)**	0.91 (0.89, 0.92)	**-0.07* (-0.11, -0.03)**	0.91 (0.89, 0.92)	**-0.07* (-0.09, -0.04)**
Pain	0.74 (0.70, 0.77)	-0.02 (-0.05, 0.01)	0.77 (0.73, 0.81)	**-0.09* (-0.12, -0.05)**	0.75 (0.72, 0.79)	-0.06 (-0.12, 0.00)	0.78 (0.74, 0.81)	**-0.10* (-0.15, -0.05)**

a. Adjusted for Age, Sex, Education, Marital Status, Race, other Sentinel Comorbidities (e.g. Depression, Stroke, Heart Disease, Cataracts), Number of Other Medical Conditions and Duration of Diabetes

b. 95% Confidence Interval based on the Bootstrap Variance Estimate

c. Adjusted mean utility score for respondents with the comorbidity minus adjusted mean utility score for respondents without the comorbidity. A negative score indicates lower utility scores for the group with the comorbidity (i.e., a HRQL deficit).

*P value <0.05 for between groups difference after adjusting for covariates.

Table 10: Adjusted[a] Mean (95% CI) Overall and Single Attribute Utility Scores according to Number of Comorbidities

	Reference Group (3 or 4 Comorbidities)	No Comorbidities minus Reference Group[b]	One Comorbidity minus Reference Group[b]	Two Comorbidities minus Reference Group[b]
Overall	0.49 (0.43, 0.55)	**0.30* (0.16, 0.44)**	**0.22* (0.08, 0.36)**	0.14 (0.00, 0.29)
Vision	0.89 (0.86, 0.92)	0.05 (-0.02, 0.12)	0.04 (-0.03, 0.11)	0.03 (-0.04, 0.11)
Hearing	0.95 (0.92, 0.98)	0.02 (-0.04, 0.09)	0.02 (-0.05, 0.09)	0.02 (-0.05, 0.08)
Speech	0.98 (0.97, 0.99)	0.02 (0.00, 0.04)	0.01 (-0.01, 0.03)	0.01 (-0.01, 0.03)
Ambulation	0.79 (0.74, 0.84)	**0.15* (0.03, 0.28)**	**0.14* (0.01, 0.26)**	0.09 (-0.03, 0.22)
Dexterity	0.92 (0.90, 0.94)	0.08 (-0.05, 0.20)	0.08 (-0.05, 0.20)	0.06 (-0.07, 0.19)
Emotion	0.84 (0.81, 0.87)	**0.14* (0.07, 0.22)**	**0.12* (0.04, 0.19)**	**0.10* (0.02, 0.17)**
Cognition	0.82 (0.78, 0.85)	**0.14* (0.03, 0.24)**	**0.11* (0.001, 0.21)**	0.09 (-0.02, 0.20)
Pain	0.68 (0.61, 0.75)	**0.16* (0.01, 0.31)**	0.09 (-0.05, 0.24)	0.02 (-0.14, 0.18)

a. Adjusted for Age as a Quadratic, Sex, Education, Marital Status, Race, Depression, Stroke, Heart Disease, Cataracts, Number of Other Medical Conditions, Insulin Use, and Duration of Diabetes

b. 95% Confidence Interval based on the Bootstrap Variance Estimate

*P value <0.05 for between groups difference after adjusting for covariates.

Table 11: Adjusted[a] Mean (95% CI) Overall and Single Attribute Utility Scores according to Self-Rated Health

	Adjusted Mean of Reference Group (Excellent)	Very Good minus Excellent[b]	Good minus Excellent[b]	Fair minus Excellent[b]	Poor minus Excellent[b]
Overall	0.72 (0.68, 0.76)	-0.01 (-0.03, 0.02)	**-0.04 (-0.07, -0.01)**	**-0.12 (-0.15, -0.09)**	**-0.36 (-0.41, -0.31)***
Vision	0.93 (0.91, 0.95)	-0.01 (-0.02, 0.01)	-0.01 (-0.02, 0.01)	0.00 (-0.02, 0.01)	**-0.03 (-0.05, -0.01)***
Hearing	0.97 (0.95, 0.99)	-0.01 (-0.02, 0.01)	0.00 (-0.02, 0.01)	-0.01 (-0.03, 0.01)	**-0.03 (-0.05, -0.01)***
Speech	1.00 (0.99, 1.00)	0.00 (0.00, 0.00)	0.00 (0.00, 0.01)	0.00 (0.00, 0.00)	**-0.01 (-0.02, -0.01)***
Ambulation	0.92 (0.89, 0.96)	-0.01 (-0.02, 0.01)	-0.01 (-0.03, 0.00)	**-0.05 (-0.07, -0.02)**	**-0.15 (-0.19, -0.11)***
Dexterity	0.99 (0.97, 1.00)	0.00 (-0.01, 0.00)	0.00 (0.00, 0.00)	0.00 (-0.01, 0.00)	**-0.03 (-0.05, -0.01)***
Emotion	0.93 (0.91, 0.95)	0.00 (-0.01, 0.02)	-0.01 (-0.02, 0.00)	**-0.03 (-0.05, -0.01)**	**-0.12 (-0.14, -0.09)***
Cognition	0.90 (0.87, 0.92)	0.01 (-0.01, 0.03)	0.00 (-0.02, 0.02)	-0.03 (-0.05, 0.00)	**-0.07 (-0.11, -0.04)***
Pain	0.83 (0.78, 0.88)	0.00 (-0.02, 0.02)	**-0.03 (-0.01, -0.05)**	**-0.08 (-0.06, -0.11)**	**-0.30 (-0.24, -0.35)***

a. Adjusted for Age as a Quadratic, Sex, Education, Marital Status, Race, Depression, Stroke, Heart Disease, Cataracts, Number of Other Medical Conditions, Insulin Use, and Duration of Diabetes

b. 95% Confidence Interval based on the Bootstrap Variance Estimate

*P value <0.05 for between groups difference after adjusting for covariates.

Table 12: Association between Physician Visits, Severity of Impairment on Overall HUI3, Demographic and Clinical Characteristics

Variable	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Overall HUI3			
No/Mild Impairment	**0.59****	**0.48**	**0.74**
Moderate	**0.66****	**0.51**	**0.86**
Severe Impairment[a]	-	-	-
Age Category			
18 to 44 years	0.95	0.68	1.32
45 to 54 years	0.89	0.65	1.22
55 to 64 years	0.97	0.73	1.27
65 to 74 years	0.88	0.69	1.12
75 years or older[a]	-	-	-
Sex			
Female	0.98	0.81	1.17
Male[a]	-	-	-
Education			
Less Than High School	1.07	0.77	1.48
High School	0.96	0.68	1.36
Post-Secondary/ Trade School/College	1.00	0.72	1.40
University[a]	-	-	-
Marital Status			
Married	1.02	0.84	1.24
Not Married[a]	-	-	-
Aboriginal			
Aboriginal	1.44	0.89	2.32
Not Aboriginal[a]	-	-	-
Duration of Diabetes			
≤ 2 years	1.01	0.77	1.31
> 2 years, ≤ 6 years	**0.73***	**0.56**	**0.95**
> 6 years, ≤ 13 years	0.99	0.78	1.28
> 13 years[a]	-	-	-
Insulin Use	1.25	0.95	1.64
Heart Disease	**2.02***	**1.63**	**2.50**
Stroke	1.51	0.99	2.32
Cataracts	1.26	0.94	1.69
Depression	**2.20***	**1.59**	**3.07**
Number of Medical Conditions	**1.27***	**1.20**	**1.35**

