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Determinants of Quality of Life in Adults with Diabetes

by

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ABSTRACT

The overall purpose of this thesis was to identify determinants of quality of life in adults with diabetes mellitus. This thesis consists of two studies. The first study tested a comprehensive model which comprised of personal, medical and lifestyle factors to explain quality of life in adults with type 2 diabetes. The model was tested with two concepts of quality of life: health-related quality of life and life satisfaction. The second study (1) tested the comprehensive model in adults with type 1 diabetes; and, (2) examined the interaction effects of diabetes type (i.e., type 1 diabetes /type 2 diabetes) on significant determinants of quality of life in the combined type 1 and type 2 diabetes group. The findings of this study identified subgroups that may be at risk for impaired quality of life and topics that require further investigation.

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Appendix I.

Prefatory Note

Operational Definitions

The following terms have been employed with specific context in this thesis.

1. The term diabetics refers to individuals with diabetes. It indicates cases where researchers didn't differentiate between type 1 and type 2 diabetes samples, or combined both diabetes groups.
2. The term health-related quality of life refers to subjective well-being assessed by any of the following measures: self-rated health, Duke Health Profile, SOLVD Health Quality of Life Questionnaire, EQ-5D, Euroqol VAS, RAND-12, RAND-36, SF-12, SF-20, SF-36, MOS SF-36, SF-36v (Short Form Health Survey for Veterans), Seattle Obstructive Lung Disease Questionnaire, Kidney Disease Quality of Life Short Form, a count of physical and/or mental unhealthy days, Nottingham Health Profile, Center for Disease Control Health-related Quality of Life Measures, Diabetes Quality of Life Measure, Modified Diabetes Quality of Life Measure, Diabetes Quality of Life Measure for adolescents, a visual analog scales of perceived health (mental/emotional and general health), Time-trade-off Utility values, Utility score, Health Utilities Index Mark 3, Quality of life after acute myocardial infarction questionnaire, Sickness Impact Profile, Quality of Well-being Scale, Pediatric Quality of Life Inventory, and Minnesota Living With Heart Failure.

3. The term life satisfaction refers to subjective well-being assessed by overall satisfaction or evaluation of one's life.

Abbreviations used in literature review summary tables

AMI	acute myocardial infarction
BRFSS 4 items	4-item health-related quality of life measure used in the BRFSS
CAD	coronary artery disease
CHF	congestive heart failure
COPD	chronic obstructive pulmonary disease
CVD	cardiovascular disease
DQOL	Diabetes Quality of Life scale
FEV1.0	an index of pulmonary function
HUI	health utility index
HR	hazard ratio
ICF	World Health Organization's International Classification of Functioning, Disability, and Health
MCS	mental composite score
OA	osteoarthritis
OR	odds ratio
PA	physical activity
PCS	physical composite score
QoL	quality of life
RA	rheumatoid arthritis
RR	relative risk
SES	socioeconomic status
SRH	self-rated health
SWLS	Satisfaction with Life Scale
T1D	type 1 diabetes
T2D	type 2 diabetes
WHR	waist hip ratio

Chapter 1- Introduction.

1.0 Overview of the chapter

This chapter provides an overview of the importance of studying quality of life of adults with diabetes. The overall study rationale, objectives of the two studies, and thesis plan are described.

1.1 Introduction

Diabetes mellitus

Diabetes mellitus has become a major health issue worldwide. More than 180 million people in the world have diabetes mellitus, and the number of diabetes patients is estimated to double by 2030 (World Health Organization, 2008). Canada is no exception. In Alberta, the prevalence of adults with diabetes has increased from 3.8 to 5.3% within 10 years, and approximately 12,000 people are newly diagnosed each year (Vermeulen et al., 2007).

Although population aging accelerates the increasing trend of diabetes, age-adjusted diabetes prevalence has been steadily increasing (Johnson & Vermeulen, 2007; Vermeulen et al., 2007). The prevalence is increasing in both type 1 diabetes (T1D; Onkamo, Väänänen, Karvonen, & Tuomilehto, 1999; Patterson, Dahlquist, Soltesz, Green, & EURODIAB ACE Study Group, 2001) and type 2 diabetes (T2D) populations (Kaufman, 2002; Haines, Wan, Lynn, Barrett, & Shield**,** 2007; Young, Reading, Elias, & O'Neil, 2000), and more people are diagnosed with T2D at a younger age (Koopman, Mainous, Diaz, & Geesey, 2005).

Diabetes is a significant economic burden. The total economic cost of diabetes is approximately 13.2 billion dollars per year (Canadian Diabetes Association, 2004). The direct cost of diabetes in Alberta is about 10% of all direct cost of the Alberta healthcare system (Tackling diabetes in Alberta, 2009). Individuals with diabetes visit physicians about two times more frequently, have higher risk of hospitalization due to complications, and are hospitalized for 2.5 times longer, than individuals without diabetes (Johnson, Rabi, Edwards, & Vermeulen, 2007). The indirect cost of diabetes is also high. T1D and T2D individuals respectively have 15 years and 5 - 10 years shorter life expectancies resulting in productivity loss (Canadian Diabetes Association, 2008). Also, the presence of diabetes is associated with 3.5% decrease in employment rate and one third reduction in annual earnings (Ng, Jacobs, & Johnson, 2001).

Quality of life in chronic disease populations

Quality of life (QoL) is especially important in chronic disease management, since chronic diseases are often not curable and have a lifelong impact on patients. In a population survey of diabetics, the mean duration of diabetes after diagnosis is approximately 11 years (Centers for Disease Control and Prevention, 2008) and during this period, diabetes affects mental, physical, and social functioning of the person (Rubin & Peyrot, 1999). Thus, QoL (i.e., the perception and subjective evaluation of individual functioning) is considered to be useful in capturing the broad impact of diabetes (Shumaker, Anderson, & Czajkowski, 1990).

QoL is valued because of its relationship with important clinical outcomes. Health-related quality of life (HRQL), one concept of QoL, has been reported to be associated with mortality in the general population (Idler & Benyamini, 1997; Kaplan & Camacho, 1983) as well as in the clinical populations (Bosworth et al., 1999). In diabetes studies, better HRQL has been found to be inversely related to mortality and diabetes complications (Clarke et al., 2009; Kleefstra et al., 2008). Similarly, life satisfaction (LS), another concept of QoL, has been reported to be associated with mortality and morbidity (Koivumaa-Honkanen et al., 2000; Koivumaa-Honkanen et al., 2001; Koivumaa-Honkanen, Honkanen, Koskenvuo, Viinamaki, & Kaprio, 2002; Koivumaa-Honkanen et al., 2004). In addition, poor HRQL was found to be associated with higher healthcare utilization in the general (Parkerson, Harrell, Hammond, & Wang, 2001; Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997; Dominick, Ahern, Gold, & Heller, 2002) and clinical populations (Ethgen, Kahler, Kong, Reginster, & Wolfe, 2002; Singh, Nelson, Fink, & Nichol, 2005; Mapes et al., 2003; Fan et al., 2002; Sprenkle, Niewoehner, Nelson, & Nichol, 2004; Rodriguez-Artalejo et al., 2005; Konstam et al., 1996).

Determinants of quality of life

Various factors affect QoL of individuals with diabetes. Studies on adults with diabetes have identified demographic factors (Pan et al., 2006; Glasgow, Ruggiero, Eakin, Dryfoos, & Chobanian, 1997; Nicollucci et al, 2009; Koopmanschap & CODE-2 Advisory Board, 2002), diabetes-related factors (e.g., insulin use, diabetes complications, comorbidities, glycemic control; Brown et al., 2000; Glasgow et al., 1997; Hoey et al., 2001), and lifestyle behaviours (e.g.,

smoking, physical activity, and diet; Glasgow et al, 1997; Li, Ford, Mokdad, Jiles, & Giles, 2007; Jimenez-Garcia et al., 2008) to be associated with QoL.

The relationship between personality and QoL has been reported in the general population (Diener, Oishi, & Lucas, 2003; Chapman, Deberstein, & Lyness, 2007); however, studies examining this relationship in the diabetes population have been limited. A study of adults who were newly diagnosed with T1D found that higher scores on neuroticism were associated with poor HRQL (Taylor, Frier, Gold, Deary, & Edinburgh Prospective Diabetes Study, 2003). Another study identified that coping, mood, and social support mediated the relationship between personality and QoL (Rose et al., 1998). Although few studies examined effects of personality on QoL, studies have identified that personality is associated with specific determinants (i.e., glycemic control and complication) of QoL (Vollrath, Landolt, Gnehm, Laimbacher, & Sennhauser, 2007; Lane et al., 2000; Brickman, Yount, Blaney, Rothberg, & De-nour, 1996). These findings support the potential relationship between personality and QoL.

Differences in quality of life between T1D and T2D adults

Although the two diabetes types (T1D and T2D groups) are both characterized by high blood glucose level, they both have a very different etiology. Researchers have compared QoL scores between T1D and T2D; however, the findings have been inconsistent (Jacobson, de Groot, & Samson, 1994; Coffey et al., 2002; Currie et al., 2006; Naughton et al., 2008). Furthermore, few studies have investigated differences in determinants of QoL between adults with T1D and T2D.

In summary, although demographic factors, personality, medical factors, and lifestyle behaviours are individually associated with QoL, their independent effects on QoL, requires further investigation. In addition, limited information exists on differences in QoL between adults with T1D and T2D. To address these questions, this study tested a comprehensive model that consisted of personal (i.e., demographic factors and personality), medical, and lifestyle factors on QoL, and investigated differences in determinants of QoL between adults with T1D and T2D.

1.2 Overall Rationale for the Study

According to previous studies, personal factors (i.e., demographic factors and personality), medical characteristics, and lifestyle behaviours are associated with QoL (i.e., HRQL and LS). Given diverse determinants of QoL, we tested a model that consists of personal, medical and lifestyle factors based on the frameworks used by Glasgow et al. (1997) and Plotnikoff, Karunamuni, Johnson, Kotovych, and Svenson (2008). The information obtained from testing this comprehensive model will be able to identify high-risk population groups among diabetes patients who may benefit from additional services and to develop effective strategies to improve the QoL of the diabetes population.

To our knowledge this study is the first to: (1) simultaneously examine three diverse domains (i.e., personal, medical, and lifestyle factors) to explain HRQL and LS; (2) investigate the role of personality on QoL; (3) separately test a

comprehensive model for both diabetes types (i.e., T1D and T2D); and (4) test a comprehensive model with two separate outcomes of QoL (i.e., HRQL and LS).

1.3 Research Aim Study 1

The objective of Study 1 is to test a comprehensive model (which includes personal, medical and lifestyle factors) to explain: (1) HRQL; and, (2) LS in the T2D population.

1.4 Research Aim Study 2

The objectives of Study 2 are to: (1) test a comprehensive model (which includes personal, medical and lifestyle factors) to explain: (a) HRQL; and, (b) LS, in the T1D population; and, (2) examine the interaction effects of diabetes type (i.e., T1D/T2D) on significant determinants of QoL in the combined T1D and T2D group.

1.5 Thesis Plan

This thesis takes a mixed format design classified in the guidelines set by the Faculty of Graduate Studies and Research and Centre for Health Promotion Studies, School of Public Health, University of Alberta. This thesis consists of two studies (Chapters 3 and 4) that aim to answer the two main research questions through secondary analyses of a large study.

The first two chapters are introductory chapters. Chapter 1 provides an introduction of the overall study. Chapter 2 summarizes the relevant literature on

the topic. Chapters 3 and 4 are two independent manuscripts which consist of their own introduction, methods, results and discussion. Due to the use of the same database, some content within the methods sections of these two manuscripts are duplicated. Following the two papers, Chapter 5 summarizes the study findings, and provides recommendations regarding future research and practice. The final section (Appendix) consists of detailed information (i.e., analysis results, study questionnaire, and the study ethical approval).

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Chapter 2- Literature review

2.0 Overview of the chapter

This chapter provides an overview of research on quality of life (QoL). The main sections of this chapter include: (1) the importance of understanding QoL in the diabetes population; (2) previous research which has examined determinants of QoL; (3) the study's rationale; and, (4) the research objectives. The studies that were reviewed in this section are summarized in the literature summary tables at the end of the chapter.

2.1 Introduction

Diabetes mellitus

Diabetes mellitus has become a major health issue in Canada. About 1.8 million Canadians (5.5%) are diagnosed with diabetes mellitus, and more than 150,000 are newly diagnosed each year (Public Health Agency of Canada, 2008). The actual number of those living with diabetes may be over 2 million, considering that 30% of diabetes cases are undiagnosed (Harris et al., 1998). The combination of the aging population, prevalence of sedentary lifestyles and obesity, high incidence of diabetes among Aboriginal people, and increasing number of immigrants from high-risk ethnic groups (i.e., Asians and Hispanics) is estimated to increase the Canadian diabetes population to 3 million by 2010 (Canadian Diabetes Association, 2008).

Diabetes is rarely fatal; however, its complications and comorbidities cause mortality and morbidity. According to Canadian national data, 28% of type 2

diabetes (T2D) patients have macrovascular complications (i.e., heart disease, peripheral vascular disease, and stroke), and 38% have microvascular complications (i.e., neuropathy, retinopathy, nephropathy, and diabetic foot; Harris, Ekoé, Zdanowicz, & Webster-Bogaert, 2005). Prevalence of comorbidities is also high amongst the diabetes population. Two thirds of the T2D patients have hypertension, 59% have dyslipidemia, and 14% have depression (Harris et al., 2005). Due to the high prevalence of diabetes complications and comorbidities, diabetics have 2 times higher overall mortality compared to the non-diabetic population (Canadian Diabetes Association, 2008). The cardiovascular disease mortality is particularly high among diabetes patients, and 80% die of cardiovascular disease (Canadian Diabetes Association, 2008).

High mortality and morbidity amongst the diabetes population is a very significant economic burden. Diabetes is associated with work-related productivity loss. In a US study, among adults with diabetes (45–64 yrs old), the proportion of people not working, work disabled, and with work limitations are 8.1%, 3.4%, and 5.7% higher, respectively compared to those without diabetes (Tunceli, Zeng, Habib & Williams, 2009). Another study of US adults identified that the presence of diabetes was associated with 3.5% decrease in employment rate and one third reduction in annual earnings (Ng, Jacobs, & Johnson, 2001). In addition, the healthcare cost of the diabetes population is higher compared to the non-diabetic population. Diabetes individuals see physicians more frequently and have higher probability of being hospitalized by complications than those without this disease (Public Health Agency of Canada, 2008). The healthcare cost for diabetes treatment

was 4.66 billion Canadian dollars in 2000 and is estimated to increase to 8.14 billion dollars by 2010 (1996 dollar values; Ohinmaa, Jacobs, Simpson, & Johnson, 2004). The entire economic cost of diabetes, including work-related productivity loss and the healthcare cost, is estimated to be 13.2 billion Canadian dollars per year (Canadian Diabetes Association, 2004). Clearly, there is an urgent need to recognize the challenges of diabetes and effective ways to intervene on diabetes patients.

Quality of life in chronic disease populations

Increasing evidence suggests the importance of QoL in health and clinical practice (Rejeski, Brawley, & Shumaker, 1996; Smith, Avis, & Assmann, 1999). Contrary to objective markers such as disease stages and biomarkers, QoL is the perception and subjective evaluation of individual functioning (Shumaker, Anderson, & Czajkowski, 1990). QoL is especially important in chronic disease management, since chronic diseases are often not curable and have lifelong influence on patients. The mean duration after diagnosis with diabetes is approximately 11 years (Centers for Disease Control and Prevention, 2008) and during this period, diabetes affects diverse aspects of the person's life (e.g., mental, physical and social functioning; Rubin & Peyrot, 1999). With regard to lifelong impact of diabetes, maintenance of optimal QoL has become the principal objective of diabetes management (Rubin & Peyrot, 1999).

Health-related quality of life (HRQL) and life satisfaction (LS) are two concepts of QoL. HRQL implies to health-oriented QoL that are affected by medical factors but not the broad concept of satisfaction or happiness (Fries & Spitz,

1990). On the other hand, although LS can be influenced by specific domains of life (e.g., employment and personal relationship), LS refers to a subjective evaluation of overall life (Diener, 1984).

Health-related quality of life

Measures that assess HRQL are widely used as an indicator and a predictor of health outcomes. In the past, health outcomes were assessed only by objective measures such as biomarkers and disease stages; however, practitioners and researchers working in clinical settings identified that objective outcomes do not always correlate with subjective outcomes (Revicki, 1989; Rejeski et al., 1996). For example, cancer patients who underwent the surgery to remove the esophagus and stomach would obtain remarkable improvement in cancer stages (objective outcomes), but their QoL (subjective outcome) was low because they were no longer able to eat regular foods. Therefore, for the comprehensive understanding of patients' status, measures that assess HRQL were developed. Today HRQL is measured in various health studies and mandated in most clinical trials (Rejeski et al., 1996).

In addition to monitoring subjective health status, HRQL provides valuable information about mortality and healthcare cost. In Idler and Benyamini's (1997) review of 27 community studies, most reported a consistent association between mortality and HRQL (i.e., self-rated health). One of the studies in the review reported a significant correlation between HRQL (i.e., perceived health rating) and mortality after adjusting for demographic, health status, lifestyle behaviours and psychosocial factors (Kaplan & Camacho, 1983). According to this study, the

age-adjusted relative risk of all-cause mortality in the people who rated their health as “poor” compared to the people who rated their health as “excellent” was 2.33 for men and 5.10 for women.

The ability of HRQL to predict mortality has also been examined in various population subgroups. In chronic obstructive pulmonary disease patients, HRQL was independently associated with all-cause and respiratory mortality after adjusting for age, lung function and BMI (Domingo-Salvany et al., 2002). Similarly, poor HRQL (i.e., self-rated health) was associated with all-cause and coronary artery disease (CAD)-related mortality in CAD patients after adjusting for demographic factors, disease severity, and comorbidities (Bosworth et al., 1999a). A 5-year cohort study of T2D patients found that 0.1 higher EQ-5D index score was associated with decreased risk of diabetes complications, and mortality (Clarke et al., 2009). Another cohort study of 1,143 T2D patients identified inverse relationship between physical composite summary of RAND-36 and mortality (Kleefstra et al., 2008).

Measures of HRQL can also be used to predict healthcare cost. In a longitudinal study of adult primary care patients, baseline HRQL score was found to be a predictor of 1-year health services charges (Parkerson, Harrell, Hammond, & Wang, 2001). Poor HRQL was associated with increased use of physician services in the working population (Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997) and risk for short-term (30-days) and long-term (1-year) future hospitalization in the elderly population (Dominick, Ahern, Gold, & Heller, 2002). Similarly, lower level of HRQL were associated with higher future healthcare

utilization in patients with arthritis (Ethgen, Kahler, Kong, Reginster, & Wolfe, 2002; Singh, Nelson, Fink, & Nichol, 2005), and higher hospitalization in patients with kidney disease (Mapes et al., 2003), obstructive lung disease (Fan et al., 2002 ; Sprenkle, Niewoehner, Nelson, & Nichol, 2004) and heart failure (Rodriguez-Artalejo et al., 2005; Konstam et al., 1996). Due to valuable healthcare information that measures of HRQL provides, it is important that we understand the determinants of HRQL.