*P value<0.01
a – reference category

Table 13: Association between Hospitalizations, Severity of Impairment on Overall HUI3, Demographic and Clinical Characteristics

Variable	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Overall HUI3			
No/Mild Impairment	**0.67***	**0.51**	**0.89**
Moderate	0.77	0.55	1.06
Severe Impairment	-	-	-
Age Category			
18 to 44 years	1.12	0.70	1.82
45 to 54 years	1.03	0.68	1.58
55 to 64 years	0.94	0.66	1.33
65 to 74 years	0.98	0.74	1.31
75 years or older[a]	-	-	-
Sex			
Female	0.98	0.76	1.27
Male[a]	-	-	-
Education			
Less Than High School	**1.76***	**1.11**	**2.77**
High School	1.40	0.82	2.35
Post-Secondary/ Trade School/College	1.29	0.81	2.03
University[a]	-	-	-
Marital Status			
Married	0.99	0.77	1.26
Not Married[a]	-	-	-
Aboriginal			
Aboriginal	1.35	0.77	2.35
Not Aboriginal[a]	-	-	-
Duration of Diabetes			
≤ 2 years	0.90	0.72	1.38
> 2 years ≤ 6 years	1.20	0.67	1.21
> 6 years ≤ 13 years	1.00	0.88	1.56
> 13 years[a]	-	-	-
Insulin Use	**1.45***	**1.07**	**1.96**
Heart Disease	**2.70***	**2.13**	**3.41**
Stroke	**1.83***	**1.19**	**2.79**
Cataracts	0.80	0.59	1.07
Depression	**1.58***	**1.07**	**2.31**
Number of Medical Conditions	**1.13***	**1.04**	**1.21**

*P value <0.05
a – reference category

Table 14: Association between Emergency Room Visits, Severity of Impairment on Overall HUI3, Demographic and Clinical Characteristics

Variable	Odds Ratio	Lower Limit 95% CI	Upper Limit 95% CI
Overall HUI3			
No/Mild Impairment	**0.46***	**0.24**	**0.86**
Moderate	0.59	0.32	1.10
Severe Impairment[a]	-	-	-
Age Category			
18 to 44 years	2.06	0.85	4.96
45 to 54 years	1.27	0.51	3.15
55 to 64 years	1.38	0.67	2.86
65 to 74 years	1.29	0.64	2.63
75 years or older[a]	-	-	-
Sex			
Female	0.85	0.53	1.37
Male[a]	-	-	-
Education			
Less Than High School	0.68	0.30	1.56
High School	0.17	0.05	0.59
Post-Secondary/ Trade School/College	0.63	0.28	1.40
University[a]	-	-	-
Marital Status			
Married	0.83	0.52	1.35
Not Married[a]	-	-	-
Aboriginal			
Aboriginal	0.69	0.15	3.28
Not Aboriginal[a]	-	-	-
Duration of Diabetes			
≤ 2 years	1.19	0.62	2.28
> 2 years ≤ 6 years	0.82	0.43	1.52
> 6 years ≤ 13 years	1.20	0.64	2.21
> 13 years[a]	-	-	-
Insulin Use	**2.04***	**1.21**	**3.44**
Heart Disease	**1.72***	**1.04**	**2.84**
Stroke	1.66	0.62	4.40
Cataracts	0.62	0.30	1.27
Depression	1.17	0.55	2.49
Number of Medical Conditions	1.12	0.97	1.30

*P value<0.05
a – reference category

Table 15: Correlation between HUI3, Self-Rated Health, Depression Scale and Disability

	Self-Rated Health[B]	Depression[C]	Assistance[D]	Impact[E]
Overall HUI3	0.49	-0.25	-0.62	-0.61
Vision	**0.10**	**-0.03**	-0.20	-0.17
Ambulation	0.28	**-0.06**	**-0.55**	-0.37
Dexterity	**0.13**	**-0.01**	-0.24	-0.15
Emotion	0.29	-0.34	-0.22	-0.26
Pain	**0.41**	-0.20	-0.46	**-0.53**

A. Bold entries indicate that the strength of correlation was correctly hypothesized
B. Self-Rated Health (Excellent, Very Good, Good, Fair, Poor)
C. Depression Scale Short Form
D. Total number of activities requiring assistance
E. Impact of health problems

Appendix 1
Health Utilities Index Mark 3 Classification System

HUI3 Health Status Classification System

Attribute	Level	Level Description
Vision	1	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street, without glasses or contact lenses
	2	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street, but with glasses
	3	Able to read ordinary newsprint with or without glasses but unable to recognize a friend on the other side of the street, even with glasses
	4	Able to recognize a friend on the other side of the street with or without glasses but unable to read ordinary newsprint even with glasses
	5	Unable to read ordinary newsprint and unable to recognize a friend on the other side of the street, even with glasses
	6	Unable to see at all
Hearing	1	Able to hear what is said in a group conversation with at least three other people, without a hearing aid
	2	Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid, but requires a hearing aid to hear what is said in a group conversation with at least three other people
	3	Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid and able to hear what is said in a group conversation with at least three other people with a hearing aid
	4	Able to hear what is said in a conversation with one other person in a quiet room without a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid
	5	Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid
	6	Unable to hear at all
Speech	1	Able to be understood completely when speaking with strangers or friends
	2	Able to be understood partially when speaking with strangers but able to be understood completely when speaking with people who know the respondent well
	3	Able to be understood partially when speaking with strangers or people who know the respondent well
	4	Unable to be understood when speaking with strangers but able to be understood partially by people who know the respondent well
	5	Unable to be understood when speaking to other people (or unable to speak at all)
Ambulation	1	Able to walk around the neighbourhood without difficulty and without walking equipment
	2	Able to walk around the neighbourhood with difficulty, but does not require walking equipment or the help of another person
	3	Able to walk around the neighbourhood with walking equipment, but without the help of another person
	4	Able to walk only short distances with walking equipment and requires a wheelchair to get around the neighbourhood
	5	Unable to walk alone, even with walking equipment; able to walk short distances with the help of another person, and requires a wheelchair to get around the neighbourhood
	6	Cannot walk at all
Dexterity	1	Full use of two hands and ten fingers
	2	Limitations in the use of hands or fingers, but does not require special tools or help of another person
	3	Limitations in the use of hands or fingers, is independent with use of special tools (does not require the help of another person)
	4	Limitations in the use of hands or fingers, requires the help of another person for some tasks (not independent even with the use of special tools)
	5	Limitations in the use of hands or fingers, requires the help of another person for most tasks (not independent even with the use of special tools)
	6	Limitations in the use of hands or fingers, requires the help of another person for all tasks (not independent even with the use of special tools)
Emotion	1	Happy and interested in life
	2	Somewhat happy
	3	Somewhat unhappy
	4	Very unhappy
	5	So unhappy that life is not worthwhile
Cognition	1	Able to remember most things, think clearly and solve day to day problems
	2	Able to remember most things, but have a little difficulty when trying to think and solve day to day problems
	3	Somewhat forgetful, but able to think clearly and solve day to day problems
	4	Somewhat forgetful, and have a little difficulty when trying to think or solve day to day problems
	5	Very forgetful, and have great difficulty when trying to think and or solve day to day problems
	6	Unable to remember anything at all, and unable to think or solve day to day problems
Pain	1	Free of pain and discomfort
	2	Mild to moderate pain that prevents no activities
	3	Moderate pain that prevents a few activities
	4	Moderate to severe pain that prevents some activities
	5	Severe pain that prevents most activities

Source: http://www.fcs.mcmaster.ca/hug/index.html

Appendix 2
Hypotheses for Objective One

Hypotheses	Supported (Clinically Important Difference)	Supported ($p < 0.05$)
H1) – Overall HUI3 scores will be lower for respondents with longer duration of diabetes.	Yes	Yes
H2) – Overall HUI3 scores will be lower for respondents whose diabetes was managed with insulin relative to those who did not report using insulin.	Yes	Yes
H3) – Overall HUI3 scores will be lower for respondents who report having cataracts relative to respondents who do not.	Yes	Yes
H4) – Overall HUI3 scores will be lower for respondents who report having heart disease relative to respondents who do not.	Yes	Yes
H5) – Overall HUI3 scores will be lower for respondents who report having had a stroke relative to respondents who do not.	Yes	Yes
H6) – Overall HUI3 scores will be lower for respondents who report having depression relative to respondents who do not.	Yes	Yes
H7) – Overall HUI3 scores will be highest for respondents who report having no complications and will be progressively lower as the number of complications increases.	Yes	Yes
H8) – Overall HUI3 scores will be progressively lower as the self-rating of health declines from excellent to poor.	Yes	Yes
H9) – Scores on the pain and discomfort attribute of the HUI3 will be lower for respondents who are treated with insulin.	Yes	Yes
H10) – Scores on the ambulation attribute of the HUI3 will be lower for individuals who are treated with insulin.	No	Yes
H11) – Scores on the dexterity attribute of the HUI3 will be lower for individuals who are treated with insulin.	No	Yes
H12) – Scores on the vision attribute of the HUI3 will be lower for individuals who are treated with insulin.	No	Yes
H13) – Scores on the emotion attribute of the HUI3 will be lower for individuals who are treated with insulin.	No	No
H14) – Scores on the pain and discomfort attribute of the HUI3 will be lower for respondents with a longer duration of diabetes.	No	Yes
H15) – Scores on the ambulation attribute of the HUI3 will be lower for respondents with a longer duration of diabetes.	No	Yes
H16) – Scores on the dexterity attribute of the HUI3 will be lower for respondents with a longer duration of diabetes.	No	No
H17) – Scores on the vision attribute of the HUI3 will be lower for respondents with a longer duration of diabetes.	No	No
H18) – The pain and discomfort attribute of the HUI3 will be highest for respondents who report having no complications and will be progressively lower as the number of complications increases.	Yes	Yes
H19) – The ambulation attribute of the HUI3 will be highest for respondents who report having no complications and will be progressively lower as the number of complications increases.	Yes	Yes
H20) – The dexterity attribute of the HUI3 will be highest for respondents who report having no complications and will be progressively lower as the number of complications increases.	Yes	No
H21) – The vision attribute of the HUI3 will be highest for respondents who report having no complications and will be progressively lower as	Yes	No

the number of complications increases.		
H22) – The emotion attribute of the HUI3 will be highest for respondents who report having no complications and will be progressively lower as the number of complications increases.	Yes	Yes
H23) – The pain and discomfort attribute of the HUI3 will be progressively lower as the self-rating of health declines from excellent to poor.	Yes	Yes
H24) – The ambulation attribute of the HUI3 will be progressively lower as the self-rating of health declines from excellent to poor.	Yes	Yes
H25) – The dexterity attribute of the HUI3 will be progressively lower as the self-rating of health declines from excellent to poor.	No	No
H26) – The vision attribute of the HUI3 will be progressively lower as the self-rating of health declines from excellent to poor.	No	No
H27) – The emotion attribute of the HUI3 will be progressively lower as the self-rating of health declines from excellent to poor.	No	No
H28) – Scores on the vision attribute will be significantly lower for respondents with cataracts.	No	Yes
H29) – Scores on the pain and discomfort attribute will be significantly lower for respondents with heart disease.	Yes	Yes
H30) – Scores on the ambulation attribute will be significantly lower for respondents with heart disease.	No	No
H31) – Scores on the emotion attribute will be significantly lower for respondents with heart disease.	No	Yes
H32) – Scores on the pain and discomfort attribute will be significantly lower for respondents with stroke.	Yes	No
H33) – Scores on the ambulation attribute will be significantly lower for respondents with stroke.	Yes	Yes
H34) – Scores on the dexterity attribute will be significantly lower for respondents with stroke.	No	No
H35) – Scores on the cognition attribute will be significantly lower for respondents with stroke.	Yes	Yes
H36) – Scores on the emotion attribute will be significantly lower for respondents with stroke.	No	Yes
H37) – Scores on the pain and discomfort attribute will be significantly lower for respondents with depression.	Yes	Yes
H38) – Scores on the emotion attribute will be significantly lower for respondents with depression.	Yes	Yes
Hypotheses Supported		
Overall HUI3	8/8 (100.0)	8/8 (100.0)
Single Attributes	14/30 (46.7)	19/30 (63.3)
Total	**22/38 (57.9)**	**27/38(71.1)**

Appendix 3
Tables 16 Through 51

Table 16: Association between Insulin Use, Duration of Diabetes and Overall HUI3 Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	**-0.06***	**0.02**	**-0.09**	**-0.03**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.04***	**0.01**	**0.01**	**0.06**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.06***	**0.01**	**0.03**	**0.08**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.02	0.01	-0.01	0.05
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.09***	**0.01**	**-0.11**	**-0.06**
High School (Yes =1, No=0)	**-0.05***	**0.02**	**-0.08**	**-0.01**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.04***	**0.01**	**-0.06**	**-0.01**
Sex (1=male, 2=female)	0.02	0.01	-0.01	0.04
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Aboriginal (Yes =1, No=0)	-0.02	0.03	-0.08	0.05
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00002**	**-0.0001**	**-0.0001**
Number of Medical Conditions	**-0.05***	**0.003**	**-0.06**	**-0.05**
Cataracts (Yes =1, No=0)	-0.02	0.02	-0.05	0.01
Heart Disease (Yes =1, No=0)	**-0.08***	**0.01**	**-0.10**	**-0.05**
Stroke (Yes =1, No=0)	**-0.15***	**0.03**	**-0.20**	**-0.09**
Depression (Yes =1, No=0)	**-0.17***	**0.02**	**-0.22**	**-0.13**
Adjusted $R^2 = 0.29$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 17: Association between Insulin Use, Duration of Diabetes and Vision Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.003**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.02	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.01	-0.01	0.02
High School (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	-0.01	0.02
Sex (1=male, 2=female)	0.00	0.00	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.00
Aboriginal (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Cataracts (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.003**
Heart Disease (Yes =1, No=0)	0.00	0.00	-0.01	0.01
Stroke (Yes =1, No=0)	-0.01	0.01	-0.04	0.01
Depression (Yes =1, No=0)	-0.02	0.01	-0.04	0.00
Adjusted $R^2 = 0.05$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 18: Association between Insulin Use, Duration of Diabetes and Hearing Attribute Scores Adjusted for Comorbidities and Determinants of Health