Population surveys have identified various determinants of HRQL. Brown and colleagues (2003) reported that people from BRFSS (Behavioral Risk Factor Surveillance System) with lower HRQL tended to be female, non-white, less educated, a smoker, and have arthritis, obesity and activity limitations. Further analyses of BRFSS and other US national surveys have also identified physical activity as a determinant of HRQL (Brown et al., 2003; Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007). Another population study of US adults reported that demographic variables (i.e., age, gender, race, education, income) and existence of chronic conditions (i.e., diabetes, asthma, high blood pressure, heart disease, stroke, emphysema) were also associated with lower HRQL scores (Lubetkin, Jia, Franks, & Gold, 2005). Chronic conditions are also important determinants of HRQL in the elderly population. In a model that consisted of demographic factors, lifestyle behaviours and chronic conditions (e.g., arthritis, diabetes, back problem, heart disease, depression), the latter factor explained about 20% of variance for HRQL (Orfila et al., 2006). Similarly, personal factors (i.e., demographic factors and

personality), medical variables and lifestyle behaviours (described below) are important factors for explaining HRQL in population subgroups.

A study of adults with asthma identified that gender, race, education, employment, and income were associated with HRQL (Ford, Mannino, Redd, Moriarty, & Mokdad, 2004). Another study of older patients with arthritis (N=10,923) found differences in HRQL levels by age, gender, race, residence, marital status, and income (Dominick, Ahern, Gold, & Heller, 2004). Gender, race, education, income and marital status were also associated with HRQL in patients with coronary artery disease (Bosworth et al., 1999b).

In studies on the diabetes population, demographic variables (i.e., age, gender, education, income, type of health insurance, marital status, living situation) have been reported to be associated with HRQL (Pan et al., 2006; Glasgow, Ruggiero, Eakin, Dryfoos, & Chobanian, 1997; Jacobson, de Groot, & Samson, 1994; Maddigan, Feeny, Majumdar, Farris, & Johnson, 2006). In a study of adolescents (10-18yrs) with T1D, girls and those belonging to minor ethnic groups were associated with poorer health perception (Hoey et al., 2001). In T1D adults, people who are older, female and have lower income tended to report lower HRQL (Lloyd & Orchard, 1999). In T2D adults, age, gender, education, and marital status were associated with HRQL (Redekop et al., 2002; Nicolucci et al., 2009).

Personality is associated with HRQL. In a community-based study of older adults, neuroticism was negatively associated with several domains of HRQL (i.e., health perception, bodily pain, and mental health) in both men and women (Kempen, Jelicic, & Ormel, 1997). Chapman, Duberstein and Lyness (2007)

studied personality in older adults and found that low "neuroticism" and high "conscientious" levels were associated with higher HRQL. Furthermore, the relationship between personality traits and HRQL were studied in cancer (Yamaoka et al., 1998), heart disease (van den Berg, Ranchor, van Sonderen, van Gelder, & van Veldhuisen, 2005; Westlake et al., 2002), and subarachnoid hemorrhage patients (Visser-Meily, Rhebergen, Rinkel, van Zandvoort, & Post, 2009).

Rose et al. (1998) found that the relationship between personality and HRQL were mediated through coping, mood, and social support in diabetes adults. Among newly diagnosed T1D adults, higher score of neuroticism at diagnosis was consistently associated with poorer HRQL over the 12 months after diabetes diagnosis (Taylor, Frier, Gold, Deary, & Edinburgh Prospective Diabetes Study, 2003).

Studies have also found that personality affects specific determinants (i.e., glycemic control and diabetes complications) of QoL. High scores on "conscientiousness" and "agreeableness," and low scores on "neuroticism" have been reported to correlate with good glycemic control in T1D children (Vollrath, Landolt, Gnehm, Laimbacher, & Sennhauser, 2007). T1D (N=60) and T2D (N=70) adults with depression demonstrated higher neutroticism scores (Robinson, Stevens, Bush, & Fuller, 1989). High scores on "conscientiousness" and medium scores on "neuroticism" were associated with delayed development of renal complication in T1D (Brickman, Yount, Blaney, Rothberg, & De-Nour, 1996). High scores on "neuroticism" and low scores on "altruism" (one facet of agreeableness) were

associated with good glycemic control in T2D samples (Lane et al., 2000). These findings support the relationship between personality and HRQL; however, further studies on personality and QoL are necessary in diabetes population.

Medical factors such as chronic diseases are also important determinants of HRQL. In a US population study, having more cardiovascular disease risk factors (i.e., diabetes, hypertension, high blood cholesterol, obesity, and smoking) was associated with lower HRQL (Li et al., 2008). Diagnosis of chronic diseases has been associated with lower HRQL, and the levels of decreased HRQL differed among diseases (Schlenk et al., 1998; Arnold et al., 2004). Studies on each disease identified effects of disease-specific factors on HRQL. In those with diabetes, comorbidities, diabetes complications, type of treatment (i.e., insulin), and glycemic control were reported to affect HRQL level. The increase in number and severity of comorbidities and diabetes complications were associated with poorer HRQL (Brown et al., 2000; Glasgow et al., 1997; Huang, Brown, Ewigman, Foley, & Meltzer, 2007; Maddigan, Feeny, & Johnson, 2005). Insulin treatment was associated with lower HRQL (Brown et al., 2004; Brown et al., 2000; Glasgow et al., 1997), and good glycemic control was associated with higher HRQL (Testa, Simonson, & Turner, 1998). In a large sample of T1D adolescents (N=2,101), lower HbA1c and BMI was associated with better HRQL (Hoey et al., 2001). Diabetes duration, diabetes complications, and hypoglycemic episode were associated with HRQL in T1D adults (Lloyd & Orchard, 1999).

Similarly, a large study of T2D (N=1,348) reported that insulin, poor glycemic control, diabetes complication and obesity were associated with lower

HRQL (Redekop et al., 2002). A Canadian study of T2D (N=5,134) found that longer diabetes duration, insulin use, comorbidities (i.e., stroke and depression), and obesity were related to lower HRQL (Maddigan et al., 2006). The inverse relationships of insulin use and diabetes duration with HRQL were identified in other studies of T2D (Johnson & Maddigan, 2004; Maddigan, Feeny, Johnson, & DOVE Investigators, 2004; Nicolucci et al., 2009; Koopmanschap & CODE-2 Advisory Board, 2002). In a 4-year longitudinal study of T2D adults, participants who were using insulin had lower HRQL at baseline. Although the study didn't find significant changes in HRQL among people who initiated insulin therapy during the study period, people on insulin treatment consistently reported lower HRQL levels compared to those on non-insulin treatment (Davis, Clifford, Davis, & Fremantle Diabetes Study, 2001). Among 1,233 T2D adults not using insulin, diabetes complications (i.e., coronary artery disease, peripheral vascular disease, peripheral sensory neuropathy, autonomic neuropathy, and diabetic foot) were associated with poor scores in some domains of SF-36 (one HRQL measure; Lloyd, Sawyer, & Hopkinson, 2001). In addition, obesity was associated with lower HRQL in adults with T2D (Sundaram et al., 2007; Lloyd et al., 2001; Koopmanschap & CODE-2 Advisory Board, 2002; Maddigan, et al., 2006).

Lifestyle behaviour also affects HRQL. In a large study of adults in the general population (N=3,756) physical activity was associated with HRQL after adjusting for demographic factors and BMI (Sodergren, Sundquist, Johansson, & Sundquist, 2008). Another study of adults in the general population identified an accumulation of healthy lifestyle (e.g., diet, physical activity, smoking and drinking

behaviours) was associated with higher HRQL (Tountas, Manios, Dimitrakaki, & Tzavara, 2007). In cancer survivors, increased physical activity was associated with improvement in HRQL (Alfano et al., 2007). Blanchard, Courneya, Stein, and the *American Cancer Society's SCS-II* (2008) studied three lifestyle behaviours (i.e., smoking, physical activity, and eating 5 servings of fruits and vegetables a day) in survivors of six different cancers and reported that the accumulation of healthy lifestyle behaviours was associated with better HRQL after adjusting for age, race, marital status, education, cancer stage, and a number of comorbidities. Similarly in diabetes patients, the number of the three healthy lifestyle behaviours mentioned in Blanchard's study was related to better HRQL after adjusting for demographic variables, duration of diabetes, diabetes complications and comorbidities (Li, Ford, Mokdad, Jiles, & Giles, 2007). Further, sedentary behaviour was associated with lower HRQL in diabetic adults (Jimenez-Garcia et al., 2008), and physical activity was identified as an independent predictor of HRQL in a comprehensive model that consisted of demographic, medical, and self-care behaviours (Glasgow et al., 1997). In a study of 397 adults with T1D, physical activity was associated with HRQL (Lloyd & Orchard, 1999).

The effect of behaviour interventions further supports the relationship between lifestyle behaviours and HRQL. A 6-month physical activity intervention in postmenopausal women identified dose-dependent relationship between physical activity and HRQL (Martin, Church, Thompson, Earnest, & Blair, 2009). Rehabilitation programs that promote healthy lifestyle behaviours improved HRQL level in CAD patients (Oldridge et al., 1991; Yu et al., 2004; Marchionni et al.,

2003). A systematic review of interventions for diabetes patients has reported the effectiveness of education and behavioural modification programs on HRQL improvement (Zhang, Norris, Chowdhury, Gregg, & Zhang, 2007). This review included two studies which found that the exercise programs improved HRQL. One of the two studies examined the effect of cardiac rehabilitation program (aerobic physical activity and education) in heart disease patients with (N=70) and without diabetes (N=221). In the diabetes group, post-intervention HRQL level was higher in all aspects of HRQL examined by SF-36 (Milani & Lavie, 1996).

In adolescents with T1D, an aerobic training program improved all domains of SF-36 (Wiesinger et al., 2001). In a randomized control intervention study of sedentary T2D people (N=26), intervention group demonstrated increased physical activity and HRQL level (Kirk et al., 2001). Kaplan, Hartwell, Wilson and Wallace (1987) compared (N=76) 10-week diet, physical activity, and combination of diet and physical activity intervention in T2D adults. The combination and diet only groups improved HRQL compared to control group at 12 and 18 month follow-up.

According to our review on studies that have examined determinants of HRQL, demographic, medical, and lifestyle behavioural variables are associated with HRQL. However, some of the factors that were examined in these studies are correlated with each other, and adjusting for possible confounders has been reported to attenuate or diminish the association between certain factors and HRQL. For example, although race (Hispanic) was individually correlated with HRQL, it was no longer significant after adjusting for income and education (Lubetkin et al., 2005). Further, Orfila et al. (2006) tested a sequential multiple regression model for

HRQL in the elderly adults and reported that gender was no longer significant after adding chronic conditions (i.e., chronic diseases) to the model. Thus, a comprehensive model should be tested to identify determinants of HRQL.

Based on a conceptual model proposed by Wilson and Cleary (1995), Orfila et al. (2006) tested a comprehensive model that integrated sociodemographic factors, lifestyle variables, functional capacity, and chronic conditions in elderly adults which explained 42% of variance for HRQL. Rose, Fliege, Hildebrandt, Schirop, and Klapp (2002) integrated characteristics of patient, illness, and doctor-patient relationship based on Glasgow's conceptual model (1995) to explain HRQL which accounted for 62% of variance. Glasgow and colleagues (1997) investigated factors associated with HRQL in a national sample of US adults with diabetes (N=2,056), and tested a model which consisted of demographic factors (i.e., age, gender, education, income, insurance type, living situation), medical history factors (i.e., type of diabetes, duration of diabetes, insulin medication, numbers of comorbidities, complications, and hospitalization), and self-management behaviours (i.e., glucose testing, exercise, diet). This model was tested in three components of HRQL (i.e., physical, social, and mental functioning) explaining 29%, 19% and 17% of the respective variances.

See summary tables 2-1-1(HRQL, mortality, and morbidity), 2-2-1(HRQL and demographic factors), 2-3-1(HRQL and medical factors), and 2-4-1(HRQL and lifestyle factors).

Life satisfaction

LS, another indicator of QoL, is the general perception of individuals' lives, rather than specific dimensions (e.g., work, housing). Therefore, measures of LS are used to assess the overall evaluation of life (Diener, 1984). Similar to HRQL, LS provides valuable health information related to mortality and morbidity. For example, in a nation-wide study in Finland, LS was associated with all-cause mortality for men (although no relationship was identified between LS and mortality for women; Koivumaa-Honkanen et al., 2000). LS in this study also predicted suicide (Koivumaa-Honkanen et al., 2001), injury death (Koivumaa-Honkanen, Honkanen, Koskenvuo, Viinamaki, & Kaprio, 2002), and work disability in the general population (Koivumaa-Honkanen et al., 2004).

Researchers have studied the relationships between LS and diverse factors. For example, Strine, Chapman, Balluz, Moriarty, and Mokdad (2008) reported that demographic factors, existence of chronic illness, lifestyle behaviours, and HRQL were associated with LS in a national US adult sample. According to this study and other studies presented below, similar to HRQL, personal factors (i.e., demographic factors, personality), medical factors, and lifestyle behaviours in this study were reported as important factors associated with LS.

Age, race, first generation immigrants, marital status, education, employment, and financial situation have been reported to be associated with LS (Clemente & Sauer, 1976; Mookherjee, 1992; Hutchinson et al., 2004; Melin, Fugl-Meyer, & Fugl-Meyer, 2003; Fugl-Meyer, Melin, & Fugl-Meyer, 2002). The role of demographic factors has also been examined in clinical subgroups. Pierce

and Hanks (2006) reported that ethnicity and marital status were associated with LS in traumatic brain injury patients, and gender differences were reported in spinal cord injury patients (Dijkers, 1999). In a study of T1D patients, a satisfaction score (a combined score of satisfaction with global and specific domains of life) was higher in Caucasian males compared to Caucasian females (Faulkner, 2003). In a study of T1D adolescents (N=2,101), female gender, older age, but not minor ethnicity was associated with poor satisfaction score (Hoey et al., 2001).

Personality has also been reported to be associated with LS in university students (Libran, 2006; Schimmack, Oishi, Furr, & Funder, 2004; Schimmack, Diener, & Oishi, 2002) and adults from various cultures (Schimmack, Radhakrishnan, Oishi, Dzokoto, & Ahadi, 2002). Huovinen, Kaprio, and Koskenvuo (2001) studied the relationship among personality, LS and asthma. High "extraversion" score was correlated with an increased incidence of adult-onset asthma, and prevalence of asthma was associated with low LS and high neuroticism scores. Courneya et al. (2000) examined relationships between LS and demographic (i.e., age, gender, marital status, education, income, and BMI), medical (i.e., functional status, time since surgery, tumor site, disease stage, types of cancer treatment), and personality variables in colorectal cancer patients. Of these factors, marital status and personality variables were significantly correlated with LS. In a hierarchical regression analysis, marital status explained 15% of variance for LS; adding personality to the analysis significantly increased the explained variance by 29%.

Disease and health status are other determinants of LS. Obesity and weight gain were associated with LS (Rosmond, Lapidus, Marin, & Bjorntorp, 1996; Korkeila, Kaprio, Rissanen, Koshenvuo, & Sorensen, 1998). Absence of chronic illness correlated with high LS in adult samples (Hutchinson et al., 2004; O'Dea, Hunter, & Anjos, 1999; Strine et al., 2008). Asthma patients presented lower LS compared to those without this condition (Huovinen et al., 2001); however, Grigg, Thommasen, Tidesley and Michalos (2006) found no difference in LS between diabetics and nondiabetics. Some researchers have studied the effect of disease-specific factors on LS to further understand the lower LS among clinical populations. In a study of spinal cord injury patients, years since injury and disability were associated with higher LS (Dijkers, 1999). In a diabetes study, insulin treatment was associated with lower LS (Grigg et al., 2006). Among T1D adolescents, good glycemic control and lower BMI were associated with higher satisfaction scores (Hoey et al., 2001).

In a US adult population study, in terms of lifestyle behaviours, smoking, alcohol consumption, and physical activity were associated with LS (Strine et al., 2008). Physical activity has been reported to be positively associated with higher LS among Swedish adults (Melin et al., 2003), elderly people across European countries (Borg et al., 2008) and adolescents (Valois, Zullig, Huebner, & Drane, 2004).

Relationships between lifestyle behaviours and LS have been studied in diabetes populations using satisfaction scores. Satisfaction scores were higher in physically active patients compared to sedentary individuals in a study of young

T1D patients (Zoppini, Carlini, & Muggeo, 2003). In an intervention study of T2D patients, the intervention group significantly improved self-management behaviours (i.e., glucose self-testing, lifestyle behaviours, and foot care) and satisfaction scores versus the controls (Menard et al., 2007). In these studies, global and specific domains of life satisfaction were not separately analyzed; thus, further study is needed to identify the relationship between lifestyle behaviours and LS in the diabetes population.

See summary tables 2-1-2 (LS, mortality, and morbidity), 2-2-2(LS and demographic factors), 2-3-2(LS and medical factors), and 2-4-2(LS and lifestyle factors).

Comparison of HRQL and LS

As mentioned in the previous section, HRQL and LS are different domains of QoL, and researchers have studied both HRQL and LS to understand characteristics of each concept. Surveys of general adult population reported a positive relationship between HRQL and LS scores (Strine et al., 2008; Clemente & Sauer, 1976; O'Dea et al., 1999). O'Dea and colleagues (1999) further investigated the determinants of HRQL and LS and found that illness, employment, and marital status predicted HRQL; employment (for male) and illness predicted LS. Another study of 968 adults identified that age was positively associated with LS, but negatively with HRQL (i.e., self-rated health; Grigg et al., 2006).

To the best of our knowledge, only one study assessed both HRQL and LS to study QoL of diabetics. The study reported that the correlation coefficients between HRQL and satisfaction score were 0.50 and 0.42 in T1D and T2D,

respectively (Jacobson et al., 1994). A diabetes-specific quality of life questionnaire, which is frequently used as a measure of HRQL consists of items that assess health-oriented QoL and satisfaction with specific and overall domains of life (The Diabetes Control and Complications Trial Research Group, 1988). This may partially explain the reason few studies assessed both HRQL and LS.

Comparison of QoL score between T1D and T2D populations

Jacobson et al. (1994) examined differences in HRQL scores between T1D (N=111) and T2D (N= 129) samples. HRQL scores (i.e., physical and social functioning) were higher in T2D group compared to T1D group, and social functioning (one domain of HRQL) remained significantly higher in the T2D group after adjusting for demographic and medical factors (i.e., complications and diabetes duration). Another study reported that the mean health utility score for diet-controlled non-obese T2D men without microvascular, neuropathic, or cardiovascular complications were slightly higher than T1D men without complication (Coffey et al., 2002). A study of diabetes adults (T1D: N=236, T2D: N=889) found no difference in HRQL measured by EQ-5D and QoL-DN, but reported a higher SF-36 score in T2D than T1D (Currie et al., 2006). In a study of youth with T1D (N=2,188) and T2D (N=257), HRQL was lower in T2D compared to T1D group (Naughton et al., 2008). The findings are inconsistent amongst these studies. In addition, to our knowledge, few studies have investigated factors which explain the difference in QoL between two diabetes types.

In summary, the review of previous studies identified several topics that require further investigation. First, although studies have identified diverse

determinants of QoL in diabetes populations, independent effects of these determinants are not established. Second, despite studies that emphasized the role of personality on QoL, few studies have examined personality and QoL in diabetes population. Third, limited information exists on differences in determinants of QoL between T1D and T2D people.

See summary table 2-5 for comparison studies of HRQL between type 1 and type 2 diabetes people.

2.2. Overall Rationale for the Study

According to the literature, personal factors (i.e., demographic factors and personality), medical characteristics, and lifestyle behaviours contribute to explain QoL (i.e., HRQL and LS). Given the diverse determinants of QoL, we tested a model that consists of personal, medical and lifestyle factors based on the frameworks used by Glasgow et al. (1997) and Plotnikoff et al. (2008). The information obtained from testing this comprehensive model will not only identify high-risk population groups among diabetes patients who may benefit from additional services, but will also assist in developing effective strategies to improve the QoL of the general diabetes population.