	β	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years ,≤ 6 years (Yes =1, No=0)	0.00	0.01	-0.01	0.01
> 6 years ,≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.01***	**0.01**	**-0.03**	**-0.0004**
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.002**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.00	-0.02	0.004
Sex (1=male, 2=female)	**0.02***	**0.00**	**0.01**	**0.03**
Marital Status (Yes =1, No=0)	**-0.01***	**0.00**	**-0.02**	**-0.002**
Aboriginal (Yes =1, No=0)	0.00	0.01	-0.03	0.01
Age	**0.01***	**0.00**	**0.003**	**0.01**
Age^2	**-0.00005***	**0.00**	**-0.00008**	**-0.00003**
Number of Medical Conditions	**-0.004***	**0.00**	**-0.01**	**-0.001**
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Cataracts (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Heart Disease (Yes =1, No=0)	-0.00	0.01	-0.02	0.01
Stroke (Yes =1, No=0)	-0.02	0.01	-0.04	0.01
Depression (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Adjusted $R^2 = 0.05$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 19: Association between Insulin Use, Duration of Diabetes, and Speech Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	0.00	0.00	0.00	0.01
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.00	0.00	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.004***	**0.00**	**-0.01**	**-0.001**
High School (Yes =1, No=0)	0.00	0.00	0.00	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.003***	**0.00**	**-0.005**	**-0.0003**
Sex (1=male, 2=female)	0.00	0.00	0.00	0.00
Marital Status (Yes =1, No=0)	0.00	0.00	0.00	0.00
Aboriginal (Yes =1, No=0)	0.00	0.00	0.00	0.01
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Cataracts (Yes =1, No=0)	0.01	0.00	-0.01	0.00
Heart Disease (Yes =1, No=0)	0.00	0.00	0.00	0.00
Stroke (Yes =1, No=0)	0.01	0.00	-0.01	0.00
Depression (Yes =1, No=0)	0.00	0.00	0.00	0.01
Adjusted $R^2 = 0.01$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 20: Association between Insulin Use, Duration of Diabetes and Ambulation Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	**-0.04***	**0.01**	**-0.07**	**-0.01**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.06**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.04***	**0.01**	**0.01**	**0.06**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.06**
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.02**
High School (Yes =1, No=0)	-0.01	0.01	-0.03	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.001**
Sex (1=male, 2=female)	0.00	0.01	-0.02	0.01
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Aboriginal (Yes =1, No=0)	0.03	0.01	0.00	0.05
Age	0.01	0.00	0.01	0.01
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.0001**
Number of Medical Conditions	**-0.02***	**0.00**	**-0.02**	**-0.01**
Cataracts (Yes =1, No=0)	-0.01	0.02	-0.05	0.02
Heart Disease (Yes =1, No=0)	-0.02	0.01	-0.04	0.00
Stroke (Yes =1, No=0)	**-0.12***	**0.03**	**-0.17**	**-0.06**
Depression (Yes =1, No=0)	-0.02	0.02	-0.05	0.01
Adjusted $R^2 = 0.15$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 21: Association between Insulin Use, Duration of Diabetes and Dexterity Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	**-0.01***	**0.01**	**-0.02**	**-0.001**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.01	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.01***	**0.00**	**0.001**	**0.01**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.01***	**0.00**	**0.001**	**0.02**
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.00	-0.01	0.00
High School (Yes =1, No=0)	0.00	0.00	0.00	0.01
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	0.00	0.01
Sex (1=male, 2=female)	0.00	0.00	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Aboriginal (Yes =1, No=0)	**0.01***	**0.00**	**0.01**	**0.02**
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	**-0.002***	**0.00**	**-0.004**	**-0.0003**
Cataracts (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Heart Disease (Yes =1, No=0)	-0.01	0.00	-0.02	0.00
Stroke (Yes =1, No=0)	-0.03	0.02	-0.07	0.01
Depression (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Adjusted $R^2 = 0.03$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 22: Association between Insulin Use, Duration of Diabetes, and Emotion Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.02	0.00
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.01**
High School (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Sex (1=male, 2=female)	0.01	0.00	0.001	0.02
Marital Status (Yes =1, No=0)	0.02	0.01	0.01	0.03
Aboriginal (Yes =1, No=0)	0.03	0.01	0.01	0.05
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.004**
Cataracts (Yes =1, No=0)	0.00	0.01	0.00	0.02
Heart Disease (Yes =1, No=0)	**-0.01***	**0.01**	**-0.02**	**-0.001**
Stroke (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.01**
Depression (Yes =1, No=0)	**-0.14***	**0.02**	**-0.17**	**-0.10**
Adjusted $R^2 = 0.16$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 23: Association between Insulin Use, Duration of Diabetes, and Cognition Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Duration of Diabetes				
≤ 2 years (Yes =1, No=0)	**0.02***	**0.01**	**0.00**	**0.03**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.02***	**0.01**	**0.001**	**0.03**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Education				
Less Than High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.04**	**-0.02**
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.003**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.01	-0.02	0.00
Sex (1=male, 2=female)	0.01	0.01	0.00	0.02
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.04	0.02
Age	0.01	0.00	0.00	0.01
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00004**
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.01**
Cataracts (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Heart Disease (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.01**
Stroke (Yes =1, No=0)	**-0.07***	**0.02**	**-0.11**	**-0.03**
Depression (Yes =1, No=0)	**-0.07***	**0.01**	**-0.09**	**-0.04**
Adjusted $R^2 = 0.09$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 24: Association between Insulin Use, Duration of Diabetes, and Pain Attribute Scores Adjusted for Comorbidities and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Insulin Use (Yes =1, No=0)	**-0.07***	**0.02**	**-0.11**	**-0.04**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.02	0.02	-0.01	0.05
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.03***	**0.02**	**0.01**	**0.06**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.02	-0.03	0.03
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.06***	**0.02**	**-0.10**	**-0.03**
High School (Yes =1, No=0)	**-0.04***	**0.02**	**-0.08**	**-0.005**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.04***	**0.02**	**-0.07**	**-0.01**
Sex (1=male, 2=female)	-0.01	0.01	-0.03	0.01
Marital Status (Yes =1, No=0)	0.00	0.01	-0.03	0.02
Aboriginal (Yes =1, No=0)	-0.06	0.05	-0.15	0.03
Age	-0.01	0.00	-0.01	0.00
Age^2	**0.0001***	**0.00**	**0.00001**	**0.0001**
Number of Medical Conditions	**-0.06***	**0.00**	**-0.07**	**-0.05**
Cataracts (Yes =1, No=0)	-0.02	0.02	-0.05	0.01
Heart Disease (Yes =1, No=0)	**-0.08***	**0.02**	**-0.11**	**-0.05**
Stroke (Yes =1, No=0)	-0.05	0.03	-0.11	0.01
Depression (Yes =1, No=0)	**-0.11***	**0.03**	**-0.16**	**-0.06**
Adjusted $R^2 = 0.22$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 25: Association between Comorbidities and Overall HUI3 Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	-0.03*	0.02	-0.06	0.01
Heart Disease (Yes =1, No=0)	**-0.08***	**0.01**	**-0.11**	**-0.05**
Stroke (Yes =1, No=0)	**-0.15***	**0.03**	**-0.21**	**-0.09**
Depression (Yes =1, No=0)	**-0.17***	**0.02**	**-0.22**	**-0.12**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.05***	**0.01**	**0.03**	**0.08**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.07***	**0.01**	**0.04**	**0.10**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.03***	**0.01**	**0.004**	**0.06**
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.09***	**0.01**	**-0.11**	**-0.06**
High School (Yes =1, No=0)	**-0.04***	**0.02**	**-0.07**	**-0.01**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.01**
Sex (1=male, 2=female)	0.01	0.01	-0.01	0.04
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Aboriginal (Yes =1, No=0)	-0.01	0.03	-0.08	0.04
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.0001**
Number of Medical Conditions	**-0.05***	**0.00**	**-0.06**	**-0.05**
Adjusted R^2 = 0.29				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 26: Association between Comorbidities and Vision Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.003**
Heart Disease (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Stroke (Yes =1, No=0)	-0.02	0.01	-0.04	0.01
Depression (Yes =1, No=0)	-0.02	0.01	-0.04	0.00
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.01***	**0.01**	**0.002**	**0.03**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.01***	**0.01**	**0.001**	**0.03**
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.01	-0.01	0.02
High School (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Sex (1=male, 2=female)	0.00	0.00	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Aboriginal (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Adjusted R^2 = 0.04				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 27: Association between Comorbidities and Hearing Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Heart Disease (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Stroke (Yes =1, No=0)	-0.02	0.01	-0.04	0.01
Depression (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	0.00	0.01	-0.01	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.01***	**0.01**	**-0.03**	**-0.0004**
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.002**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.00	-0.02	0.004
Sex (1=male, 2=female)	**0.02***	**0.00**	**0.01**	**0.03**
Marital Status (Yes =1, No=0)	**-0.01***	**0.00**	**-0.02**	**-0.002**
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Age	**0.01***	**0.00**	**0.003**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00003**
Number of Medical Conditions	**-0.004***	**0.00**	**-0.01**	**-0.001**
Adjusted R^2 = 0.05				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 28: Association between Comorbidities and Speech Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	-0.01	0.00	-0.01	0.00
Heart Disease (Yes =1, No=0)	0.00	0.00	0.00	0.00
Stroke (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Depression (Yes =1, No=0)	0.00	0.00	0.00	0.01
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.004***	**0.00**	**-0.001**	**-0.001**
High School (Yes =1, No=0)	0.00	0.00	0.00	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.003***	**0.00**	**-0.005**	**-0.0004**
Sex (1=male, 2=female)	0.00	0.00	0.00	0.00
Marital Status (Yes =1, No=0)	0.00	0.00	0.00	0.00
Aboriginal (Yes =1, No=0)	0.00	0.00	0.00	0.01
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Adjusted R^2 =0.01				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 29: Association between Comorbidities and Ambulation Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	-0.02	0.02	-0.05	0.02
Heart Disease (Yes =1, No=0)	-0.02	0.01	-0.04	0.00
Stroke (Yes =1, No=0)	**-0.12***	**0.03**	**-0.17**	**-0.07**
Depression (Yes =1, No=0)	-0.02	0.02	-0.05	0.01
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.05***	**0.01**	**0.02**	**0.07**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.05***	**0.01**	**0.02**	**0.07**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.04***	**0.01**	**0.02**	**0.07**
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.02**
High School (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.02	0.01	-0.03	0.00
Sex (1=male, 2=female)	0.00	0.01	-0.02	0.01
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Aboriginal (Yes =1, No=0)	0.02	0.02	-0.01	0.05
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.0001**
Number of Medical Conditions	**-0.02***	**0.00**	**-0.02**	**-0.01**
Adjusted $R^2 = 0.15$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 30: Association between Comorbidities and Dexterity Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Heart Disease (Yes =1, No=0)	-0.01	0.00	-0.02	0.00
Stroke (Yes =1, No=0)	-0.03	0.02	-0.07	0.01
Depression (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.01	0.00	0.00	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.00	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	0.02	0.00	0.01	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.00	-0.01	0.00
High School (Yes =1, No=0)	0.00	0.00	0.00	0.01
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	0.00	0.01
Sex (1=male, 2=female)	0.00	0.00	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Aboriginal (Yes =1, No=0)	0.01	0.00	0.01	0.02
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	-0.002	0.00	-0.004	-0.0004
Adjusted $R^2 = 0.04$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 31: Association between Comorbidities and Emotion Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Heart Disease (Yes =1, No=0)	**-0.01***	**0.01**	**-0.02**	**-0.002**
Stroke (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.008**
Depression (Yes =1, No=0)	**-0.14***	**0.02**	**-0.17**	**-0.10**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.01**
High School (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Sex (1=male, 2=female)	**0.01***	**0.00**	**0.001**	**0.02**
Marital Status (Yes =1, No=0)	**0.02***	**0.01**	**0.01**	**0.03**
Aboriginal (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.05**
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.004**
Adjusted $R^2 = 0.10$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 32: Association between Comorbidities and Cognition Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Heart Disease (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.01**
Stroke (Yes =1, No=0)	**-0.07***	**0.02**	**-0.11**	**-0.03**
Depression (Yes =1, No=0)	**-0.07***	**0.01**	**-0.09**	**-0.04**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.02***	**0.01**	**0.0004**	**0.03**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.02***	**0.01**	**0.0008**	**0.03**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.04**	**-0.02**
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.002**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.01	-0.02	0.00
Sex (1=male, 2=female)	0.01	0.01	0.00	0.02
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.04	0.02
Age	**0.01***	**0.00**	**0.004**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00004**
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.01**
Adjusted $R^2 = 0.09$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 33: Association between Comorbidities and Pain Attribute Scores Adjusted for Duration of Diabetes and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Cataracts (Yes =1, No=0)	-0.02	0.02	-0.05	0.01
Heart Disease (Yes =1, No=0)	**-0.09***	**0.02**	**-0.12**	**-0.05**
Stroke (Yes =1, No=0)	-0.06	0.03	-0.12	0.00
Depression (Yes =1, No=0)	**-0.10***	**0.03**	**-0.15**	**-0.05**
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.04***	**0.02**	**0.01**	**0.07**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.05***	**0.01**	**0.03**	**0.08**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.02	0.02	-0.01	0.05
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.06***	**0.02**	**-0.09**	**-0.03**
High School (Yes =1, No=0)	**-0.04***	**0.02**	**-0.08**	**-0.002**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.04***	**0.02**	**-0.07**	**-0.01**
Sex (1=male, 2=female)	-0.01	0.01	-0.03	0.01
Marital Status (Yes =1, No=0)	-0.01	0.01	-0.03	0.02
Aboriginal (Yes =1, No=0)	-0.06	0.05	-0.15	0.03
Age	**-0.01***	**0.00**	**-0.01**	**-0.0002**
Age^2	**0.0001***	**0.00**	**0.00001**	**0.0001**
Number of Medical Conditions	**-0.06***	**0.00**	**-0.07**	**-0.05**
Adjusted $R^2 = 0.21$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 34: Association between Total Number of Comorbidities and Overall HUI3 Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	**0.30***	**0.07**	**0.16**	**0.44**
One (Yes =1, No=0)	**0.22***	**0.07**	**0.08**	**0.36**
Two (Yes =1, No=0)	0.14	0.07	0.00	0.29
Three or four	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.04***	**0.01**	**0.01**	**0.06**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.06***	**0.01**	**0.03**	**0.09**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.02	0.01	-0.01	0.05
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.09***	**0.01**	**-0.12**	**-0.06**
High School (Yes =1, No=0)	**-0.05***	**0.02**	**-0.08**	**-0.02**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.04***	**0.01**	**-0.06**	**-0.01**
Sex (1=male, 2=female)	0.02	0.01	0.00	0.04
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Aboriginal (Yes =1, No=0)	-0.02	0.03	-0.08	0.05
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.0001**
Number of Medical Conditions	**-0.05***	**0.00**	**-0.06**	**-0.06**
Insulin Use (Yes =1, No=0)	**-0.06***	**0.02**	**-0.09**	**-0.02**
Adjusted $R^2 = 0.28$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 35: Association between Total Number of Comorbidities and Vision Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	0.05	0.04	-0.02	0.12
One (Yes =1, No=0)	0.04	0.04	-0.03	0.11
Two (Yes =1, No=0)	0.03	0.04	-0.04	0.11
Three or four	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.01	-0.01	0.02
High School (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Sex (1=male, 2=female)	0.00	0.00	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Aboriginal (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Insulin Use (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.002**
Adjusted $R^2 = 0.04$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 36: Association between Total Number of Comorbidities and Hearing Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	0.02	0.03	-0.04	0.09
One (Yes =1, No=0)	0.02	0.03	-0.05	0.09
Two (Yes =1, No=0)	0.02	0.03	-0.05	0.08
Three or four	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	0.00	0.01	-0.01	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.03	0.00
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.01***	**0.01**	**-0.03**	**-0.001**
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.002**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.00	-0.02	0.004
Sex (1=male, 2=female)	**0.02***	**0.00**	**0.01**	**0.03**
Marital Status (Yes =1, No=0)	**-0.01***	**0.00**	**-0.02**	**-0.002**
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Age	0.01	0.00	0.003	0.01
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00003**
Number of Medical Conditions	**-0.004***	**0.00**	**-0.01**	**-0.002**
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Adjusted $R^2 = 0.05$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 37: Association between Total Number of Comorbidities and Speech Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	0.02	0.01	0.00	0.04
One (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Two (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Three or four	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.00	0.00	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.00	-0.01	0.00
High School (Yes =1, No=0)	0.00	0.00	0.00	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	0.00	0.00
Sex (1=male, 2=female)	0.00	0.00	0.00	0.00
Marital Status (Yes =1, No=0)	0.00	0.00	0.00	0.00
Aboriginal (Yes =1, No=0)	0.00	0.00	0.00	0.01
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Insulin Use (Yes =1, No=0)	0.00	0.00	0.00	0.01
Adjusted $R^2 = 0.01$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 38: Association between Total Number of Comorbidities and Ambulation Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	**0.15***	**0.06**	**0.03**	**0.28**
One (Yes =1, No=0)	**0.14***	**0.06**	**0.01**	**0.26**
Two (Yes =1, No=0)	0.09	0.06	-0.03	0.22
Three or four				
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.06**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.04***	**0.01**	**0.01**	**0.06**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.04***	**0.01**	**0.01**	**0.06**
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.02**
High School (Yes =1, No=0)	**-0.01***	**0.01**	**-0.03**	**0.01**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.0004**
Sex (1=male, 2=female)	0.00	0.01	-0.02	0.01
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Aboriginal (Yes =1, No=0)	0.02	0.02	-0.01	0.05
Age	**0.01***	**0.02**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.0001**
Number of Medical Conditions	**-0.02***	**0.00**	**-0.02**	**-0.01**
Insulin Use (Yes =1, No=0)	**-0.04***	**0.01**	**-0.07**	**-0.02**
Adjusted $R^2 = 0.15$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 39: Association between Total Number of Comorbidities and Dexterity Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	0.08	0.06	-0.05	0.20
One (Yes =1, No=0)	0.08	0.06	-0.05	0.20
Two (Yes =1, No=0)	0.06	0.06	-0.07	0.19
Three or four	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.01	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.00	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.01***	**0.00**	**0.01**	**0.02**
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.00	-0.01	0.00
High School (Yes =1, No=0)	0.00	0.00	0.00	0.01
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	0.00	0.01
Sex (1=male, 2=female)	0.00	0.00	0.00	0.01
Marital Status (Yes =1, No=0)	-0.01	0.00	-0.01	0.00
Aboriginal (Yes =1, No=0)	0.01	0.00	0.00	0.01
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	**-0.002***	**0.00**	**-0.004**	**-0.0003**
Insulin Use (Yes =1, No=0)	**-0.01***	**0.01**	**-0.02**	**-0.001**