To our knowledge this study is the first to: (1) examine three diverse domains (i.e., personal, medical, and lifestyle factors) to explain HRQL and LS; (2) investigate the role of personality on QoL; (3) separately test a comprehensive model for both diabetes types (i.e., T1D and T2D); and, (4) test a comprehensive model with two separate outcomes of QoL (i.e., HRQL and LS).

2.3. Research Aim Study 1

The objective of Study 1 is to test a comprehensive model (which includes personal, medical and lifestyle factors to explain: (1) HRQL and (2) LS, in the T2D population.

2.4. Research Aim Study 2

The objectives of Study 2 are to: (1) test a comprehensive model (which includes personal, medical and lifestyle factors) to explain: (a) HRQL; and, (b) LS, in the T1D population; and, (2) examine the interaction effects of diabetes type (i.e., T1D/T2D) on significant determinants of QoL in the combined T1D and T2D group.

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Table 2-1-1. Literature review on HRQL, mortality and morbidity

Authors & published year	Participants	Measures	Adjusted covariates	Major results
General population				
Kaplan & Camacho, 1983	Adults (N=6,928)	SRH	Age	RR for mortality was 2.33 (men) and 5.10 (women). (SRH poor vs excellent).
Idler & Benyamini, 1997	Review (27 studies)	SRH		SRH and mortality were associated.
Miilunpalo et al., 1997	Noninstitutionalized adults (N=2,840)	SRH	Age, sex and social status	SRH was inversely association with mortality and the number of physician contacts per year.
Parkerson, 2001	Primary care patients (N=1,202)	Duke Health Profile	Age, gender	HRQL explained an additional 5% of the variance for future primary care clinic visit.
Dominick et al.,2002	Older adults (65yrs≤; N=84,065)	4 items HRQL measure from BRFSS	Demographic factors and comorbidity	All four HRQL questions were significant predictors of 30-day and 1-year hospitalization and mortality.
Clinical population				
Konstam et al., 1996	Congestive heart failure patients (N=5,025)	SOLVD Health Quality of Life Questionnaire (physical functioning, emotional distress, social health, intimacy, life satisfaction, perceived health, productivity)	Age, treatment, ejection fraction, and New York Heart Association functional class.	1. Baseline assessment of HRQL predicted mortality and CHF-related hospitalizations. 2. Predictors of mortality and CHF-related hospitalizations were activities of daily living (RR=1.16 for mortality, RR=1.22 for hospitalization,), general health (RR=1.21 for mortality RR= 1.19 for hospitalization), and social functioning (RR=1.10 for mortality RR=1.16 for hospitalization). 3. Activities of daily living, general health and heart failure symptoms were independent risk factors for mortality and hospitalization.
Bosworth et al., 1999	Heart disease patients (N=2,885)	SRH	Comorbidities, disease severity, HRQL(SF-36), psychosocial factors, demographic factors	1. OR for all-cause mortality was 2.96 (SRH poor vs very good) after controlling for comorbidities, disease severity, HRQL, psychosocial factors, and demographic variables) 2. OR for CAD-related mortality was 3.58 (poor vs very good SRH).

Table 2-1-1.(cont'd) Literature review on HRQL, mortality and morbidity

Authors & published year	Participants	Measures	Adjusted covariates	Major results
Domingo-Salvany et al., 2002	COPD patients (male; N=321)	1. SF-36 2. St. George's Respiratory Questionnaire	Age, FEV1.0, BMI	HRs for the total mortality-standardized for both HRQL measures were 1.3.
Ethgen et al., 2002	Rheumatoid arthritis (RA) patients (N=642) osteoarthritis (OA) patients (n=395)	1. SF-36 2. Stanford Health Assessment Questionnaire (HAQ)	Age, sex, BMI and comorbidities	1. With HAQ, OA and RA patients in the worst quarter reported a 199% and 48% increase in rheumatologist visits, respectively. 2. With SF-36, RA patients in the highest quarter reported a decrease of 31% in general practitioner visits (PCS) and a decrease of 52% in hospitalization (MCS).
Fan et al., 2002	Chronic lung disease patients (N=3,282)	1. Seattle Obstructive Lung Disease Questionnaire (SOLDQ) 2. SF-36	Comorbidity, long-term steroid use, prior hospitalization for COPD, age, site, distance from hospital, smoking, and employment.	1. OR of hospitalization for COPD was 5.0 for baseline SOLDQ physical function scores (the lowest quartile vs the highest quartile). 2. OR of death was 6.8 (the lowest quartile of physical function). 3. OR of hospitalizations specifically for COPD was 6.0 (the lowest quartile of physical function). 4. In SF-36, patients in the lowest quartile of PCS had an increased risk of hospitalization and death. 5. The MCS score was not associated with hospitalization for COPD.
Mapes et al., 2003	Hemodialysis patients (N=17,236)	Kidney Disease Quality of Life Short Form (KDQOL-SFTM)	Sociodemographic variables, comorbidities, and laboratory factors	1. Adjusted RRs for death and hospitalization were 1.96 and 1.56 (the lowest quintile vs the highest quintile of PCS). 2. The adjusted RR for mortality per 10point lower HRQL score were 1.13 for MCS and 1.25 for PCS.

Table 2-1-1.(cont'd) Literature review on HRQL, mortality and morbidity

Authors & published year	Participants	Measures	Adjusted covariates	Major results
Sprenkle et al., 2004	Asthma or COPD patients (N=8,354)	SF-36V	1. For PCS, prior hospitalization, age, gender, employment status 2. For MCS, prior hospitalization, prior specialty medicine visit, age, gender, employment status	1. HR of death was 5.47 (the fourth quartile vs the first quartile of PCS). 2. ORs of hospitalization, primary care visits and specialty medicine visits were 1.82, 1.54, and 1.46 (the fourth quartile vs the first quartile of PCS). 3. MCS predicted subsequent death but didn't predict subsequent hospitalization or high outpatient utilization.
Rodriguez-Artalejo, 2005	Heart failure patients (N=394)	1. SF-36 2. Minnesota Living With Heart Failure	Age, sex, education, comorbidities, biomedical, psychosocial, and health care variables.	1. HRs of rehospitalization were higher in patients with worse scores on the physical functioning (HR=1.65), general health (HR=1.73), mental health (HR=1.65), physical summary score (HR=1.52) of the SF-36 subscale. 2. The HRs of mortality were higher in patients with worse scores on the physical functioning (HR=2.08), general health (HR=1.72), vitality (HR=2.08), mental health (HR=2.46), and emotional summary score (HR=2.02).
Singh, et al. 2005	Arthritis patients (N=18,464)	SF-36V		1. ORs of hospitalization and mortality were 1.49 and 1.69 (the lowest tertile of PCS). 2. ORs of hospitalization and mortality were 1.20 and 2.14 (the lowest tertile of MCS).
Diabetes population				
Kleefstra et al., 2008	Primary care patients with type 2 diabetes (N=1,143)	RAND-36		PCS of the RAND-36 was inversely associated with mortality (HR=0.979).
Clarke et al. , 2009	Type 2 diabetes patients (N=7,348)	EQ5D		0.1 higher EQ5D index score was associated with: 1. an additional 7% lower risk of vascular events; 2. 13% lower risk of complications; and, 3. up to 14% lower rate of all-cause mortality.

Table 2-1-2. Literature review on LS, mortality and morbidity

Authors & published year	Participants	Measures	Adjusted covariates	Major results
General population				
Koivumaa-Honkanen et al., 2000	General population (N=22,461)	A four-item life satisfaction scale	Age, marital status, social class, smoking, alcohol use, and physical activity	1. The age-adjusted HRs of all-cause, disease, or injury mortality among dissatisfied versus satisfied men were 2.11, 1.83, and 3.01, respectively. 2. Adjusting for marital status, social class, smoking, alcohol use, and physical activity, the age-adjusted HRs diminished to 1.49, 1.35, and 1.93, respectively. 3. Women did not show an association between LS and mortality.
Koivumaa-Honkanen et al., 2001	General population (N=29,173)	A four-item life satisfaction scale	Age, sex, baseline health status, alcohol consumption, smoking status, and PA	1. Dissatisfaction at baseline was associated with a higher risk of suicide throughout the 20-year follow-up period (age-adjusted HR =3.02). 2. Adjusting for age, sex, baseline health status, alcohol consumption, smoking status, and PA, life dissatisfaction predicted suicide (HR=1.74).
Koivumaa-Honkanen et al. 2002	General population (N=29,173)	A four-item life satisfaction scale	Age, gender, baseline health status, PA, smoking, alcohol use, marital status, social class	1. Dissatisfaction predicted fatal unintentional (HR=2.83) and intentional injury (HR=3.26). 2. After adjusting for age, gender, baseline health status, PA, smoking, alcohol use, marital status, social class, dissatisfaction predicted intentional injury death (HR=1.71), but not for unintentional injury.
Koivumaa-Honkanen et al. 2004	General population (N=22,136)	A four-item life satisfaction scale	Age, baseline health status, marital status, social class and health behaviour	1. Dissatisfaction provided a statistically significant prediction of pensioning due to all causes (HR= 1.6), psychiatric (HR= 2.6), and non-psychiatric causes (HR= 1.3).

Table 2-2-1. Summary of studies which examined relationships between demographic factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
General population				
Brown et al., 2003	Adults (N=175,850)	Count of unhealthy days (physical or mental)	Age, gender, race, education, BMI, arthritis, activity limitation, smoking status, PA	People who report lower HRQL were more likely to be women, non-white, and less educated.
Lubetkin et al., 2005	Adults (N=13,646)	1.EQ-5D 2. Euroqol VAS	Age, sex, race/ethnicity, income, education, and six common chronic conditions (DM, asthma, high blood pressure, heart disease, stroke, emphysema)	1. Age was inversely associated with HRQL. 2. Income, education, and (each of the six chronic conditions) were associated with HRQL. 3. Sex and race were weakly associated with HRQL.
Orfila et al., 2006	Elderly adults (72yrs≤; N=544)	Nottingham Health Profile (NHP),	Age, gender, living arrangement, social class, education, functional capacity, number of chronic conditions, chronic conditions, smoking status, alcohol intake	Demographic and lifestyle factors explained 12.9% of the variance for HRQL.
Clinical population				
Bosworth et al., 1999	CAD patients (N=2,855)	1. SRH 2. SF-36	Age, gender, race, income, education, marital status, smoking	1. Age did not differ significantly across 5 rating of SRH. 2. Being female, not married, and being non-Caucasian were positively associated with lower levels of SRH. 3. Increased education and income were associated with better SRH. 4. Smoking status was not significantly associated with SRH. 5. The increased presence of comorbidities was related to poorer SRH.

Table 2-2-1.(cont'd) Summary of studies which examined relationships between demographic factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Dominick et al., 2004	Older adults with arthritis (OA or RA) (65yrs≤; N=10,923)	CDC HRQOL measure (9 items) "days" HRQL items were days of not good physical health, mental health, days of activity limitation and pain	Age, gender, race, residence, marital status, income, comorbid illness (Charlson Comorbidity Score)	1. People who reported fair/poor general health were older, non-whites, nursing home residents, married subjects, lower income, and having more comorbid illnesses. 2. Subjects who were 85yrs≤, male, living in a nursing home, married, and lower income and having more comorbid illnesses had poorer scores on more than one of the "days" HRQL items. 3. Race was not significantly related to any of the "days" HRQL items.
Ford et al., 2004	Asthma adults (N=12,111)	BRFSS 4 items	Age, gender, race, education, income, employment, smoking, PA, BMI, insurance coverage, last routine checkup.	1. Employment, smoking, and PA were related to HRQL. 2. Education was associated with HRQL for all measures except activity limitation days. 3. Women were more likely to report lower HRQL. 4. Compared with whites, Hispanics were more likely to report being in poor/fair health, and African Americans were less likely to report poor HRQL. 5. People with lower incomes tends to have lower HRQL. 6. Insurance coverage and the time since their last routine checkup were not associated with any of HRQL measures. 7. The heaviest participants tends to have lower HRQL.
Arnold et al., 2004	Adults (57yrs≤) with (N=1,457) and without chronic diseases (N=1,851)	SF-20 Cantrill's ladder (overall QoL)	Age, sex, marital status, education	1. Lower HRQL in lung disease, heart disease, back problem, rheumatoid arthritis, migraine 2. Lower QoL in heart and migraine

Table 2-2-1.(cont'd) Summary of studies which examined relationships between demographic factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Diabetes population				
Glasgow et al., 1997	Diabetes adults (N=2,056)	SF-20	Age, sex, education, income, insurance type, living situation, diabetes duration, insulin, number of comorbidities, complications, hospitalizations,	Male, young, higher education, higher income, private/managed care organization insurance, living with another were associated with higher HRQL
Pan et al., 2006	Diabetes adults (BRFSS)	Self-rated health	Age, race, gender, education, health insurance coverage insulin usage, duration of diabetes, obesity smoking	Prevalence of poor/fair health increase in older age, female, non-white ethnicity, no health insurance, and lower education.
Jacobson et al., 1994	Adults T1D and T2D (N=240)	1. Diabetes Quality of Life Measure 2. SF-36	Age, gender, education, marital status, treatment type, diabetes duration, diabetes complication	1. Age (type 1 & 2), marital status, insulin (type2), complications were associated with HRQL. 2. Gender, education, diabetes duration were not significant (type 1 & 2).
Hoey et al., 2001	Adolescents T1D (N=2,101)	DQOL for adolescents		Gender (female), ethnic minorities, and poor glycemic control were associated with poorer HRQL.
Lloyd & Orchard,1999	Adults T1D (N=397)	SF-36		1. Age, gender, income, diabetes duration, physical activity, diabetes complications (cardiovascular disease, neuropathy, retinopathy), and hypoglycemic episode were associated with domains of SF-36. 2. Gender, income, physical activity, diabetes complications (cardiovascular disease, retinopathy) were independently associated with general health of SF-36.

Table 2-2-1.(cont'd) Summary of studies which examined relationships between demographic factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Redekop et al., 2002	Adults T2D (N=1,348)	1.EQ5D 2.Euroqol VAS		1. VAS score: older age, female gender, (insulin, obesity and complications) were associated with lower VAS score. 2. EQ5D: older age, female gender, (longer diabetes duration, insulin therapy, complications, obesity and poor glycemic control) were associated with poor EQ5D utility score.
Koopmanschap et al., 2002	Adults T2D (N=4,189)	EQ-5D	Age, sex, treatment type, BMI, HbA1c, complications	Age, gender, BMI and HbA1c were associated with HRQL.
Maddigan et al., 2006	Adults T2D (N=5,134)	HUI3	Age, gender, marital status, education, aboriginal status, stress, food security, diabetes duration, stroke, heart disease, osteoarthritis, depression, insulin, BMI, PA, drinking, smoking, sense of belonging	1. Lower education, older age, and being married were associated with better HRQL. 2. Stroke, depression, diabetes duration, insulin use, and obesity were associated with HRQL. 3. Physical activity was associated with better HRQL.
Nicolucci et al., 2009	Adults T2D (N=2,499)	1. SF-36, 2. WHO-Well Being Questionnaire	Age, gender, marital status, living situation, occupation, education, diabetes duration, insulin, BMI, HbA1c, number of comorbidies, diabetes complications,	Older age, female gender, lower education, and marital status(divorce/widowed), were associated with lower HRQL.

Table 2-2-2. Summary of studies which examined relationships between demographic factors and life satisfaction

Authors & published year	Participants	Outcome measures	Independent variables	Major results
General population				
Clemente & Sauer, 1976	Adults (N=1,347)	LS- 4item	Race, age, SES, marital, perceived health, social participation	1. Age, race, and perceived health were predictors of LS 2. Marital status, social participation were weak predictor of LS 3. SES had negligible impact on LS. (Education and income were weak and not significant.) 4. Age, race, education, income, marital, HRQL, vote, church participation, and gender explained 17.2% of the variances for LS
Mokherjee, 1992	Adults (N=1,532)	LS- 7items (6 specific and 1 overall)	Age, race, marital status, education, financial status	1. Financial, marital, and educational status were significant predictor and explained 16% of variance for LS 2. Age, race were not significant in 1988 but were significant in 1978
O'Dea et al., 1999	Middle age adults (49-55yrs; N=189)	LS-subject rate LS on 7point scale		1. No gender difference in LS 2. Employment (male) was a predictor of LS
Fugl-Meyer, 2002	Adults (N=2,533)	LiSat-11 (overall life and 10 specific domains)	Age, gender, marital and immigrant status	1. Age was not significantly associated with overall LS 2. Gender difference were not identified in LS 3. Marital status (no partner) and first-generation immigrant were associated with lower LS
Melin et al., 2003	Adults (N=2,533)	LiSat-11 (overall life and 10 specific domains)	Education level, employment, perceived financial situation, perceived health, subjective performance ability, PA	1. Employment, marital status, perceived financial situation, immigrant status (being a first generation immigrant), and perceived health were associated with LS 2. Level of LS differed by employment status, perceived financial situation, perceived health, subjective performance ability and PA.

Table 2-2-2. (cont'd) Summary of studies which examined relationships between demographic factors and life satisfaction

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Hutchinson et al., 2004	Young adults (15-50 yrs; N=2,580)	LS- 1item 'Are you satisfied with your life as a whole?	Age, gender, education, employment, marital status, church attendance, religiosity, acute & chronic illness, self-esteem	1. LS was associated with gender, education, employment, marital status, chronic illness, church attendance, religiosity, and self-esteem. 2. Age×gender interaction: young men had higher LS compared to old men
Arnold et al., 2004	Adults (57yrs≤) with (N=1,457) & w/o chronic diseases (N=1,851)	Cantrill's ladder (overall QoL) MOS SF-20	Age, sex, marital status, education	1. Correlation HRQL and QoL was 0.16-0.53 2. Sex (in control & hypertension groups), marital status (control, hypertension, RA), age (RA) were significantly associated with QoL 3. Variance for overall QoL explained by demographic factors were 3-12%
Strine et al., 2008	Adults (BRFSS 2005)	In general, how satisfied are you with your life?	Age, gender, education, race, marital status, employment status, smoking habits, physical activity, height and weight, and alcohol consumption, CVD, asthma, arthritis, diabetes	1. Persons aged 45–54 yrs were most likely to be dissatisfactied with life followed by those aged 18–24 yrs. 2. Females have slightly lower LS. 3. Black non-Hispanics demonstrated lower LS compared to other race/ethnicities. 4. Education and LS were positively associated 5. People currently married had higher LS compared to previously married/never married. 6. The prevalence of dissatisfaction was higher among unable to work/unemployed compared to employed, retired, and homemakers or students. 7. Persons who were dissatisfied/very dissatisfied (vs very satisfied) were more likely to have asthma (OR = 1.7), arthritis (OR = 2.0), diabetes (OR = 1.8), and heart disease (OR = 2.2) after adjusting for age, sex, race, education, marital status, and employment status.

Table 2-2-2. (cont'd) Summary of studies which examined relationships between demographic factors and life satisfaction

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Strine et al., 2008 (cont'd)				8. Persons who were dissatisfied/very dissatisfied (vs very satisfied) were more likely to smoke (OR=2.3), be obese (OR=1.5), drink heavily (OR=1.6), and be physically inactive (OR=2.2) after adjusting for age, sex, race, education, marital status, and employment status.
Clinical population				
Dijkers, 1999	Spinal cord injury patients (N=2,183)	SWLS	Age, gender, race, marital status, residence, occupation, time since injury, number of hospitalizations, sociocognitive disability, and 3 handicap components	1. Mean score of LS differed by age, gender, race, marital status, residence, and occupation, 2. Stepwise linear regression analysis resulted in a model including gender, number of rehospitalizations in the last year, years since injury, sociocognitive disability and three handicap components.
Pierce et al., 2006	Traumatic brain injury patients (N=180)	SWLS	Age, gender, race, marital status, education, years after injury, number of impairments, cognitive function, functional ability, reintegration into the community	1. The combination of ICF components and demographic factors predicted LS (R^2=0.17) 2. Race, marital status, cognitive score, and community integration scores (home, social, and productivity) were related to LS score.