Adjusted $R^2 = 0.04$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 40: Association between Total Number of Comorbidities and Emotion Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	**0.14***	**0.04**	**0.07**	**0.22**
One (Yes =1, No=0)	**0.12***	**0.04**	**0.04**	**0.19**
Two (Yes =1, No=0)	**0.10***	**0.04**	**0.02**	**0.17**
Three or four	-	-	-	-
Duration of Diabetes				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Education				
Less Than High School (Yes =1, No=0)	**-0.03**	**0.01**	**-0.04**	**-0.01**
High School (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Sex (1=male, 2=female)	0.01	0.00	0.00	0.02
Marital Status (Yes =1, No=0)	**0.02***	**0.01**	**0.01**	**0.03**
Aboriginal (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.05**
Age	0.00	0.00	0.00	0.01
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	**-0.01***	**0.00**	**-0.02**	**-0.01**
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Adjusted $R^2 = 0.10$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 41: Association between Total Number of Comorbidities and Cognition Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	**0.14***	**0.05**	**0.03**	**0.24**
One (Yes =1, No=0)	**0.11***	**0.05**	**0.001**	**0.21**
Two (Yes =1, No=0)	0.09	0.06	-0.02	0.20
Three or four	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	**0.02***	**0.01**	**0.00**	**0.03**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.02***	**0.01**	**0.001**	**0.03**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.02**
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.01**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.01	-0.02	0.00
Sex (1=male, 2=female)	**0.01***	**0.01**	**0.001**	**0.02**
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.04	0.02
Age	**0.01***	**0.00**	**0.005**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00003**
Number of Medical Conditions	-0.01*	0.00	-0.01	-0.01
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Adjusted $R^2 = 0.07$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 42: Association between Total Number of Comorbidities and Pain Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Zero (Yes =1, No=0)	**0.15***	**0.08**	**0.01**	**0.30**
One (Yes =1, No=0)	0.09	0.08	-0.06	0.24
Two (Yes =1, No=0)	0.02	0.08	-0.14	0.18
Three or four	-	-	-	-
Duration of Diabetes				
≤ 2 years (Yes =1, No=0)	0.02	0.02	-0.02	0.05
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.03***	**0.01**	**0.005**	**0.06**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.02	-0.03	0.03
Education				
Less Than High School (Yes =1, No=0)	**-0.07***	**0.02**	**-0.10**	**-0.04**
High School (Yes =1, No=0)	**-0.05***	**0.02**	**-0.08**	**-0.01**
Post-Secondary/ Trade School/College (Yes =1, No=0)	**-0.04***	**0.02**	**-0.08**	**-0.01**
Sex (1=male, 2=female)	-0.01	0.01	-0.03	0.02
Marital Status (Yes =1, No=0)	0.00	0.01	-0.03	0.02
Aboriginal (Yes =1, No=0)	-0.05	0.05	-0.14	0.04
Age	-0.01	0.00	-0.01	0.00
Age^2	**0.0001***	**0.00**	**0.00001**	**0.0001**
Number of Medical Conditions	**-0.06***	**0.00**	**-0.07**	**-0.05**
Insulin Use (Yes =1, No=0)	**-0.07***	**0.02**	**-0.10**	**-0.04**
Adjusted $R^2 = 0.22$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 43: Association between Self-Rated Health and Overall HUI3 Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	**-0.33***	**0.02**	**-0.37**	**-0.28**
Fair (Yes =1, No=0)	**-0.11***	**0.02**	**-0.15**	**-0.08**
Good (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.01**
Very Good (Yes =1, No=0)	0.00	0.01	-0.03	0.02
Excellent	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.01	0.01	-0.01	0.04
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.06**
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	-0.02	0.03
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.05***	**0.01**	**-0.07**	**-0.02**
High School (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.001**
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.02	0.01	-0.04	0.00
Sex (1=male, 2=female)	0.01	0.01	-0.01	0.03
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Aboriginal (Yes =1, No=0)	-0.02	0.03	-0.08	0.04
Age	**0.01***	**0.00**	**0.01**	**0.02**
Age^2	**-0.0001***	**0.00**	**-0.00015**	**-0.00008**
Number of Medical Conditions	**-0.03***	**0.00**	**-0.04**	**-0.03**
Insulin Use (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.01**
Cataract (Yes =1, No=0)	-0.01	0.01	-0.04	0.03
Stroke (Yes =1, No=0)	**-0.10***	**0.03**	**-0.15**	**-0.05**
Heart Disease (Yes =1, No=0)	**-0.03***	**0.01**	**-0.06**	**-0.003**
Depression (Yes =1, No=0)	**-0.14***	**0.02**	**-0.18**	**-0.10**
Adjusted $R^2 = 0.39$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 44: Association between Self-Rated Health and Vision Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Total Number of Complications				
Poor (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.01**
Fair (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Good (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Very Good (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Excellent	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.02	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.01	-0.01	0.02
High School (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Sex (1=male, 2=female)	0.00	0.01	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Aboriginal (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Age	0.00	0.00	0.00	0.01
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Insulin Use (Yes =1, No=0)	**-0.01***	**0.01**	**-0.03**	**-0.001**
Cataract (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.002**
Stroke (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Heart Disease (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Depression (Yes =1, No=0)	-0.02	0.01	-0.04	0.00
Adjusted $R^2 = 0.05$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 45: Association between Self-Rated Health and Hearing Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.01**
Fair (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Good (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Very Good (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Excellent	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
> 2 years ≤ 6 years (Yes =1, No=0)	0.00	0.01	-0.01	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	-0.01	0.01	-0.02	0.001
High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.001**
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	-0.01	0.01
Sex (1=male, 2=female)	**0.02***	**0.00**	**0.01**	**0.03**
Marital Status (Yes =1, No=0)	**-0.01***	**0.00**	**-0.02**	**-0.002**
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Age	**0.01***	**0.00**	**0.003**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00003**
Number of Medical Conditions	**-0.003***	**0.00**	**-0.01**	**-0.001**
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Cataract (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Stroke (Yes =1, No=0)	-0.01	0.01	-0.04	0.01
Heart Disease (Yes =1, No=0)	0.00	0.00	-0.01	0.01
Depression (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Adjusted $R^2 = 0.05$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 46: Association between Self-Rated Health and Speech Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Excellent				
Poor (Yes =1, No=0)	**-0.01***	**0.01**	**-0.02**	**-0.005**
Fair (Yes =1, No=0)	**-0.003***	**0.00**	**-0.005**	**-0.0004**
Good (Yes =1, No=0)	0.00	0.00	0.00	0.00
Very Good (Yes =1, No=0)	0.00	0.00	0.00	0.00
Excellent	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.00	0.00	0.01
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.003***	**0.00**	**-0.01**	**-0.0001**
High School (Yes =1, No=0)	0.00	0.00	0.00	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	0.00	0.00
Sex (1=male, 2=female)	0.00	0.00	0.00	0.00
Marital Status (Yes =1, No=0)	0.00	0.00	0.00	0.00
Aboriginal (Yes =1, No=0)	0.00	0.00	0.00	0.01
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Insulin Use (Yes =1, No=0)	0.00	0.00	0.00	0.01
Cataract (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Stroke (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Heart Disease (Yes =1, No=0)	0.00	0.00	0.00	0.01
Depression (Yes =1, No=0)	0.00	0.00	0.00	0.01
Adjusted $R^2 = 0.02$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 47: Association between Self-Rated Health and Ambulation Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	**-0.14***	**0.02**	**-0.17**	**-0.10**
Fair (Yes =1, No=0)	**-0.04***	**0.01**	**-0.06**	**-0.02**
Good (Yes =1, No=0)	-0.01	0.01	-0.03	0.00
Very Good (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Excellent	-	-	-	-
Duration of Diabetes				
≤ 2 years (Yes =1, No=0)	**0.02***	**0.01**	**0.001**	**0.05**
> 2 years, ≤ 6 years (Yes =1, No=0)	**0.04***	**0.01**	**0.003**	**0.05**
> 6 years, ≤ 13 years (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.05**
Education				
Less Than High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.002**
High School (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.01	-0.03	0.01
Sex (1=male, 2=female)	-0.01	0.01	-0.02	0.01
Marital Status (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Aboriginal (Yes =1, No=0)	0.02	0.01	0.00	0.05
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00007**
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.004**
Insulin Use (Yes =1, No=0)	**-0.03***	**0.01**	**-0.05**	**-0.005**
Cataract (Yes =1, No=0)	-0.01	0.02	-0.04	0.02
Stroke (Yes =1, No=0)	**-0.10***	**0.03**	**-0.15**	**-0.05**
Heart Disease (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Depression (Yes =1, No=0)	-0.01	0.01	-0.04	0.02
Adjusted $R^2 = 0.19$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 48: Association between Self-Rated Health and Dexterity Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	-0.03	0.01	-0.04	-0.01
Fair (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Good (Yes =1, No=0)	0.00	0.00	0.00	0.00
Very Good (Yes =1, No=0)	0.00	0.00	0.00	0.00
Excellent	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.01	0.00	0.00	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.00	0.00	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	0.01	0.00	0.01	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	0.00	0.00	-0.01	0.00
High School (Yes =1, No=0)	0.00	0.00	0.00	0.01
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.00	0.00	0.00	0.01
Sex (1=male, 2=female)	0.00	0.00	-0.01	0.01
Marital Status (Yes =1, No=0)	0.00	0.00	-0.01	0.00
Aboriginal (Yes =1, No=0)	0.01	0.00	0.00	0.02
Age	0.00	0.00	0.00	0.00
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	0.00	0.00
Insulin Use (Yes =1, No=0)	-0.01	0.01	-0.02	0.00
Cataract (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Stroke (Yes =1, No=0)	-0.03	0.02	-0.07	0.01
Heart Disease (Yes =1, No=0)	0.00	0.00	-0.01	0.01
Depression (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Adjusted $R^2 = 0.05$				

A Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 49: Association between Self-Rated Health and Emotion Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	**-0.10***	**0.02**	**-0.13**	**-0.07**
Fair (Yes =1, No=0)	**-0.03***	**0.01**	**-0.04**	**-0.01**
Good (Yes =1, No=0)	-0.01	0.01	-0.02	0.00
Very Good (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Excellent	-	-	-	-
Duration of Diabetes				
≤ 2 years (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
> 2 years, ≤ 6 years (Yes =1, No=0)	0.00	0.01	-0.01	0.01
> 6 years, ≤ 13 years (Yes =1, No=0)	-0.01	0.01	-0.03	0.00
Education				
Less Than High School (Yes =1, No=0)	-0.01	0.01	-0.03	0.00
High School (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Post-Secondary/ Trade School/College (Yes =1, No=0)	0.01	0.01	0.00	0.03
Sex (1=male, 2=female)	0.01	0.00	0.00	0.02
Marital Status (Yes =1, No=0)	**0.02***	**0.01**	**0.01**	**0.03**
Aboriginal (Yes =1, No=0)	**0.03***	**0.01**	**0.01**	**0.05**
Age	0.00	0.00	0.00	0.01
Age^2	0.00	0.00	0.00	0.00
Number of Medical Conditions	0.00	0.00	-0.01	0.00
Insulin Use (Yes =1, No=0)	0.00	0.01	-0.010	0.02
Cataract (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Stroke (Yes =1, No=0)	-0.02	0.01	-0.04	0.01
Heart Disease (Yes =1, No=0)	0.00	0.01	-0.01	0.01
Depression (Yes =1, No=0)	**-0.12***	**0.02**	**-0.16**	**-0.09**
Adjusted $R^2 = 0.21$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 50: Association between Self-Rated Health and Cognition Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	**-0.06***	**0.02**	**-0.09**	**-0.03**
Fair (Yes =1, No=0)	-0.02	0.01	-0.04	0.01
Good (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Very Good (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Excellent (Yes=1, No=0)	-	-	-	-
Duration of Diabetes				
≤ 2 years (Yes =1, No=0)	0.01	0.01	0.00	0.03
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Education				
Less Than High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.01**
High School (Yes =1, No=0)	-0.02	0.01	-0.03	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Sex (1=male, 2=female)	0.01	0.01	0.00	0.02
Marital Status (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.04	0.02
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001**	**0.00**	**-0.0001**	**-0.00004**
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.002**
Insulin Use (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Cataract (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Stroke (Yes =1, No=0)	**-0.06***	**0.02**	**-0.10**	**-0.02**
Heart Disease (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.004**
Depression (Yes =1, No=0)	**-0.06***	**0.01**	**-0.09**	**-0.03**
Adjusted $R^2 = 0.10$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05