Table 2-2-2. (cont'd) Summary of studies which examined relationships between demographic factors and life satisfaction

Author & published year	Participants	Outcome measures	Independent variables	Major results
Diabetes population				
Hoey et al., 2001	Adolescents T1D (N=2,101)	Diabetes Quality of Life questionnaire for adolescents	Age, gender, diabetes duration, HbA1c, family burden related to diabetes	1. Lower HbA1c was associated with better satisfaction score 2. Age and gender affect satisfaction score. (The scores start to decline at 12 yrs in girls and at 16yrs in boys.) 3. Belonging to ethnic minority group was not associated with satisfaction score.
Faulkner, 2003	Adolescents T1D (N=69)	Diabetes Quality of Life Instrument for Youth (7-item diabetes specific & 10-item general LS)	Age, gender, metabolic control	1. Adolescents with DM have lower LS compared to non-diabetic control. 2. Age and metabolic control were not associated with LS. 3. Female had lower LS.

Table 2-3-1. Summary of studies which examined relationship between medical factors and health-related quality of life

Author & published year	Participants	Outcome measures	Independent variables	Major results
General population				
Brown et al., 2003	Adults (N=37,054)	Count of unhealthy days (physical or mental)	Age, gender, race, education, BMI, arthritis, activity limitation, smoking status, PA	Low HRQL was associated with higher prevalence of obesity, arthritis, activity limitation due to health problems.
Brown et al., 2004	Adults (N=37,054)	BRFSS 4 items	Age, gender, education, employment, current smoking, BMI, duration of diabetes, insulin treatment	CVD was associated with lower HRQL after multivariate adjustment.
Lubetkin et al., 2005	Adults (N=13,646)	EQ-5D	Age, sex, race/ethnicity, income, education, and six common chronic conditions	Each of the six conditions (DM, asthma, high blood pressure, heart disease, stroke, emphysema) was independently associated with lower HRQL.
Orfila et al., 2006	Elderly adults (72yrs≤; N=544)	Nottingham Health Profile (NHP),	Age, gender, living arrangement, social class, education, functional capacity, number of chronic conditions, chronic conditions, smoking status, alcohol intake	Adding chronic disease increased the explained variance by 19.5%. (Demographic and lifestyle factors explained 12.9% of the variance for HRQL.)
Li et al.,2008	Adults (BRFSS)	BRFSS 4 items	CVD risk factors: diabetes, hypertension, high cholesterol, obesity, smoking	A number of CVD risk factors was associated with HRQL.

Table 2-3-1. (cont'd) Summary of studies which examined relationship between medical factors and health-related quality of life

Author & published year	Participants	Outcome measures	Independent variables	Major results
Clinical population				
Schlenk et al., 1998	Urinary incontinence, prostate cancer, COPD, AIDS, fibromyalgia and hyperlipidaemia patients (N=321) Control (N=2,472)	SF-36		1. Prostate cancer and hyperlipidaemia patients have the highest HRQL level across the chronic disorders. 2. Homebound, elderly, incontinent patients had the lowest HRQL for physical functioning. 3. Hospitalized patients had the lowest HRQL in general health and social functioning. 4. COPD patients had the lowest HRQL in role-physical, role-emotional and mental health. 5. Patients with fibromyalgia had the lowest HRQL in bodily pain and vitality. 6. Compared to control, patients with urinary incontinence, COPD, AIDS and fibromyalgia generally had lower HRQL. 7. Prostate cancer and hyperlipidaemia patients had HRQL comparable to normative data.
Arnold et al., 2004	Adults (57yrs≤) with (N=1,457) w/o chronic disease (N=1,851)	SF-20	Age, sex, marital status, education	HRQL was lower in lung disease, heart disease, back problem, rheumatoid arthritis, migraine groups compared to control group.
Diabetes population				
Testa et al., 1998*	Diabetes adults (N=569)		Intervention (glipizide) Control (placebo)	Intervention group achieved better glycemic control and HRQL
Brown et al., 2000	Diabetes adults (N=292)	Time-trade-off Utility values		Insulin treatment, presence of depression, diabetic retinopathy and co-morbidities were associated with lower utility value.

Table 2-3-1. (cont'd) Summary of studies which examined relationship between medical factors and health-related quality of life

Author & published year	Participants	Outcome measures	Independent variables	Major results
Brown et al., 2004	Older adults (50yrs≤; N=37,054) Diabetes adults (N=4,032)	BRFSS 4items	Age, race/ethnicity, sex, education, employment status, current smoking, body mass index, insulin treatment and duration of diabetes, and CVD.	1. People using insulin (vs non-insulin) had OR=1.71 of having 14≤ unhealthy days (physical or mental) after multivariate adjustment. 2. People with CVD (vs not having CVD) had OR=1.84 of having 14≤ unhealthy days (physical/mental) after multivariateadjustment.
Pan et al., 2006	Diabetes adults	Self-rated health	Age, race, gender, education, health insurance coverage insulin usage, duration of diabetes, obesity smoking	Prevalence of poor health increase with insulin use and diabetes duration.
Maddigan et al., 2005	Adults (N=2,280)	HUI3	Age, gender, education, number of medical conditions	Number of comorbidities (arthritis, heart disease, stroke) was associated with decreased HRQL level.
Huang et al., 2007	Adults (N=701)	Utility score (ratings on a 0–1, 0=death, 1=perfect health)	Diabetes complications, diabetes treatment (intensive, conventional, comprehensive)	Severity of complication was associated with lower HRQL. (End-stage complications were associated with a lower mean utility score than its intermediate complications.)
Jacobson et al., 1994	Adults T1D and T2D (N=240)	1. Diabetes Quality of Life Measure 2. SF-36	Age, gender, education, marital status, treatment type, diabetes duration, diabetes complications	1. Insulin (type2) and complications were associated with HRQL. 2. Diabetes duration was not significant in both type1 and 2 diabetes groups.
Glasgow et al., 1997	Adults (N=2,056) T1D (N=247) T2D (N=1,536)	SF-20	Age, sex, education, income, insurance, living situation, insulin, diabetes duration, number of comorbidities, complications, hospitalizations	HRQL was associated with insulin (type 2), diabetes duration, number of complications, comorbidities, and hospitalizations.

Table 2-3-1. (cont'd) Summary of studies which examined relationship between medical factors and health-related quality of life

Author & published year	Participants	Outcome measures	Independent variables	Major results
Hoey et al., 2001	Adolescents T1D (N=2,101)	Diabetes Quality of Life questionnaire for adolescents	Age, gender, diabetes duration, HbA1c, family burden related to diabetes	1. Lower HbA1c was associated with better health perception. 2. Greater BMI was associated with worse health Perception. 3. Higher daily insulin doses were associated with poorer health perception.
Lloyd & Orchard,1999	Adults T1D (N= 397)	SF-36		1. Age, gender, income, diabetes duration, physical activity, diabetes complications (cardiovascular disease, neuropathy, retinopathy), and hypoglycemic episode were associated with domains of SF-36. 2. Gender, income, physical activity, diabetes complications (cardiovascular disease, retinopathy) were independently associated with general health of SF-36.
Lloyd et al., 2001	Adults T2D (N=1,233)	SF-36	Diabetes complications [hypertension, peripheral sensory neuropathy (PSN), peripheral vascular disease (PVD), coronary artery disease (CAD), retinopathy]	1. Hypertension didn't affect HRQL. 2. PSN, PVD, CAD were associated with lower HRQL. 3. HRQL (domains of SF-36) was associated with severity of complications.
Davis et al., 2001	Adults T2D (N=1,290)	1. Modified DQOL 2. the Rosser index		1. Baseline: Insulin group had poorer HRQL scores for satisfaction, worry, impact, and total score. 2. Longitudinal: no significant change in HRQL level before and after initiation of insulin. Patients who were on insulin during the study period consistently demonstrated lower HRQL.

Table 2-3-1. (cont'd) Summary of studies which examined relationship between medical factors and health-related quality of life

Author & published year	Participants	Outcome measures	Independent variables	Major results
Koopmanschapet al., 2002	Adults T2D (N= 4,189)	EQ-5D	Age, sex, treatment type, BMI, HbA1c, complications	1. Both micro- and macro-vascular complications were associated with poorer HRQL. 2. Insulin was associated with lower HRQL. 3. Age, gender, BMI, and HbA1c were independently associated with HRQL.
Redekop et al., 2002	Adults T2D (N=1,348)	EQ-5D, Euroqol VAS scores		1. VAS score: insulin, obesity and complication were associated with lower VAS score. 2. EQ-5D: 1) In univariate analysis, age, gender, diabetes duration, insulin, complications, obesity and HbA1c were associated with EQ-5D utility index. 2) Complications, insulin, obesity, (age and gender) were independently associated with HRQL in regression model. 3) HbA1c was not significant after adjusting for complications, insulin, obesity, age and gender.
Johnson et al., 2004	Adults T2D (N=372)	1. RAND-12 2. SF-12	Age, gender, income, education, first nations status, BMI	Insulin use, longer diabetes duration, and emergency room visits were associated with lower HRQL.
Maddigan et al., 2004	Adults T2D (N=394)	1. RAND-12 2. HUI2 3. HUI3		Insulin use, longer duration of diabetes, and more days off work were associated with HRQL.
Maddigan et al., 2006	Adults T2D (N=5,134)	HUI3	Age, gender, marital status, education, aboriginal status, stress, food security, diabetes duration, stroke, heart disease, OA, depression, insulin, BMI, PA, drinking, smoking, sense of belonging	1. Stroke, depression, diabetes duration, insulin use, obesity, and physical activity were associated with HRQL. 2. Lower education, older age, and being married were associated with better HRQL. 3. Physical activity was associated with better HRQL.

Table 2-3-1. (cont'd) Summary of studies which examined relationship between medical factors and health-related quality of life

Author & published year	Participants	Outcome measures	Independent variables	Major results
Sundaram et al., 2007	Adults T2D (N=385)	1. SF-12 2. Audit of Diabetes Dependent Quality of Life (ADDQoL)		1. Obesity was significantly associated with poorer PCS and MCS scores. 2. Depressive symptoms were associated with lower PCS, MCS and ADDQoL scores. 3. In MR, obesity and depression were independently associated with PCS and MCS; however, glycemic control was not significant.
Nicolucci et al., 2009	Adults T2D (N=2,499)	1. SF-36, 2. WHO-Well Being Questionnaire	Age, gender, marital status, living situation, occupation, education, diabetes duration, insulin, BMI, HbA1c, number of comorbidies, diabetes complications,	Diabetes duration, insulin, BMI, HbA1c, number of comorbidities, and diabetes complications were associated with HRQL.

*intervention study

Table 2-3-2. Summary of studies which examined relationship between medical factors and life satisfaction

Author & published year	Participants	Outcome measures	Independent variables	Major results
General population				
Rosmond et al., 1996	Middle age men (N=1,040)	LS- Are you generally satisfied with your present life situation?	Smoking, alcohol, and WHR	LS was significantly associated with BMI after adjusting for smoking, alcohol, and WHR.
Korkeila et al., 1998	Adults (N=5,867)	Allardt's 4-item scale		Low LS was associated with weight gain.
O'Dea et al., 1999	Middle age adults (49-55yrs; N=189)	LS-subject rate LS on 7point scale		Illness (male & female) was a predictor of LS.
Hutchinson et al., 2004	Young adults (15-50 yrs; N=2,580)	LS- 1item 'Are you satisfied with your life as a whole?	Age, gender, education, employment, marital status, church attendance, religiosity, acute & chronic illness, self-esteem	LS was associated with absence of chronic illness.
Strine et al., 2008	Adults (BRFSS 2005)	In general, how satisfied are you with your life?	Age, gender, education, race, marital status, employment status, smoking habits, physical activity, height and weight, and alcohol consumption, CVD, asthma, arthritis, diabetes	1. Persons who were dissatisfied/very dissatisfied (vs very satisfied) were more likely to have asthma (OR = 1.7), arthritis (OR = 2.0), diabetes (OR = 1.8), and heart disease (OR = 2.2) after adjusting for age, sex, race, education, marital status, and employment status. 2. Persons who were dissatisfied/very dissatisfied (vs very satisfied) were more likely to smoke (OR=2.3), be obese (OR=1.5), drink heavily (OR=1.6), and be physically inactive (OR=2.2) after adjusting for age, sex, race, education, marital status, and employment status.
Clinical population				
Dijkers,1999	Spinal cord injury patients (N=2,183)	SWLS		Years since injury, sociocognitive disability, and three handicap components (i.e., mobility, occupation, and social integration) were associated with LS.

Table 2-3-2. (cont'd) Summary of studies which examined relationship between medical factors and life satisfaction

Author & published year	Participants	Outcome measures	Independent variables	Major results
Huovinen et al., 2001	Adults (N=11,540)	Allardt's four-item scale	Age, sex, asthma	Low life satisfaction was associated with asthma prevalence.
Diabetes population				
Grigg et al., 2006	Adults (N=968) Diabetes adults (N=127)	16 QoL items (1-item: satisfaction with life as a whole)	Gender, age, race (aboriginal), BMI,	1. Diabetics do not have poorer LS scores. 2. Age, gender, race, and BMI explained 0.9% of the variance for LS.
Hoey et al., 2001	Adolescents T1D (N=2,101)	DQOL		Higher BMI and poor glycemic control were associated with poorer HRQL.

Table 2-4-1. Summary of studies which examined relationship between lifestyle factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
General population				
Brown et al., 2003	Adults (N=175,850)	HRQL: count of unhealthy days (physical or mental)	Age, gender, race, education, BMI, arthritis, activity limitation, smoking status, PA	The relative odds of 14≤ unhealthy days (physical or mental) in those with the recommended level of activity compared to physically inactive adults were 0.67 for 18-44yrs group, 0.40 for 45-64yrs group, and 0.41 for 65 yrs≤ group.
Kruger et al., 2007	Adults (N=9,173)	4-items HRQL (self-rated health, physically unhealthy/mentally unhealthy/activity limitation days)	Age, gender, race, education, BMI, PA	1. Physically inactive adults had lower HRQL regardless of BMI category. 2. After adjusted for BMI, age, sex, educational level, marital status and race, physically inactive persons were more likely to report fair or poor health (OR=2.79), 14 ≤physically unhealthy days (OR=2.58), 14 ≤mentally unhealthy days (OR=1.79), and 14 ≤activity limitation days(OR=3.00) than those who met PA recommendations.
Li et al., 2008	Adults	four HRQL questions	CVD risk factors: diabetes, hypertension, high cholesterol, obesity, smoking	1. People having 4≤ CVD risk factors compared to those without any CVD risk factors ORs were 14.0 for poor or fair health, 6.4 for 14≤ physically unhealthy days, 4.8 for 14≤ mentally unhealthy days, 8.0 for 14≤impaired activity days. 2. A number of CVD risk factors was associated with all 4 items of HRQL.
Tountas et al., 2007	Hospital employee (N=395)	SF-36	Sex, age, occupation, BMI and chronic disease	The accumulation of the four health behaviours (diet, exercise, smoking and alcohol intake) were associated with increased likelihood of scoring higher in almost all SF-36 physical health subscales.

Table 2-4-1. (cont'd) Summary of studies which examined relationship between lifestyle factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Sodergren et al., 2008	Adults (N=3,756)	SRH	Age, gender, country of birth, education, employment, marital status, housing tenure, smoking and BMI	Higher levels of exercise and total PA were associated with good SRH after adjustment for age, gender, country of birth, education, employment, marital status, housing tenure, smoking and BMI.
Martin et al., 2009*	Sedentary postmenopausal women (N=430) 6-month randomized controlled trial	SF-36	4, 8, or 12 kcal/kg/week which corresponds to 50%, 100%, and 150% of current physical activity recommendations	Exercise-induced QOL improvements were dose dependent.
Clinical population				
Oldridge et al., 1991*	Patients with depression or anxiety, or both, after AMI (N=201)	Quality of life after acute myocardial infarction questionnaire	12 month follow-up of cardiac rehabilitation program	The intervention improved HRQL score.
Marchionni et al., 2003*	Outpatients after AMI (45yrs≤; N=773)	Sickness Impact Profile	Hospital-based CR, home-based CR, or no CR assessment: baseline, after CR, and 6 and 12 months	1. In middle-aged and older group both CR and control patients improved HRQL. 2. In very old patients, only CR group improved HRQL.
Yu et al., 2004*	Recent AMI or after elective percutaneous coronary intervention patients (N=269)	SF-36	Multiphase intervention that consisted of 1. ambulating program, 2. education and exercise program, and 3. home exercise program	Rehabilitation group compared to control group increased physical functioning, physical role, bodily pain, vitality, social functioning, emotional role, and mental health dimensions of SF-36.

Table 2-4-1. (cont'd) Summary of studies which examined relationship between lifestyle factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Alfano et al., 2007	Breast cancer survivors (N=545)	SF-36 (physical subscales)	Age, education, menopause status, treatment, stage of disease, tamoxifen use, smoking status, BMI, and race/ethnicity	1. Greater pre-diagnosis PA was associated with better physical functioning at 39 months. 2. Greater post-diagnosis sports/recreational PA was related to better physical functioning. 3. Increased PA after cancer was related to better physical functioning.
Blanchard et al., 2008	Cancer survivors (N=9,105)	RAND-36	Race, stage, marital status, education, age, and total number of comorbidities	Positive association between the number of lifestyle behaviour recommendations being met and HRQL for breast, prostate, colorectal, bladder, uterine, and skin melanoma cancer survivors.
Diabetes population				
Milani et al., 1996*	291 consecutive coronary patients (70 with diabetes mellitus).	SF-36	Cardiac rehabilitation 4 to 6 weeks assessment at baseline and 12 weeks	Intervention significantly improved mental health, general health, bodily pain, functional status, well-being and total QoL score.
Glasgow et al., 1997	Diabetes adults (N=2,056)	SF-20	Age, sex, education, income, insurance type, living situation, diabetes duration, insulin, number of comorbidities, complications, hospitalizations, glucose testing, diet behaviour	A significant correlation with all three dimensions of HRQL (physical, social, and mental) after adjusting for other variables.
Li et al., 2007	Diabetes adults (18yrs≤; N=16,428).	4 items (general health rating, physically unhealthy days, mentally unhealthy days, and impaired activity day)	Sex, race, age, income, education, BMI, hypertension, high cholesterol, myocardial infarction, coronary heart disease, stroke, arthritis, asthma,	Participants with all three healthy lifestyle habits (HLH: smoking, PA, and diet) (vs none of the three HLHs) were less likely to report poor or fair health (adjusted OR=0.49, ≥14 physically unhealthy days (OR=0.56), ≥14 mentally unhealthy days (OR=0.35), or ≥14 impaired activity days (OR=0.35).

Table 2-4-1. (cont'd) Summary of studies which examined relationship between lifestyle factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Li et al., 2007 (cont'd)			disability, diabetes duration, foot ulcer, retinopathy, and use of insulin and oral agents	
Zhang et al., 2007*	Review of interventions for adults with diabetes	SF-36		Pooled effects from 5 educational interventions demonstrated significantly improved physical function 3.4 and mental health 4.2, and a decrease in bodily pain 3.6.
Jimenez-Garcia et al., 2008	Diabetes adults (N=21,650)	SRH	Age, gender, comorbidities, BMI, physical activity	Variables that were independently and significantly associated with SRH were age 54-64 years (OR=1.5) and 65 years≤ (OR=2.1); presence of comorbidity (high blood pressure and/or heart or respiratory chronic disease) (OR=4.3); female sex (OR=1.2); lower educational level (OR=1.7); obesity(BMI 30≤;OR=1.3); no PA (OR=1.6).
Wiesinger et al., 2001*	Adolescents T1D (N=23)	MOS SF-36	Aerobic training (n=15) control (n=8)	All HRQOL scales improved in the training group.
Lloyd & Orchard,1999	Adults T1D (N= 397)	SF-36		1. Age, gender, income, diabetes duration, physical activity, diabetes complications (CVD, neuropathy, retinopathy), and hypoglycemic episode were associated with domains of SF-36. 2. Gender, income, PA, diabetes complications (CVD, retinopathy) were independently associated with general health of SF-36.
Kaplan et al., 1987*	Adults T2D (N=76)	Quality of Well-being Scale (mobility, physical activity, social activity)	Diet, PA, PA+Diet, control	At 18-month PA+Diet and Diet group significantly improved glycemic control and HRQL. (These changes were independent of changes in weight.)

Table 2-4-1. (cont'd) Summary of studies which examined relationship between lifestyle factors and health-related quality of life

Authors & published year	Participants	Outcome measures	Independent variables	Major results
Kirk et al., 2001*	Adults T2D (N=26)	1.SF-36 2.22-Item Well-Being Questionnaire	Intervention group (consultation and standard PA information)	After 5 weeks, intervention group increased PA level and improved most domains of SF-36
Maddigan et al., 2006	Adults T2D (N=5,134)	HUI3	Age, gender, marital status, education, aboriginal status, stress, food security, diabetes duration, stroke, heart disease, osteoarthritis, depression, insulin, BMI, PA, drinking, smoking, sense of belonging	1. Lower education, older age, and being married were associated with better HRQL. 2. Stroke, depression, diabetes duration, insulin use, obesity, and physical activity were associated with HRQL. 3. Physical activity was associated with better HRQL.

*intervention study

Table 2-4-2. Summary of studies which examined relationship between lifestyle factors and life satisfaction

Authors & published year	Participants	Outcome measures	Independent variables	Major results
General population				
Melin et al., 2003	Adults (N=2,533)	LiSat-11 (overall life and 10 specific domains)	Education, employment, perceived financial situation, perceived health, subjective performance ability, PA	Level of overall LS differed by PA.
Valois et al., 2004	Adolescents (N=4,758)	Brief Multidimensional Student Life Satisfaction Scale	Race, gender	No PA for 20 minutes over the past 7 days, no stretching (past 7 days), no PA to strengthen or tone muscles (past 7 days), no physical education class (spending 20min≤), and no attendance on sport teams were associated with reduced LS for specific race/gender groups.
Borg et al. 2008	Older adults with reduced ADL (65yrs≤; N=2,195)	Life Satisfaction Index Z		1. Correlations between LS and participation in PA was r=0.17-0.30. 2. Correlation between HRQL and LS was r=0.40-0.46.
Strine et al., 2008	Adults (BRFSS 2005)	In general, how satisfied are you with your life?	Age, gender, education, race, marital status, employment status, smoking habits, PA, height and weight, alcohol consumption, CVD, asthma, arthritis, diabetes	Persons who were dissatisfied/very dissatisfied (vs very satisfied) were more likely to smoke (OR=2.3), be obese (OR=1.5), drink heavily (OR=1.6), and be physically inactive (OR=2.2) after adjusting for age, sex, race, education, marital status, and employment status.
Diabetes population				
Zoppini et al., 2003	Young adults T1D (N=53)	DQOL		A significant differences in the satisfaction scale score between physically active and sedentary participants.
Menard et al., 2007*	Adults T2D (N=72)	DQOL	Intervention: education, exercise, phone calls	QOL improved significantly in the IMT (intensive multitherapy) group when compared to controls particularly with respect to the satisfaction scale.

*intervention study

Table 2-5. Summary of studies which compared HRQL levels between type 1 and type 2 diabetes people

Authors & published year	Participants	Outcome measures	Independent variables (non-significant variables)	Major results
Naughton et al., 2008	Youth T1D (N=2,188) T2D (N=257)	Pediatric Quality of Life Inventory (PedsQL)	T1D Insurance, age×sex interaction (in older groups, PedsQL scores were lower for girls but higher for boys), method of insulin treatment, glycemic control, emergency visit, hospitalization T2D: Insulin (better QoL), emergency visits (T1D: Race/ethnicity, parent education, duration of diabetes, and BMI) (T2D: Demographic variables, duration of diabetes, HbA1c level, BMI, comorbid conditions, and complications)	HRQL was lower in T2D compared to T1D.
Jacobson et al., 1994	Adults T1D (N=111) T2D (N=129)	1. Diabetes Quality of Life Measure 2. SF-36	T1D, T2D Marital status, frequency & severity of complications T2D Insulin (Education, sex, duration of diabetes)	1. T2D group had better score than T1D group in SF-36 (Physical& social functioning) and DQOL 2. After adjusted for demographic factors, diabetes duration, and diabetes complication, T2D still reported less impact and worries of diabetes and better social functioning.

Table 2-5. (cont'd) Summary of studies which compared HRQL levels between type 1 and type 2 diabetes people

Authors & published year	Participants	Outcome measures	Independent variables (non-significant variables)	Major results
Coffey et al., 2002	Adults T1D (N=784) T2D (N=1,257)	Self-administered version of the Quality of Well Being index	Education, blindness, symptomatic neuropathy, foot ulcers, amputation, congestive heart failure, and debilitating stroke (Age, race, education, age at onset of diabetes, duration of diabetes, cholesterol status)	1. Health utility scores were 0.69/0.65 (male/female) for diet-controlled nonobese T2D diabetics without complications. 2. Health utility scores were lower 0.67/0.64 (male/female) for T1D without complications.
Currie et al., 2006	Adults T1D (N=236) T2D (N=889)	1. EQ-5D 2. SF-36 3. QoL-DN	Diabetes-related complications	1. EQ-5D & QoL-DN score didn't differ by diabetes types. 2. SF-36_{GHP} (T2D>T1D).

Chapter 3 - Study 1.

Determinants of Quality of Life in Type 2 Diabetes Population

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ABSTRACT

Background: The identification of factors that affect quality of life (QoL) is crucial to eliminate the increasing burden of diabetes. This study tested a comprehensive model that consisted of factors across three domains (personal, medical and lifestyle factors) to understand determinants of QoL in adults with type 2 diabetes (T2D).

Methods: A total of 1,147 adults with T2D completed a self-report survey which assessed demographic factors, personality (activity trait), medical factors (diabetes duration, insulin, number of comorbidities, and BMI), lifestyle behaviours (smoking, physical activity, and diet), and the two measures of QoL [i.e., health-related quality of life (HRQL) and life satisfaction (LS)].

Results: The model explained 27.1% and 18.2% of the variance for HRQL and LS, respectively. Age was positively related to HRQL (β=0.14, $p<0.01$). Personality (activity trait) was the strongest, independent variable in both HRQL (β=0.25, $p<0.01$) and LS (β=0.25, $p<0.01$) after controlling for demographic, medical, and lifestyle factors. Physical activity was positively associated (β=0.14, $p<0.01$) with HRQL but not with LS.

Conclusion: Personality may be a useful screening tool to distinguish adults with T2D adults who are at risk for poor QoL.

Keywords: determinant, type 2 diabetes, health-related quality of life, life satisfaction

INTRODUCTION

Diabetes mellitus and quality of life[1]

Diabetes has become a major health issue. About 1.8 million Canadians (5.5%) have been diagnosed with diabetes and more than 150,000 Canadians are newly diagnosed each year (Public Health Agency of Canada, 2008). The combination of the aging population, high prevalence of sedentary lifestyles and obesity, high incidence of diabetes among Aboriginal people, and increasing number of immigrants from high-risk ethnic groups (i.e., Asians and Hispanics) is estimated to increase Canadian diabetes population to 3 million by 2010 (Canadian Diabetes Association, 2008b).

Achieving optimal quality of life (QoL) is particularly emphasized in chronic disease management, because physiological markers have limited ability to capture the impact of disease (Rubin & Peyrot, 1999; Guyatt, Feeny, & Patrick, 1993; Smith, Avis, & Assmann, 1999). A review of cancer studies found that health-related quality of life (HRQL) status was a better predictor of survival than performance status (Osoba, 1999). The ability of HRQL to predict important health outcomes (e.g., mortality) has also been reported in diabetes studies. A 5-year cohort of 7,348 individuals with type 2 diabetes (T2D) identified that 0.1 higher EQ-5D index score was associated with lower risk of cardiovascular events, diabetes complications, and all-cause mortality (Clarke et al., 2009). Another study of T2D identified an inverse relationship between Physical Component Summary of RAND-36 and mortality after controlling for age, sex, diabetes

[1] Note: In the submitted paper, we will delete the subheadings

duration, HbA1c, renal function, blood pressure, HDL cholesterol, macrovascular complications, BMI, and smoking (Kleefstra et al., 2008).

Two concepts of QoL that are frequently employed in studies are HRQL and life satisfaction (LS). HRQL is a domain of QoL that is affected by medical factors but not the broad concept of satisfaction or happiness (Fries & Spitz, 1990). On the other hand, although LS can be influenced by specific domains of life (e.g., employment and personal relationship), it is a subjective evaluation of overall life (Diener, 1984).

Previous studies have identified various determinants of HRQL and LS in adults with diabetes. A US population survey found that age, gender, ethnicity, education, having health insurance, duration of diabetes, insulin use, obesity, and smoking were associated with HRQL (Pan et al., 2006). Another US diabetes study (N=2,056 adults) identified relationships between demographic factors (age, gender, education, income), medical history variables (duration of diabetes, insulin use, number of comorbidities and complications), lifestyle behaviours (physical activity) and three domains of HRQL (Glasgow, Ruggiero, Eakin, Dryfoos, & Chobanian, 1997). In studies specific to adults with T2D, older age, female gender, fewer years of education, being divorced/widowed, being employed, using insulin, higher number of comorbidities, higher BMI and poor glycemic control were identified to be associated with lower HRQL (Redekop et al., 2002; Nicolucci et al, 2009).

Few studies have employed LS to examine QoL of diabetics. Grigg, Thommasen, Tidesley and Michalos (2006) identified a significant relationship

between insulin use and LS in a sample of T2D adults. In a 12-month self-management intervention study (N=72; T2D adults), intervention group increased engagement in self-management behaviours (e.g., glucose self-testing, lifestyle behaviours, and foot care) and satisfaction score (i.e., combined score of global and specific life satisfaction; Menard et al, 2007).

Personality and quality of life

Personality is also a determinant of HRQL and LS. Low "neutroticism" and high "conscientious" are associated with higher HRQL in older adults (Chapman, Duberstein, & Lyness, 2007). Relationships between personality and HRQL have been reported in cancer (Yamaoka et al., 1998), heart disease (van den Berg, Ranchor, van Sonderen, van Gelder, & van Veldhuisen, 2005; Westlake et al., 2002), and subarachnoid hemorrhage patients (Visser-Meily, Rhebergen, Rinkel, van Zandvoort, & Post, 2009). To our knowledge, two studies have examined the relationship between personality and HRQL in diabetics. Rose et al. (1998) found that personality affected HRQL through coping, mood, and social support in diabetes adults (N=116). Another study of adults with type 1 diabetes (T1D; N=84) identified that higher neuroticism scores at the time of diagnosis of diabetes was associated with poorer HRQL over 12 months (Taylor, Frier, Gold, Deary, & Edinburgh Prospective Diabetes Study, 2003).

The relationship between personality and LS has also been studied in non-diabetic populations. Personality and LS have been examined in university students (Libran, 2006; Schimmack, Oishi, Furr, & Funder, 2004; Schimmack, Diener, & Oishi, 2002) and adults from various cultures (Schimmack,

Radhakrishnan, Oishi, Dzokoto, & Ahadi, 2002). These studies identified that two domains of personality (i.e., neuroticism and extraversion) are associated with LS. Courneya et al. (2000) examined relationships between personality and LS in colorectal cancer patients. In a hierarchical regression, adding personality increased the explained variance by 29%.

Although limited information exists on the direct relationship between personality and QoL in diabetics, researchers have identified relationships between personality and determinants of QoL. In both T1D (N=60) and T2D (N=70) groups, people with depression demonstrated higher neuroticism scores (Robinson, Stevens, Bush, & Fuller, 1989). High scores on "neuroticism" and low scores on "altruism" (one facet of agreeableness) were also associated with good glycemic control in T2D individuals (Lane et al., 2000). Based on these findings, personality may have influence on QoL in the diabetes population.

Although demographic factors, personality, medical factors, and lifestyle behaviours have been reported to be associated with QoL, theses factors may be related to each other and adjusting for other factors may attenuate or diminish the individual relationships between these factors and QoL (Lubetkin, Jia, Franks, & Gold, 2005; Orfila et al., 2006). A comprehensive model could address this issue. To identify independent determinants of QoL from diverse factors, we therefore tested a comprehensive model which consisted of personal (demographic factors and personality), medical, and lifestyle factors based on the frameworks used by Glasgow et al. (1997) and Plotnikoff, Karunamuni, Johnson, Kotovych, and Svenson (2008).

All the study variables (except personality) were hypothesized to be associated with HRQL and LS in the univariabte analyses. However, no hypotheses were provided for activity (personality) trait (univariate) and all the variables examined in the multivariate models due to the exploratory nature of the topic.

METHODS

Sample

This study is a secondary analysis of data collected from the *Alberta Longitudinal Exercise and Diabetes Research Advancement* (ALEXANDRA) study, a population-based, longitudinal study of physical activity determinants in diabetes adults in Alberta, Canada. The study procedures, response rates, and measures are explained elsewhere (Plotnikoff et al., 2006). In brief, adult (18 yrs and older) residents of Alberta with diabetes were assessed longitudinally (baseline, 6-month, and 18-month) with factors related to physical activity. The baseline assessment was completed by 2,319 people. Of these participants 1,662 (510 T1D and 1,152 T2D) completed the 6-month assessment (Plotnikoff et al., 2006; Plotnikoff et al., 2007). The data from the 6-month assessment were used for this study. The demographic characteristics of the study sample are presented in the Table 3-1, and reflect age and gender proportions of the Canadian diabetes population (Health Canada, 2003).

Table 3-1 about here

Measures

Self-report questionnaires were employed to collect all data: personal factors (i.e., demographic factors and personality), medical factors (i.e., type of diabetes, diabetes duration, diabetes medication, and comorbidities), lifestyle behaviours (i.e., smoking, physical activity, and diet), HRQL and LS.

Personal factors:

Demographic factors (i.e., age, gender, marital status, educational, and gross annual income) were assessed based on Statistics Canada 2001 census (Statistics Canada, 2001; Plotnikoff et al., 2006). The activity (personality) trait (a subtrait of extroversion) measure was used to assess personality. The items asked participants to describe themselves by comparing with other persons of the same gender and age, and rating themselves on 5-point Likert scales from '1' (strongly disagree) to '5' (strongly agree) for each of the five personality trait markers (i.e., unadventurous, rambunctious, competitive, unenergetic and active). The mean scores of these five items were used. These trait markers were initially developed by Goldberg (1992) and then identified by Saucier and Ostendorf (1999) to measure activity trait. Rhodes, Courneya and Jones (2004) reported a good (α=0.78) internal consistency of an 8-item (i.e., active, adventurous, rambunctious, daring, unenergetic, unadventurous, competitive, uncompetitive) version of our employed scale with university students.

Medical factors:

Diabetes type, duration of diabetes, and type of medication were assessed by self-report measures (Plotnikoff, Brez, & Hotz, 2000; Plotnikoff et al., 2007).

Presence of comorbidities was assessed by asking, "Has a doctor or nurse ever told you that you have the following: angina, heart attack, stroke, high blood cholesterol, and high blood pressure" with response options: "yes = 1" and "no = 0 (Plotnikoff et al., 2000). The number of diagnosed comorbidities was calculated. BMI was calculated from self-reported height and weight using the following formula: BMI = weight[kg] / height[m]^2.

Lifestyle factors:

Smoking behaviour was assessed by asking current and past smoking habit (Plotnikoff, Hugo, & Cousineau, 2001). Physical activity was measured by a modified version of the *Godin Leisure-Time Exercise Questionnaire* (GLTQ; Plotnikoff et al., 2006). The GLTQ is widely used to assess physical activity and was assessed for its validity (Jacobs, Ainsworth, Hartman, & Leon, 1993; Miller, Freedson, & Kline, 1994) and reliability (Jacobs et al., 1993). The GLTQ assesses a frequency and duration (minutes) of each physical activity intensity (i.e., mild, moderate, and strenuous; Godin & Shephard, 1985; Courneya, Jones, Rhodes, & Blanchard, 2004). The total weekly minutes of moderate and strenuous physical activity were calculated (Plotnikoff et al., 2007). Mild intensity physical activity was excluded from data analysis, as mild intensity physical activity is not included in the Canadian Diabetes Physical Activity guidelines (Canadian Diabetes Association, 2008a).

Diet behaviour was assessed by the revised version of *Diabetes Self-Care Activities* (SDSCA) measure (Toobert, Hampson, & Glasgow, 2000). Participants were asked to indicate the number of days per week of following two general (i.e.,

following a healthy diet, following the eating plan), two specific (i.e., consuming recommended number of vegetable and fruits and eating high-fat foods), and one additional (i.e., spacing carbohydrates) diet behaviours. The mean score was calculated for general and specific diet scores, and z scores were used for the analysis as recommended by Toobert et al. (2000).

Outcome variables:

HRQL was assessed by a single-item question: "In general, compared to other persons your age, would you say your health is poor/ fair/ good/ very good/ excellent." This single-item measure of HRQL has been widely employed (Appels, Bosma, Grabauskas, Gostautas, & Sturmans, 1996; Idler & Benyamini, 1997; Molarius et al., 2007) and is especially recommended for population surveys (Manor, Matthews, & Power, 2001). This measure has been validated in various clinical populations, such as primary care patients (DeSalvo et al., 2006), cancer patients (de Boer et al., 2004), type 2 diabetics (Barofsky, Erickson, & Eberhardt, 2004), and with other HRQL measures (DeSalvo et al., 2006) including multiple-item HRQL measures (Barofsky et al., 2004). The response score of 1 (poor) to 5 (excellent) was calibrated into values ranging from 0 to 100 (Hays, Sherbourne, & Mazel, 1993).

Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985) was employed to measure LS. The SWLS items assess broad, rather than specific aspects of life (Courneya et al., 2000; Pavot, Diener, Colvin, & Sandvik, 1991). This scale has been validated in university students (Diener, et al., 1985)

and older adults (Pavot, et al., 1991) and has been administered in clinical studies to assess QoL (Courneya et al., 2000; Dijkers, 1999).

Data analysis

A multiple regression analysis was used to identify variables significantly associated with the dependent variables (i.e., HRQL and LS), and explained variances for the HRQL and LS models (Plotnikoff et al., 2006). Four models were tested for both HRQL and LS. The first regression model included personal variables (demographic variables and activity trait). The second model included medical variable (duration of diabetes, insulin usage, number of comorbidities, and BMI). The third model included lifestyle behaviours (smoking, physical activity, and diet behaviours). The fourth model included all the variables examined in models 1, 2 and 3. All analyses were performed by SPSS for Windows 15.0.

RESULTS

Univariate analyses between independent variables and HRQL/LS

Table 3-2 displays the result for univariate analyses between all independent variables and HRQL/LS. All variables examined except diabetes duration and gender were significantly associated with HRQL and LS.