Table 51: Association between Self-Rated Health and Pain Attribute Scores Adjusted for Duration of Diabetes, Insulin Use and Determinants of Health

	B	S.E.	Lower Limit 95% CI	Upper Limit 95% CI
Self-Rated Health				
Poor (Yes =1, No=0)	**-0.06***	**0.02**	**-0.09**	**-0.03**
Fair (Yes =1, No=0)	-0.02	0.01	-0.04	0.01
Good (Yes =1, No=0)	0.00	0.01	-0.02	0.02
Very Good (Yes =1, No=0)	0.01	0.01	-0.01	0.03
Excellent (Yes =1, No=0)	-	-	-	-
Duration of Diabetes[A]				
≤ 2 years (Yes =1, No=0)	0.01	0.01	0.00	0.03
> 2 years, ≤ 6 years (Yes =1, No=0)	0.01	0.01	0.00	0.02
> 6 years, ≤ 13 years (Yes =1, No=0)	0.00	0.01	-0.01	0.02
Education[B]				
Less Than High School (Yes =1, No=0)	**-0.02***	**0.01**	**-0.03**	**-0.007**
High School (Yes =1, No=0)	-0.02	0.01	-0.03	0.00
Post-Secondary/ Trade School/College (Yes =1, No=0)	-0.01	0.01	-0.02	0.01
Sex (1=male, 2=female)	0.01	0.01	0.00	0.02
Marital Status (Yes =1, No=0)	0.00	0.01	-0.02	0.01
Aboriginal (Yes =1, No=0)	-0.01	0.01	-0.04	0.02
Age	**0.01***	**0.00**	**0.01**	**0.01**
Age^2	**-0.0001***	**0.00**	**-0.0001**	**-0.00004**
Number of Medical Conditions	**-0.01***	**0.00**	**-0.01**	**-0.002**
Insulin Use (Yes =1, No=0)	0.01	0.01	-0.01	0.02
Cataract (Yes =1, No=0)	0.01	0.02	-0.01	0.02
Stroke (Yes =1, No=0)	**-0.06***	**0.02**	**-0.10**	**-0.02**
Heart Disease (Yes =1, No=0)	**-0.02***	**0.01**	**-0.04**	**-0.004**
Depression (Yes =1, No=0)	**-0.06***	**0.01**	**-0.09**	**-0.03**
Adjusted $R^2 = 0.29$				

A. Reference category is respondents with diabetes greater than 13 years
B. Reference category is respondents with a University Degree
*P value <0.05