Table 3-2 about here

Determinants of HRQL

Table 3-3 displays the results of multiple regression analyses for HRQL and LS. In model 1 (personal factors), older age (β=0.14, $p<0.01$), a higher

income (β=0.11, p<0.01), and higher activity trait scores (β=0.33, p<0.01) were significantly associated with a higher HRQL. This model explained 14.1% of the variance for HRQL. In model 2 (medical factors), using insulin (β=-0.14, p<0.01), higher number of comorbidities
(β=-0.21, p<0.01) and a higher BMI (β=-0.29, p<0.01) were associated with lower HRQL. This model accounted for 16.4% of the variance. In model 3 (lifestyle factors), being a non-smoker (β=-0.10, P<0.01), higher physical activity level (β=0.14, p<0.01), and a higher general healthy diet score (β=0.15, p<0.01) were positively associated with HRQL. The model explained 6.3% of the variance.

In model 4 (combined model), age (β=0.11, p<0.01), income (β=0.08, p<0.01), activity trait (β=0.25, p<0.01), insulin(β=-0.12, p<0.01), comorbidities (β=-0.21, p<0.01), BMI (β=-0.20, p<0.01), smoking status (β=-0.10, p<0.01), and physical activity level (β=0.10, p<0.01) remained significant. The combined model explained 27.1% of variance for HRQL.

Determinants of LS

In model 1 (personal factors), all the variables were significantly associated with LS. Older age (β=0.21, p<0.01), female gender (β=0.08, p<0.01), having a partner (β=0.08, p<0.01), having a college degree (β=0.07, p<0.01), a higher income (β=0.11, p<0.01), and higher activity trait scores (β=0.30, p<0.01) were positively associated with LS. This model explained 15.1% of variance for LS. In model 2 (medical factors), insulin use (β=-0.11, p<0.01), number of comorbidities (β=-0.08, p<0.01), and a higher BMI (β=-0.18, p<0.01) were associated with lower LS. This model explained 5.3% of variance for LS. In

model 3 (lifestyle factors), being a non-smoker (β=-0.10, p<0.01) and higher general diet scores (β=0.22, p<0.01) were associated with higher LS. This model explained 5.8% of variance for LS. In model 4 (combined model), age (β=0.17, p<0.01), gender (β=0.07, p<0.05), marital status (β=0.06, p<0.05), income (β=0.09, p<0.01), activity trait (β=0.25, p<0.01), insulin (β=-0.09, p<0.01), comorbidities (β=-0.09, p<0.01), BMI (β=-0.06, p<0.05), smoking (β=-0.07, p<0.05), and higher general diet score (β=0.10, p<0.05) remained significant. The model 4 explained 18.2% of variance for LS.

Table 3-3 about here

DISCUSSION

As we hypothesized, all variables examined in our study were significantly associated with HRQL in the univariate analyses; however, the direction of the relationship between age and HRQL was opposite to our hypothesis.

Age and HRQL/LS

A positive relationship was identified between advancing age and higher HRQL/LS before and after adjusting for other variables in the models. Although this positive relationship between age and LS is consistent with some studies (Mookherjee, 1992; Mercier, Peladeau, & Tempier, 1998), the finding for HRQL is inconsistent with most studies. Inverse relationships between age and HRQL have been reported in general (Lubetkin et al., 2005) and diabetes populations (Pan et al., 2006, Papadopoulos, Kontodimopoulos, Frydas, Ikonomakis, &

Niakas, 2007), with the exception of one study which identified that (despite decline in physical function), older age was not associated with health perception (i.e., HRQL; Mangione et al., 1993).

Several explanations are provided regarding the positive relationship between age and HRQL. First, the prevalence of depression may have confounded the positive relationship between age and HRQL. Presence of depression is associated with decreased HRQL in the T2D population (Maddigan, Feeny, Majumdar, Farris, & Johnson, 2006). The prevalence of depression is higher among middle-age compared to old-age diabetic populations (McVeigh, Mostashari, Thorpe, New York City Deptertment of Health and Mental Hygiene, & National Centers for Disease Control and Prevention, 2004; Zhao, Chen, Lin, & Sigal, 2006). In Alberta, the prevalence of affective disorder in the 20-49 yrs old, 50-64 yrs old, and 65-74 yrs old age groups were 140, 110, and 80 per 1000 people, respectively (Brown, Svenson, & Beck, 2007). Considering the mean age of our study sample (i.e., 63.7 years old), the prevalence of depression may have had an impact on our results.

Second, psychosocial factors may have influenced the relationship between age and HRQL. Social support is a predictor of HRQL in adults with T2D (Tang, Brown, Funnell, & Anderson, 2008; Karlsen, Idsoe, Hanestad, Murberg, & Bru, 2004) and specific determinants of QoL. For example, better social support including good relationships with health professionals was associated with better diabetes control (Rose, Fliege, Hildebrandt, Schirop, & Klapp, 2002), engagement in self-management behaviours (Maddigan, Majumdar,

&Johnson, 2005; Tang et al., 2008), use of problem-focused coping (Karlsen et al., 2004), and decreased risk of depression and anxiety disorders in adults with T2D (Thomas, Jones, Scarinci & Brantley, 2007).

Studies have indicated that social support and its impact on HRQL is influenced by age. Among adults with chronic diseases, young adults (18-44yrs) report lower social support compared to middle (45-64yrs) and old age (65yrs≤) groups (Sherbourne, Meredith, Rogers, & Ware, 1992). In a T2D sample, Maddigan et al. (2005) reported that age was positively associated with better scores in patient-provider relationship, and higher scores in the patient-provider relationship was associated with higher HRQL. Furthermore, a study which examined the interaction of age and social support regarding psychological status (i.e., depression and loneliness) found that younger adults were more influential to social support compared to older people (Segrin, 2003). Based on these study findings, having better social support, being less influential to social support or the combination of these two factors may explain the better HRQL level among the older individuals in our sample.

Third, the age-related HRQL we employed in this study, may have contributed to the positive relationship between age and HRQL. In our study we asked participants to rate their health compared to other people their age which may have accounted for this inconsistent finding.

Researchers have investigated over-adjustment of self-rated health. A study of 8,200 randomly chosen adults, which compared three measures of self-rated health (i.e., “How would you rate your general health status?/How do you

regard your health?/How would you assess your general health status compared to that of others of your own age?"), identified that older people tend to score higher in age-comparative self-rated health (i.e., the third option), and their tendency to overestimate their health increased according to age (Eriksson, Unden, & Elofsson, 2001). Similarly, Bhasin, Sarkisian, and Seeman (2006) examined a difference between self-rated health ("In general, how do you rate your health?") and age-comparative self-rated health ("As compared with others your own age, would you say your health is…?") in elderly people (70-79yrs). About 30% of the sample in Bhasin et al.'s study increased their age-comparative self-rated health level from their self-rated health level. Therefore, the relatively older-age sample in our study (mean age= 63.7, SD=11.4) may have contributed to the positive relationship between age and HRQL.

Interestingly, older adults with diabetes rate their HRQL better than their younger counterparts. A study reported that the odds ratio (OR) of perceived poor health among diabetics was significantly smaller in the older age group (60-74 yrs; OR=4.11) compared to younger age group (25-39 yrs; OR=16.10; Ho et al., 2007). It may also be that these older adults are more optimistic about their perception in 'surviving' and coping with the disease longer than younger adults with T2D.

This study tested a comprehensive model that consisted of variables from three categories [i.e., personal (demographic factors and personality), medical and lifestyle factors], with two different dimensions of QoL (HRQL and LS). To our knowledge, this is the first study that has tested a comprehensive model with

HRQL and LS in adults with T2D. In addition, we uniquely explored the potential effect of personality among other potential determinants of QoL. The following discussion focuses on significant factors which demonstrated β coefficients larger than 0.10 in the combined model (i.e., Model 4) with outcome variables (i.e., HRQL and LS).

Our results regarding HRQL were similar to the findings of Glasgow et al. (1997). Glasgow and colleagues (1997) tested a HRQL model that consisted of demographic factors (i.e., age, gender, education, income, insurance type, living situation), medical factors (i.e., diabetes duration, insulin, number of comorbidities, complications, and hospitalization), and self-care behaviours (i.e., glucose monitoring, physical activity, and diet) in adults with diabetes. The full model explained from 17 to 29% of the variance for the three domains of HRQL, and self-care behaviours accounted for 2 to 5% of the variance. In our study, the full model and the lifestyle behaviour model (i.e., smoking, physical activity, and diet) explained 27% and 6% of the variances for HRQL, respectively.

In our model, medical factors explained more variance for HRQL compared to LS. In a study of adults in general population, age, race, and BMI explained more variance for HRQL than LS (Grigg et al., 2006). In addition, diabetics with morbidity of medium to high severity demonstrated a lower mean score for HRQL, but not for LS (Grigg et al., 2006). These findings indicate that medical factors (i.e., BMI and comorbitidies) have a smaller impact on LS than on HRQL.

Interestingly, lifestyle behaviours (i.e., smoking, physical activity and diet) explained the same amount of variance for both HRQL and LS. This result may indicate the strong relationship between T2D and lifestyle behaviours, as the onset and management of T2D is closely related to lifestyle behaviours (Wing et al., 2001). Studies have shown that changes in lifestyle behaviours are effective in both primary (Mayer-Davis & Costacou, 2001) and secondary prevention of T2D (Look AHEAD Research Group et al., 2007). For example, a 12-month lifestyle management intervention for obese adults with T2D improved glycemic control and reduced the use of prescribed medication (Wolf et al., 2004). Thus, these benefits of lifestyle may lead to equal importance of lifestyle factors on health-oriented (i.e., HRQL) and overall (i.e., LS) QoL.

Personality and HRQL/LS

This study identified independent relationships between activity trait with HRQL and LS. This finding is consistent with previous studies that identified significant relationships between domains of personality with HRQL (Jerant, Chapman, & Franks, 2008; Kempen, Jelicic & Ormel, 1997) and LS (Courneya et al., 2000). There are a number of potential reasons for the relationship between personality and QoL, which are discussed below.

Psychological factors (e.g., coping strategies and social support) are considered important factors for understanding QoL of adults with diabetes (Rubin & Peyrot, 1999). Studies have reported that coping strategies (Samuel-Hodge, Watkins, Rowell, & Hooten, 2008; Karlsen et al., 2004) and social support (Maddigan et al., 2006; Karlsen et al., 2004) are associated with QoL in

diabetes populations. In T2D sample, these two factors (i.e., coping style and social support) explained 24% of variance for general well-being (Karlsen et al., 2004).

The use of specific coping strategies was found to be associated with personality domains. Neuroticism was associated with the use of palliative (i.e., tendency to cope with symptom rather than problem; Endler, Kocovski, & Macrodimitris, 2001) and emotion-oriented coping styles which are considered less effective coping style in a study of T2D adults (Endler et al., 2001; Deary & Frier, 1996). In contrast, extraversion was associated with use of distraction (i.e., use of actions and thoughts to avoid being preoccupated with the problem; Endler et al., 2001; r=0.29) and instrumental (i.e., use of task-oriented strategies; Endler et al., 2001; r=0.25) coping styles (Deary & Frier, 1996). In addition, Rose and colleagues (1998) tested a structural linear model on diabetes patients and identified coping as one mediator of personality.

Furthermore, coping style is associated with other determinants of QoL. According to a meta-analysis of diabetes studies, the use of problem-focused coping style was associated with better adjustment to diabetes (i.e., less anxiety, depression); however, emotion-focused coping was associated with poor adjustment (Duangdao & Roesch, 2008). Positive coping style was also related to better glycemic control (Peyrot, McMurry, & Kruger, 1999). In summary, personality is associated with the use of specific coping style, and the use of specific coping style is further related to diverse determinants of QoL in diabetes

population. These pathways may explain the positive association between activity trait and QoL identified in this study.

One component of extraversion is sociability (Saucier & Ostendorf, 1999), and the higher level of activity trait, one subtrait of extraversion, may be associated with better social support. Studies have demonstrated that extraversion is associated with larger social network (Swickert, Rosentreter, Hittner, & Mushrush, 2002; Bolger & Eckenrode, 1991) and more frequent use of social support (Swickert et al., 2002). The relationship between personality (i.e., extraversion and neuroticism) and social support has been reported in a study of women with arthritis (Fyrand, Wichstrom, Moum, Glennas, & Kvien, 1997). In addition, Rose et al. (1998) found that social support mediated the relationship between personality and QoL in a sample of 116 adult with diabetes (i.e., 86 T1D and 30 T2D). Although these studies suggest the potential of activity trait influencing QoL through social support, as suggested by Diener, Oishi, and Lucas (2003), studies are needed to investigate the effect of personality traits on QoL.

Physical activity and HRQL/LS

Consistent with previous studies (Brown, 2003; Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007; Alfano et al., 2007; Blanchard, Courneya, Stein, & American Cancer Society's SCS-II, 2008; Glasgow et al., 1997; Jimenez-Garcia et al., 2008; Li, Ford, Mokdad, Jiles, &Giles, 2007), healthy behaviours (non-smoking, physical activity, diet behaviours) were associated with better QoL (HRQL and LS) in our study. Although smoking and diet behaviour were significantly associated with both HRQL and LS, physical activity was not related

to LS in our model. This lack of association between physical activity and LS is inconsistent with other studies. In the general population, physical activity has been reported to be positively associated with LS in cross-sectional (Elavsky & McAuley, 2005; Strine, Chapman, Balluz, Moriarty, & Mokdad, 2008) and intervention studies (McAuley et al., 2000, Schnohr, Kristensen, Prescott, & Scharling, 2005). A review of 12 studies of older adults also reported a positive relationship between physical activity and LS (Rejeski & Mihalko, 2001). Physical activity was also associated with LS patients with spinal cord injury (Lannem, Sorensen, Froslie, & Hjeltnes, 2009) and T1D (Zoppini, Carlini, & Muggeo, 2003). However, one study examining children with T1D reported that physical activity was significantly associated with HRQL (i.e., overall health rating) but not with LS (Edmunds, Roche, Stratton, Wallymahmed, & Glenn, 2007).

The inconsistent findings regarding the relationship between physical activity and LS in our study and other diabetes studies may reflect the unique, different effect of physical activity on diabetes people. Unlike other diseases, among diabetics taking insulin, physical activity has a potential to provoke serious adverse effects, such as hypoglycemia, which accounts for 2 to 4% of diabetes deaths (Brazeau, Rabasa-Lhoret, Strychar, & Mircescu, 2008; Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006; Cryer, 2004). In addition, medications other than anti-diabetic drugs (e.g., diuretics and beta-blockers) have potential to interfere with their exercise capacity of T2D patients (Sigal et al., 2006).

It is also possible that because the original study aimed to assess physical activity, participants may have focused on their physical health when rating their health. This may have contributed to the strong relationship between physical activity and HRQL reported in this study.

Medical factor and HRQL/LS

Insulin use, number of comorbidities, and BMI were significantly associated with both HRQL and LS after adjusting for demographic factors, personality, and lifestyle behaviours. The finding is consistent with previous studies that have examined determinants of HRQL in adults with T2D (Koopmanscgapet & CODE-2 Advisory Board, 2002; Lloyd, Sawyer, & Hopkinson, 2001; Maddigan et al., 2006). Although the strength of the relationships were attenuated in LS compared to HRQL, these factors (i.e., insulin, number of comorbidities, and BMI) remained significant in LS. These results support the importance of current diabetes practice on controlling comorbidites and their risk factors.

Future Research and practical implications

The study identified determinants of QoL in T2D adults which provide direction for future research on QoL and information to guide practice. Future studies are encouraged to examine causal mechanisms for the identified significant associations between determinants and QoL (HRQL and LS).

To our knowledge, this study is the first to test and identify personality (i.e., activity trait) as a strong independent determinant of HRQL and LS in T2D adults. Future studies are needed to understand the mechanisms by which

personality may influence HRQL and LS. A personality assessment may be a useful screening tool for practitioners to identify people who are at risk for poor QoL.

In our sample, age was positively associated with both HRQL and LS, indicating younger adults are at higher risk for poor QoL and may benefit from additional support. This issue requires further investigation. Finally, practitioners should promote lifestyle behaviours (i.e., healthy diets, smoking cessation, and physical activity promotion), to improve QoL in this population, although it is acknowledged that not all individuals may not perceive QoL benefits from promoting physical activity.

Study strengths

Several study strengths are identified. First, the study employed a large sample of diabetes adults which reflected the age and gender distribution of Canadian diabetic population (Health Canada, 2003). Second, to our knowledge this study is first to test a comprehensive model for two different QoL measures (i.e., HRQL and LS). Finally, our study was unique in exploring the association of personality on QoL in this population.

Limitations

This study also has a number of limitations. First, this study is a secondary analyses; therefore, some measures may not have been optimal to examine determinants of QoL (e.g., age-related HRQL measure and activity trait). Second, as this is a cross-section study, the results cannot determine causal relationships between identified determinants and the QoL. Third, the use of self-report

measures for some independent variables (e.g., BMI and number of comorbidities) may have biased our results. Finally, our model didn't include psychosocial factors which are established determinants of QoL (Rubin & Peyot, 1999).

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Table 3-1. Demographic characteristics

		N=1,147
Demographic factors		
age, mean (SD)		63.71 (11.40)
gender, n (%)		
	male	605 (52.7)
	female	542 (47.3)
marital status n (%)		
	no partner	251 (21.9)
	have partner	896 (78.1)
education n (%)		
	no university degree	747 (65.1)
	university degree	400 (34.9)
annual income, n (%)		
	<$20,000	157 (13.7)
	$20,000-39,999	330 (28.8)
	$40,000-59,999	293 (25.5)
	$60,000-79,999	172 (15.0)
	$80,000-99,999	89 (7.8)
	$100,000<	106 (9.2)
Medical factors		
diabetes duration, mean (SD)		11.18 (12.83)
number of comorbidities, n (%)		
	0	220 (19.2)
	1	329 (28.7)
	2	377 (32.9)
	3	147 (12.8)
	4	62 (5.4)
	5	12 (1.0)
BMI, mean (SD)		26.21 (4.48)
Lifestyle factors		
smoking, n (%)		
	nonsmoking	1066 (92.9)
	currently smoking	81 (7.1)
PA (minutes per week), mean (SD)		179.23 (134.90)
meeting CDA guideline (150min/week), n (%)		
	not meeting	355 (30.9)
	meeting	792 (69.1)

CDA: Canadian Diabetes Association

Table 3-2. Correlation coefficients between independent and dependent variables

	dependent variables	
independent variables	HRQL	LS
age	0.13†	0.18†
gender	-0.07†	-0.04
marital status	0.07†	0.11†
education	0.05*	0.08†
income	0.10†	0.10†
activity trait	0.35†	0.32†
duration	-0.05*	0.01
insulin	-0.19†	-0.12†
comorbities	-0.24†	-0.10†
BMI	-0.32†	-0.20†
smoking	-0.11†	-0.11†
physical activity	0.16†	0.07†
diet-general	0.19*	0.22†
diet-specific	0.15†	0.15†
diet-carbohydrate	0.11†	0.13†

*$p<0.05$, †$p<0.01$

Table 3-3. Results of multiple regression analyses for HRQL and LS

	Model 1 β (HRQL/LS)	**Model 2** β (HRQL/LS)	**Model 3** β (HRQL/LS)	**Model 4** β (HRQL/LS)
Personal factors				
age	.14†/.21†			.11†/.17†
gender	.03/.08†			.04/.07*
marital status	.02/.08†			.00/.06*
education	.03/.07†			.00/.05
income	.11†/.11†			.08†/.09†
activity trait	.33†/.30†			.25†/.25†
Medical factors				
duration		.00/.04		-.03/-.01
insulin		-.14†/-.11†		-.12†/-.09†
comorbities		-.21†/-.08†		-.21†/-.09†
BMI		-.29†/-.18†		-.20†/-.06*
Lifestyle factors				
smoking			-.10†/-.10†	-.10†/-.07*
physical activity			.14†/.04	.10†/.01
diet-general			.15†/.22†	.04/.10*
diet-specific			.05/.02	.02/.01
diet-spacing			-.02/-.03	-.02/.00
Adjusted R^2	0.14†/0.15†	0.16†/0.05†	0.06†/0.06†	0.27†/0.18†

*p<0.05, †p<0.01

Smoking was coded: non-smoker=0, current smoker=1

Chapter 4 - Study 2.

Identifying Differences in Determinants of Quality of Life Between Type 1 and Type 2 Diabetes Populations

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ABSTRACT

Background: Limited evidence exists on the determinants of quality of life (QoL) specific to adults with type 1 diabetes (T1D). Further, the literature appears to be silent regarding the examination of QoL determinants between T1D and type 2 diabetes (T2D) groups. Therefore, the objectives of this study were to examine: (1) determinants of QoL in adults with T1D; and, (2) the interaction effects of diabetes type (i.e., T1D/T2D) on significant determinants of QoL in the combined T1D and T2D group.

Methods: Adults aged 18 years and older with T1D (N=490) and T2D (N=1,147) completed a self-report survey. Determinants of health-related quality of life (HRQL) and life satisfaction (LS) in the T1D sample were identified by multiple regression analyses. Based on these results, along with the findings from a previous study on the determinants of QoL in T2D adults, interactions for the identified determinants with diabetes type

(i.e., T1D/T2D) were examined.

Results: In the T1D sample, higher activity (personality) trait score (β=0.28, $p<0.01$), fewer comorbidities (β=-0.27, $p<0.01$), lower body mass index (β=-0.12, $p<0.01$), being a non-smoker (β=-0.14, $p<0.01$), and higher physical activity level (β=0.16, $p<0.01$) were associated with better HRQL. Having a partner (β=0.11, $p<0.05$), holding a college degree (β=0.16, $p<0.01$), and high activity (personality) trait score (β=0.27, $p<0.01$) were significantly associated with better LS. There was a significant age×diabetes type interaction (β=0.05, $p<0.05$) for HRQL.

Conclusions: Health services should target medical and lifestyle factors to increase QoL of T1D adults. Health practitioners should also be aware that aging has different effects on QoL between T1D and T2D adults.

Keywords: Type1 and type 2 diabetes, quality of life

INTRODUCTION

More than 180 million people in the world have diabetes mellitus, and the number of diabetes patients is estimated to double by 2030 (World Health Organization, 2008). In the province of Alberta, Canada, the prevalence of diabetes among adults has nearly doubled within the past 10 years (Vermeulen et al., 2007). The increasing trend of diabetes prevalence in the population has been reported for both type 1 diabetes (T1D; Onkamo, Väänänen, Karvonen, & Tuomilehto, 1999; Patterson, Dahlquist, Soltesz, Green, & EURODIAB ACE Study Group, 2001) and type 2 diabetes (T2D) populations (Kaufman, 2002; Haines, Wan, Lynn, Barrett, & Shield**,** 2007; Young, Reading, Elias, & O'Neil, 2000).

T1D and T2D are both characterized by impaired glucose control; however, they have a very different aetiology (Alberti & Zimmet, 1998; Cnop et al., 2005; Loghmani, 2005). Less than 10% of all cases of diabetes are T1D (Loghmani, 2005); T1D is often diagnosed during childhood or early adolescence (Loghmani, 2005); and it is an autoimmune disease, and less related to obesity and unhealthy lifestyles (Loghmani, 2005). In contrast, T2D is prevalent after puberty (Loghmani, 2005). Obesity and sedentary lifestyle increases the risk for developing T2D (Manson, Skerrett, Greenland, & VanItallie, 2004), and many people have already developed complications at time of diagnosis (Spijkerman et al., 2003; Spijkerman et al., 2004).

Since most population-based diabetes surveys combine both diabetes types, few studies have examined the determinants of QoL in T1D individuals. Studies

of adolescents and young adults with T1D identified that female gender (Graue, Wentzel-Larsen, Hanestad, Batsvik, & Sovik, 2004; Hoey et al., 2001) and longer diabetes duration were associated with lower HRQL (Buresova, Veleminsky, & Veleminsky, 2008). Physical activity was associated with better HRQL in cross-sectional (Aman et al., 2009) and intervention studies (Wiesinger et al., 2001). In studies that used life satisfaction (LS) to assess overall evaluation of life, female gender was associated with lower LS in T1D adolescents (Graue et al., 2004; Faulkner, 2003).

There appears to be only three studies which have specifically examined QoL for T1D adults. In a study of 397 adults, female gender, lower income, longer diabetes duration, having diabetes complications, experiencing more than one episode of hypoglycemia, and low physical activity level were associated with poor HRQL (Lloyd & Orchard, 1999). Female gender, obesity, diabetes complication and comorbities were associated with lower HRQL in a study of 784 T1D adults (Coffey et al., 2002). A further study (N=170) found that marital status, social relationships, and comorbidities were associated with HRQL (Parkerson et al., 1993).

Furthermore, although aetiological differences between T1D and T2D populations have been established, differences in QoL and its determinants between the two diabetes types have not been thoroughly investigated. Jacobson, de Groot, and Samson (1994) compared HRQL scores between adults with T1D and T2D, and identified higher HRQL (i.e., less impact of diabetes, fewer diabetes related worries, and higher social functioning domain of SF-36) in T2D after

adjusting for demographic factors (i.e., age, marital status, and education), diabetes complications, and diabetes duration. In a study of adults with T1D (N=784) and T2D (N=1,257), the health utility score of T2D men who were diet-controlled, nonobese, and without complications was higher than that of T1D men who were nonobese, without complications but were not diet-controlled (Coffey et al., 2002). Another study compared levels of three QoL measures in adults (T1D N=236, T2D N=889) and found no differences in EQ-5D and QoL-DN scores between the two samples, but a higher SF-36 score in the T2D group was reported (Currie et al., 2006). Finally, in two studies on youth with diabetes, HRQL was lower with T2D individuals compared to the T1D group (Varni et al., 2003; Naughton et al., 2008).

In summary, studies examining the determinants of QoL are very limited on adults with T1D. Further, despite the aetiological differences between the two diabetes types, it appears limited research has specifically examined the determinants of QoL between T1D and T2D adults. Thus, we tested a comprehensive model which was employed in our previously study of T2D (Chapter 3) to examine: (1) determinants of QoL in adults with T1D; and, (2) the interaction effects of diabetes type (i.e., T1D/T2D) on significant determinants of QoL in the combined T1D and T2D group.

Due to the exploratory nature of the topic, no hypotheses were provided for all the variables examined in the multivariate models including interaction terms.

METHODS

Sample

This study is a secondary analysis of the *Alberta Longitudinal Exercise and Diabetes Research Advancement* (ALEXANDRA) study, a population-based study of physical activity determinants in diabetes adults in Alberta, Canada. The study procedures, response rates, and measures are explained elsewhere (Plotnikoff et al., 2006). In brief, the ALEXANDRA study was a longitudinal study that assessed factors related to physical activity in adults (18 yrs and older) with diabetes. Baseline assessment was completed by 2,319 individuals with diabetes, and 1,662 (510 T1D and 1,152 T2D) completed the 6-month assessment (Plotnikoff et al., 2006; Plotnikoff et al., 2007a). The data from the 6-month assessment were used for this study.

Table 4-1 presents the characteristics of the T1D group. The characteristics of the T2D group are presented in the previous chapter (Study 1).[1] The study sample reflected the Canadian diabetes population on age and gender characteristics (Health Canada, 2003).[2]

Table 4-1 about here

Measures

Self-report questionnaires were used to collect data on all study variables.

[1] We will include the T2D demographic information in the submitted manuscript.
[2] Need to contact Dr. Johnson for recent provincial data.

Personal factors:

Demographic factors (i.e., age, gender, marital status, education, and income) were assessed based on Statistics Canada 2001 census (Statistics Canada, 2001). Personality (i.e., activity trait) was measured by 5-item unipolar activity trait markers (i.e., unadventurous, rambunctious, competitive, unenergetic and active), and the mean scores of the five items were used. These trait markers were initially developed by Goldberg (1992) and then identified by Saucier and Ostendorf (1999) to measure activity trait. An 8-item (i.e., active, adventurous, rambunctious, daring, unenergetic, unadventurous, competitive, uncompetitive) version of our employed activity trait scale demonstrated a good ($\alpha = 0.78$) internal consistency with university students (Rhodes, Courneya, & Jones, 2004).

Medical factors:

Diabetes type, duration of diabetes, insulin use, presence of comorbidities (angina, heart attack, stroke, high blood cholesterol, and high blood pressure), and BMI were assessed (Plotnikoff, Brez, & Hotz, 2000; Plotnikoff, Lippke, Prodaniuk, Wild, & Barrett, 2007b), and a number of comorbidities was calculated (score range from 0 to 5).

Lifestyle factors:

Tobacco consumption was assessed by asking current smoking behaviour (Plotnikoff, Hugo, & Cousineau, 2001), and physical activity was measured by a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ; Plotnikoff et al., 2006). The GLTEQ is a validated measure widely used to assess physical activity (Jacobs, Ainsworth, Hartman, & Leon, 1993; Miller, Freedson,

& Kline, 1994). Since mild intensity activity is not included in the Canadian Diabetes Physical Activity guidelines (Canadian Diabetes Association, 2008), only total weekly minutes of moderate and strenuous physical activity were used (Plotnikoff et al., 2007a). Three diet behaviours (i.e., general and specific diet, and spacing carbohydrate) were assessed from the revised version of Diabetes Self-Care Activities measure (Toobert, Hampson, & Glasgow, 2000).

Outcome variables:

HRQL was assessed by a single-item, question: "In general, compared to other persons your age, would you say your health is poor/fair/good/very good/excellent." The response score of 1 (poor) to 5 (excellent) was calibrated into value of 0 (poor) to 100 (excellent; Hays, Sherbourne, & Mazel, 1993). Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985) was used to measure LS.

Data analysis

A multiple regression analysis was used to identify potential variables significantly associated with HRQL and LS in the T1D group (Plotnikoff et al., 2006; Tabachnich & Fidell, 1989). Variables which were significantly associated with HRQL and LS in either the T1D or T2D groups were included and further tested for interaction effects between the two diabetes type groups. Interaction variables were created by multiplying independent variables with diabetes type. To avoid collinearity among variables, residuals of the interaction variables were used for the analysis (Burrill, n.d.). All analyses were performed by SPSS for Windows 15.0.

RESULTS

Determinants of HRQL in type 1 diabetes sample (Study objective 1)

In Model 1 (personal factors), older age (β=-0.11, p<0.05), and higher activity (personality) trait scores (β=0.38, p<0.01) were significantly associated with a higher HRQL after controlling for other demographic factors. This model explained 17.4% of the variance for HRQL. In Model 2 (medical factors), a higher number of comorbidities (β=-0.31, p<0.01) and a higher BMI (β=-0.16, p<0.01) were negatively associated with HRQL. This model explained 15.5% of the variance for HRQL. In Model 3, being a non-smoker (β=-0.14, p<0.01), higher physical activity level (β=0.29, p<0.01) and more days of spacing carbohydrate (β=0.11, p<0.05) were positively associated with HRQL. The model explained 10.6% of the variance for HRQL.

In Model 4, activity (personality) trait (β=0.28, p<0.01), number of comorbities

(β=-0.27, p<0.01), higher BMI (β=-0.12, p<0.01), smoking (β=-0.14, p<0.01), and higher physical activity level (β=0.16, p<0.01) were significantly associated with HRQL. The full model explained 28.9% of the variance for HRQL. (See

Table 4-2.)

Determinants of LS in type 1 diabetes sample (Study objective 1)

In Model 1 (personal factors), having a partner (β=0.12, p<0.01), a higher income (β=0.16, p<0.01), and higher activity trait scores (β=0.30, 1<0.01) were significantly associated with LS. The model explained 13.2% of variance for LS. In Model 2, number of comorbities (β=-0.11, p<0.01) was negatively associated

with LS. This model explained 2.0% of the variance for LS. In model 3 (lifestyle behaviours) none of the variables were significantly associated with LS. The model explained 2.9% of variance for LS. In Model 4, marital status (β=0.14, $p<0.05$), income (β=0.16, $p<0.01$), and activity trait (β=0.27, $p<0.01$) remained significant. The combined model explained 14% of variance for LS. (See Table 4-2.)

Table 4-2 about here

Determinants of HRQL/LS in type 2 diabetes sample (Study1)

In the T2D sample, older age, higher income, higher score on activity (personality) trait, not using insulin, having fewer comorbidities, lower BMI, being a non-smoker, and higher physical activity level were significantly associated with better HRQL. Age, gender, marital status, income, activity trait, insulin, comorbidities, higher BMI, smoking, and higher general diet score were significantly associated with LS. (See Table 4-3 and Study 1.)

Interaction term with diabetes type (Study objective 2)

The results of multiple regression including interaction terms with diabetes types are displayed in Table 4-3. With HRQL, the interaction of age and diabetes type was significant (β=0.05, $p<0.05$). (See Figure 4-1.) There were no significant interactions in the analysis of LS. (See Table 4-3.)

Table 4-3 about here

DISCUSSION

This study identified determinants of HRQL and LS in adults with T1D, and examined interaction effects of diabetes type (i.e., T1D/T2D) on significant determinants of QoL. The results of this study add to the limited literature on the determinants of QoL in adults with T1D and on comparison studies of QoL between the two diabetes types.

The combined model explained 29% and 14% of the variance respectively for HRQL and LS in our T1D sample. The same model accounted for similar variances in a sample of T2D (N=1,147; see Chapter 3); explaining 27% and 18% of the variance respectively for HRQL and LS.

The variance for HRQL explained in our T1D sample is similar to the finding of Glasgow, Ruggiero, Eakin, Dryfoos, and Chobanian (1997) who tested a model that consisted of demographic factors (i.e., age, gender, education, income, insurance type, living situation), medical factors (i.e., diabetes duration, insulin, number of comorbidities, complications, and hospitalization), and self-care behaviours (i.e., glucose monitoring, physical activity, and diet) in a sample of T1D and T2D adults. Their model explained 17 to 29% of the variance for three domains of HRQL.

The variance explained by our model is less, compared to other studies that included psychosocial factors to explain QoL in diabetes populations. Maddigan Feeny, Majumdar, Farris, and Johnson (2006) tested a comprehensive model that included psychosocial factors in adults with T2D. Psychosocial factors (e.g., depression, stress, sense of belonging to the community, and perceived

healthcare needs) were significantly associated with HRQL, and the model explained 36% of the variance for HRQL. Rose, Fliege, Hildebrandt, Schirop, and Klapp (2002) examined coping style, diabetes-specific knowledge, doctor-patient relationship, personal characteristics, and illness on HRQL in adults with diabetes (224 T1D and 401 T2D). The model explained 62% of the variance for HRQL. Based on these studies, the inclusion of psychosocial factors has potential to increase our understanding of QoL. Furthermore, adding psychosocial factors may help identify relationships among psychological constructs and other factors (e.g., demographic factors, personality, medical factors, and lifestyle behaviours).

Our comprehensive model explained 14.0% of the variance for LS, while the demographic variables and personality explained 13.1% of the variance for LS. Previous research has also examined personality and demographic factors on LS. In a study of university students (N=184), personality explained 12% of the variance for LS; however, age and gender didn't increase the variance for this dependent measure (Extremera & Fernandez-Berrocal, 2005). Another study of adults identified income and having a partner accounting for 8.6% of the variance for LS, and personality increased the explained variance by 25.6% (Gannon & Ranzijn, 2005). Marital status and personality, respectively explained 15% and 29% of the variance for LS in post-operation colorectal cancer patients (Courneya et al., 2000). Although the explained variances differed by each study, personality appears to explain a significant proportion of the variance for LS.

Determinants of quality of life in T1D adults

Our result identified that in addition to activity (personality) trait, a host of factors were also associated with HRQL and LS in adults with T1D. While medical (i.e., number of comorbidities, and BMI) and lifestyle factors (i.e., smoking and physical activity) were significantly associated with HRQL, demographic factors (i.e., marital status and income) were significant in LS.

Demographic factors in T1D adults

Demographic factors (i.e., marital status and income) were significantly associated with LS after controlling for other variables. This finding is consistent with previous research on non-diabetes populations (Mookherjee, 1992; Melin, Fugl-Meyer, & Fugl-Meyer, 2003). Further, our T1D sample demonstrated a lower annual income compared to the median income levels of the Alberta data from the 2005 Canadian Census (Statistics Canada, 2009). Most T1D cases are diagnosed during childhood (Loghmani, 2005), and researchers have identified that pediatric diseases have negative effects on adulthood demographic factors (e.g., socioeconomic level, education, marital life; Boman & Bodegard, 2004; Ahlfield, Soler, & Marcus, 1985). A review of studies on child-onset T1D identified that these individuals have disadvantages in employment and are likely to have lower incomes in adulthood (Milton, Holland, & Whitehead, 2006). In addition, the study reported an under-achievement in children with earlier-onset and longer diabetes duration.

Demographic factors also affect other determinants of QoL. A study on 222 T1D individuals (8 to 17 yrs) found relationships between socioeconomic

status, glycemic control and quality of life (Hassan, Loar, Anderson, & Heptulla, 2006).

Personality in T1D adults

Consistent with the Study 1, personality (activity trait) was the strongest independent variable associated with HRQL and LS. Although there is limited information on personality and QoL in adults with T1D (Taylor, Frier, Gold, Deary, & Edinburgh Prospective Diabetes Study, 2003), the relationship between personality and QoL is supported by the studies that identified relationships between personality and specific determinants of QoL: glycemic control (Vollrath, Landolt, Gnehm, Laimbacher, & Sennhauser, 2007) and diabetes complications (i.e., depression and renal disease; Robinson, Stevens, Bush, & Fuller, 1989; Brickman, Yount, Blaney, Rothberg, & De-Nour, 1996).

Despite evidence on the relationships of personality with QoL, and determinants of QoL, the mechanisms are unknown (Diener, Oishi, & Lucas, 2003). Some studies have investigated psychosocial factors to understand the link between personality and QoL. Skinner, Hampson, and Fife-Schaw (2002) tested a structural equation model that consist of personality, personal belief, and diabetes self-care behaviours, and identified that personality affected the self-care behaviours through personal beliefs (e.g., perceived consequence and treatment effectiveness). Another study of 116 diabetics found that coping, mood, and social support mediated the effect of personality on QoL (Rose et al., 1998). Also, intervention studies on coping style have been reported to be effective on

improving glycemic control and quality of life (Grey et al., 1998**;** Grey, Boland, Davidson, Yu, & Tamborlane, 1999; Grey & Berry, 2004).

Our finding regarding the strong relationship between personality and QoL suggests the potential for using a personality assessment as a screening tool to identify people who are at risk for poor QoL.

Medical and lifestyle factors in T1D adults

Our results regarding the inverse associations between BMI and comorbidities with HRQL are consistent with a study of T1D adults (N=784; Coffey et al., 2001). The positive relationship between physical activity and HRQL in our study was also consistent with research on 397 adults with T1D (Lloyd & Orchard, 1999). Although we could not identify any study that examined a direct relationship between smoking and HRQL in adults with T1D, smoking was associated with poor glycemic control (Hofer et al., 2009) and renal complication (Scott et al., 2001), established determinants of HRQL among diabetics.

There was no significant association between medical factors and LS in our study. This finding supports the results of other studies on other populations which have identified that medical factors have less or no impact on LS. In a study on the general population, age, race, and BMI explained less variance for LS (less than 0.9%) than HRQL (14%; Grigg, Thommasen, Tildesley, & Michalos, 2006). Having heart disease was associated with lower HRQL but not with rating of overall life (Arnold et al., 2004).

Age×diabetes type interaction (Study Objective 2)

The study's second objective identified a significant interaction between age and diabetes type; the T2D group had stronger positive relationship between advancing age and HRQL compared to T1D group. This finding may be explained by clinical, psychosocial, and sample characteristic differences between the two groups.

Clinical differences

The finding of a stronger positive relationship between advancing age and HRQL in T2D may be associated with less hypoglycemia in older T2D adults. Hypoglycemia is a severe diabetes complication (Cryer, 2004), and a factor associated with poor HRQL (Davis et al., 2005). The frequency of hypoglycemic episodes was reported to be lower in T2D individuals (16.37 events/patient/year) compared to T1D individuals (42.89 events/patient/year; Donnelly et al., 2005). In addition, physiologic response to hypoglycemia was reported to be triggered at a higher glucose level in T2D compared to T1D, and that older people are less sensitive to hypoglycemia (Zammitt & Frier, 2005). Thus, the better physiological response to prevent hypoglycemia in T2D and lower sensitivity to hypoglycemia in elderly, may lead to better HRQL in older T2D individuals.

Psychosocial differences

There may also be psychosocial differences which could account for the age×diabetes type interaction. First, the prevalence of depression (a factor related to decreased HRQL) may have contributed to the positive relationship between age and HRQL. Depression is more pronounced in younger than older diabetes

age groups. In Alberta, the prevalence of affective disorder in 20-49 yrs old, 50-64 yrs old, and 65-74 yrs old age groups were 140, 110, and 80 per 1000 people, respectively (Brown, Svenson, & Beck, 2007). Considering the mean age of our T1D and T2D samples (i.e., T1D 51.5yrs and T2D 63.7yrs), the prevalence of depression in the younger sample may have had an impact on our results.

Social support differences between the two groups may have also accounted for this result. Studies have indicated that social support and its impact on HRQL is influenced by age. Among adults with chronic diseases, young adults (18-44yrs) report lower social support compared to old age (65yrs≤) groups (Sherbourne, Meredith, Rogers, & Ware, 1992). In a T2D sample, Maddigan, Majumdar, and Johnson (2005) reported that age was associated with better patient-provider relationship, and that better patient-provider relationship was associated with higher HRQL. Having better social support among the older group may explain the positive relationship between age and HRQL in our study.

In addition, studies suggest poor social support among T1D individuals. A study of T1D adults with a history of pediatric diseases reported that these adults demonstrated delay or failure to achieve social development (Stam, Hartman, Deurloo, Groothoff, & Grootenhuis, 2006). Also, among young adults, individuals with T1D showed poorer social support compared to a non-diabetic group (Lloyd, Robinson, Andrews, Elston, & Fuller, 1993). In our study, more than 30% of T1D sample were diagnosed with diabetes before the age of 18, which may have affected their social development and subsequent support.

Age differences in the T1D and T2D samples

The sample's age distribution for the two diabetes groups may have influenced the effect of age on HRQL. The mean ages of the two diabetes groups was significantly different ($t=-14.98$, $p<0.00$); the mean age of our T1D and T2D samples were 51.5 (SD=16.4) and 63.7 (SD=11.4) years old, respectively. Studies have shown that older diabetics perceive their health better than younger diabetics. For example, the relationship between poor self-rated health and diabetes was weaker in the study's older age group (60-74 yrs) compared to younger age group (25-39 yrs; Ho et al., 2007). The younger age and distribution of our T1D sample may have in part accounted for our
age×diabetes type interaction.

Implications

We identified factors that had significant relationships with QoL among diverse determinants of QoL. Future studies are encouraged to examine the causal mechanisms for the identified significant associations between: (1) the various determinants of QoL; (2) the determinants and QoL (HRQL and LS); and, (3) LS and HRQL.

Medical factors (comorbidities and BMI) and lifestyle behaviours (smoking and physical activity) were significantly associated with HRQL in the T1D group. Although we didn't identify any significant relationships with these factors with LS, health practitioners should be encouraged to achieve good glycemic and cardiovascular risk factor control, and promote lifestyle

interventions (e.g., smoking cessation and physical activity) among this population.

Demographic factors (i.e., marital status and income) were significantly associated with LS in the T1D group, and the median annual income of our T1D sample was lower than the median income of the Alberta population in 2005 (Statistics Canada, 2009). Previous studies have identified that diabetes, especially during earlier life, negatively affects socioeconomic status (Milton et al., 2006; Ahlfield et al., 1985; Ng, Jacobs, & Johnson, 2001). Our results imply that major health services targeting glycemic and cardiovascular risk factor control and lifestyle may not be sufficient to improve overall QoL of T1D adults. Additional support for the socioeconomically disadvantaged individuals living with this disease may be warranted. For example, discrimination at the workplace has been an issue among diabetics. Greene (1999) suggests the necessity of legal approaches (i.e., policy development, cooperative relationships among different disciplines, and agency regulation) to resolve such inequities. Monitoring the current status of these actions may be beneficial to promote QoL of adults with diabetes in Alberta.

An interaction between age and diabetes type was identified with HRQL. Health practitioners need to be aware that aging affects QoL differently in the T1D and T2D adults.

Study strengths

Several study strengths are identified. First, this study adds to the limited research on adults with T1D. Second, the study examined a large population

sample of diabetes adults. Third, our sample generally reflected the demographic characteristics of the Canadian diabetes population on age and gender characteristics (Health Canada, 2003). Fourth, this study employed two measures of QoL (i.e., HRQL and LS). Finally, our study investigated the association of personality in the diabetes population.

Limitations

This study also has some limitations. First, because this is a secondary study, some measures were not specifically designed to examine QoL (e.g., activity trait). Second, since this is a cross-sectional study, the results cannot imply causality amongst the significant relationships. Third, some variables (e.g., number of comorbidities) may have been biased due to the use of self-report measures. Fourth, the study may have benefited by investigating interactions among other factors than just diabetes type. Fifth, the study participants were recruited through Alberta Registry, and this may have resulted in more cases with T1D (30% of overall sample. Finally, our study didn't include psychosocial factors which are established determinants of QoL (Rubin & Peyot, 1999).

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Table 4-1. Demographic characteristics of type 1 diabetes sample

		N=490
Demographic factors		
age, mean (SD)		51.70 (16.42)
gender, n (%)		
	male	230 (46.9)
	female	260 (53.1)
marital status n (%)		
	no partner	125 (25.5)
	have partner	265 (74.5)
education n (%)		
	no university degree	276 (56.3)
	university degree	214 (43.7)
annual income, n (%)		
	<$20,000	50 (10.2)
	$20,000-39,999	112 (22.9)
	$40,000-59,999	105 (21.4)
	$60,000-79,999	109 (22.2)
	$80,000-99,999	43 (8.8)
	$100,000<	71 (14.5)
Medical factors		
diabetes duration, mean (SD)		21.57 (12.77)
number of comorbidities, n (%)		
	None	199 (40.6)
	One	138 (28.2)
	Two	85 (17.3)
	Three	44 (9.0)
	Four	20 (4.1)
	Five	4 (0.8)
BMI, mean (SD)		29.09 (5.69)
Lifestyle factors		
smoking, n(%)		
	Nonsmoking	457 (93.3)
	Currently smoking	33 (6.7)
PA (minutes per week), mean (SD)		184.37 (133.50)
meeting CDA guideline (150min/week), n (%)		
	not meeting	162 (33.1)
	meeting	328 (66.9)

Table 4-2. Results of multiple regression results for type 1 diabetes group

	Model 1 β (HRQL/LS)	Model 2 β (HRQL/LS)	Model 3 β (HRQL/LS)	Model 4 β (HRQL/LS)
Personal factors				
age	-.11*/.09			.02/.10
gender	.03/.08			-.01/.07
marital status	.06/.12†			.06/.11*
education	.08/.02			.02/-.01
income	.03/.16†			-.01/.16†
activity trait	.38†/.30†			.28†/.27†
Medical factors				
diabetes duration		-.07/.06		-.05/.03
insulin		-/-		-/-
comorbities		-.31†/-.11†		-.27†/-.09
BMI		-.16†/-.09		-.12†/-.03
Lifestyle factors				
smoking			-.14†/.07	-.14†/-.03
physical activity			.29†/.08	.16†/.00
diet-general			-.04/.06	-.07/.03
diet-specific			.03/.08	.02/.06
diet-spacing			.11*/.03	.09/.03
Adjusted R^2	0.17†/0.13†	0.15†/0.02†	0.11†/0.03†	0.29†/0.14†

*p<0.05, †p<0.01

Smoking was coded: non-smoker=0, current smoker=1

Table 4-3. Multiple regression results including interaction terms

Health-related quality of life

independent variable	β	Sig.
T1D/T2D	.09	.00†
age	.09	.01†
income	.06	.02*
activity trait	.26	.00†
number of comorbidities	-.24	.00†
BMI	-.19	.00†
smoking	-.11	.00†
physical activity	.13	.00†
T1D/T2D × age	.05	.04*
T1D/T2D × income	.03	.23
T1D/T2D × activity trait	-.02	.46
T1D/T2D × comorbidity	.03	.25
T1D/T2D × BMI	-.02	.40
T1D/T2D × smoking	.02	.31
T1D/T2D × physical activity	-.02	.29

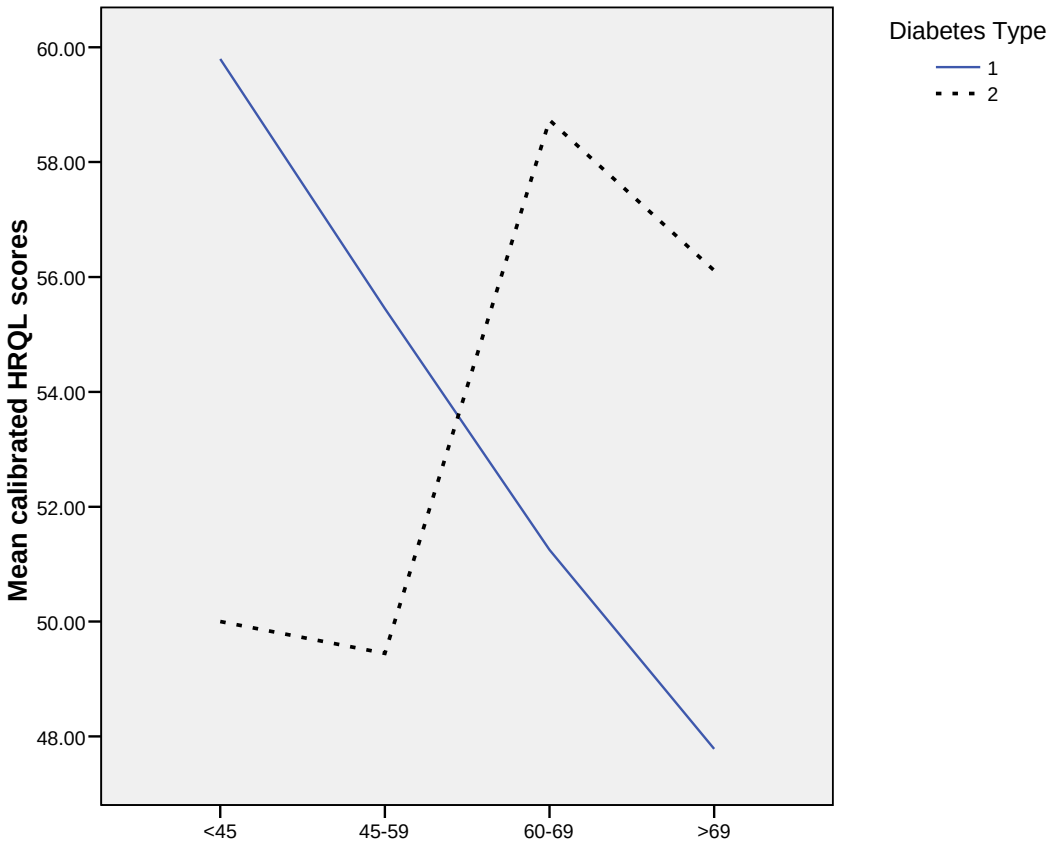
Life Satisfaction

independent variable	β	Sig.
T1D/T2D	.05	.06
age	.17	.00†
gender	.07	.00†
marital status	.07	.00†
income	.12	.00†
activity trait	.26	.00†
number of comorbidities	-.10	.00†
BMI	-.06	.02*
smoking	-.06	.01†
diet (general)	.10	.00†
T1D/T2D × age	.05	.08
T1D/T2D × gender	-.00	.88
T1D/T2D × marital status	-.03	.27
T1D/T2D × income	-.02	.43
T1D/T2D × activity trait	-.02	.71
T1D/T2D × comorbidity	-.03	.88
T1D/T2D × BMI	-.03	.58
T1D/T2D × smoking	-.02	.52
T1D/T2D × diet (general)	.01	.81

*p<0.05, †p<0.01

Smoking was coded: non-smoker=0, current smoker=1

Figure 4-1. Regression slopes of age predicting health-related quality of life (unadjusted)



Chapter 5- Conclusions

5.0 Overview of Chapter

This chapter summarizes the major findings and discussion of Study 1 and Study 2. Recommendations for future research and practice are provided.

5.1 Main results

Study 1

The objective of Study 1 was to test a comprehensive model (which includes personal, medical and lifestyle factors) to explain: (1) HRQL; and, (2) LS in the T2D population. The data of 1,147 adults with T2D were analyzed.

All independent variables (except gender and diabetes duration with LS) examined in the study were significantly associated with HRQL and LS in the univariate analyses.

In the multiple regression analyses, the full model explained 27.1% of the variance for HRQL. Older age, higher income, higher activity (personality) trait score, not using insulin, fewer comorbidities, lower BMI, being a non-smoker, and higher physical activity were significantly associated with better HRQL.

The full model explained 18% of the variance for LS. Older age, female gender, having a partner, higher income, higher activity (personality) trait score, not using insulin, fewer comorbidities, lower BMI, being a non-smoker, and higher scores in general healthy diet were significantly associated with lower LS.

Our findings on the relationships between insulin use, number of comorbidities, BMI, smoking, physical activity, and HRQL are consistent with

previous studies (Brown et al., 2004; Nicolucci et al., 2009; Pan et al., 2006; Brown et al., 2003; Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007; Alfano et al., 2007; Blanchard, Courneya, Stein, & American Cancer Society's SCS-II, 2008; Glasgow, Ruggiero, Eakin, Dryfoos, & Chobanian, 1997; Jimenez-Garcia et al., 2008; Li, Ford, Mokdad, Jiles, & Giles, 2007). To our knowledge, this study is the first to identify determinants of LS among adults with T2D.

Three major findings of this study revealed: (1) a positive relationship between age and HRQL; (2) personality (i.e., activity trait) was the strongest determinant for both HRQL and LS; and, (3) no significant relationship between physical activity and LS was reported.

Advancing age demonstrated a positive relationship with HRQL and LS after adjusting for other variables (i.e., demographic factors, personality, medical factors, and lifestyle behaviours). Although some studies have reported positive relationships between age and LS (Mookherjee, 1992; Mercier, Peladeau, & Tempier, 1998), to our knowledge, no study has reported a positive association between age and HRQL. The potential reasons for the positive relationship between age and HRQL included: (1) the prevalence of other determinants of quality of life (QoL; e.g., depression); (2) social support; and, (3) the characteristics of an age-related HRQL measure.

Personality and HRQL/LS

Among demographic, medical, and lifestyle factors, personality (activity trait) was the strongest independent variable associated with both HRQL and LS. In studies of diabetics, personality has been found to be associated with QoL

(Taylor, Frier, Gold, Deary, & Edinburgh Prospective Diabetes Study, 2003) and specific determinants of QoL (i.e., glycemic control and diabetes complication; Vollrath, Landolt, Gnehm, Laimbacher, & Sennhauser, 2007; Robinson, Stevens, Bush, & Fuller, 1989; Brickman, Yount, Blaney, Rothberg, & De-Nour, 1996).

Although researchers have identified personality as a determinant of QoL, it is not entirely clear how personality affects QoL (Diener, Oishi, & Lucas, 2003). Some research suggests that personality, like human genes, directly affects QoL; others support the idea of indirect pathways through affecting people's cognition and reaction to their environment or situation (Diener et al., 2003). In diabetes studies, psychosocial factors (e.g., coping and mood) have been identified to mediate the relationship between personality and QoL (Rose et al., 1998). However, further study is needed in this area.

Physical activity and LS

Physical activity was the only lifestyle variable that was not significantly associated with both HRQL and LS among three lifestyle behaviours (i.e., smoking, physical activity, and diet). The non-significant relationship between physical activity and LS is inconsistent to previous studies that identified a positive relationship between physical activity and LS in general and other clinical adults populations (Elavsky & McAuley, 2005; Strine, Chapman, Balluz, Moriarty, & Mokdad, 2008; McAuley et al., 2000; Schnohr, Kristensen, Prescott, & Scharling, 2005; Rejeski & Mihalko, 2001; Lannem, Sorensen, Froslie, & Hjeltnes, 2009). Although these studies found positive relationships between physical activity and LS, this relationship has been inconsistent in studies of type

1 diabetes (T1D) children and adolescents (Zoppini, Carlini, & Muggeo, 2003; Edmunds, Roche, Stratton, Wallymahmed, & Glenn, 2007).

Unlike other diseases, physical activity has a potential to provoke serious adverse effects (e.g., hypoglycemia; Brazeau, Rabasa-Lhoret, Strychar, & Mircescu, 2008; Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006). In addition, medications other than anti-diabetic drugs (e.g., diuretics and beta-blockers) have potential to interfere with their exercise capacity of T2D patients (Sigal et al., 2006). Both of the above reasons may additionally explain the non-significant relationship between physical activity and LS in our sample.

Study 2

The first objective of Study 2 was to test a comprehensive model to explain: (a) HRQL; and, (b) LS, in the T1D population. The same factors as Study 1 (i.e., personal, medical, and lifestyle factors) were examined with 490 adults with T1D.

The medical factors (i.e., number of comorbidities and BMI) and lifestyle factors (i.e., smoking and physical activity) were significantly associated with HRQL. In contrast, the demographic factors (i.e., marital status and income) were significantly associated with LS. The significant medical and lifestyle factors associated with HRQL were consistent with previous studies of adults with T1D (Coffey et al., 2001; Lloyd & Orchard, 1999). Further, to our knowledge, this study is first to identify determinants of LS in adults with T1D.

Marital status and income were significantly associated with LS, and our T1D sample demonstrated lower income levels compared to the median income of Alberta residents in 2005 (Statistics Canada, 2009). Previous studies of individuals with T1D have found that diabetes negatively affects their employment and education opportunities (Milton, Holland, & Whitehead, 2006). Since employment is generally related to income, the positive relationship between income and LS may have originated from poor employment status among Albertan adults with T1D.

The second objective of Study 2 was to examine the interaction effects of diabetes type (i.e., T1D/T2D) with significant determinants of QoL. Using the results of Study 2-Objective 1 (i.e., T1D N=490) and Study 1 (i.e., T2D N=1,147), interaction terms were tested for diabetes type and all factors that were significantly associated with HRQL or LS, controlling for all the other variables in the comprehensive model.

An interaction between age and type of diabetes was significantly associated with HRQL. The result suggests that the T2D group had stronger positive relationship between advancing age and HRQL compared to T1D group. No interaction term was significant in LS. Reasons for the different effects of age in T1D and T2D were discussed in relation to the following factors: hypoglycemia and age distribution of our study sample.

5.2 Strengths of the studies

The research has a number of methodological strengths. The study employed a large, population-based sample to examine our study objectives. In addition, our sample reflected the age and gender characteristics of the Canadian diabetes population (Health Canada, 2003). The study examined a large sample of adults with T1D; limited QoL information exists on adults with T1D. Finally, the examination of both diabetes types is a further strength as most population surveys neither differentiate diabetes types nor separately examine both diabetes groups in one study. Consequently, very few studies are able to compare T1D and T2D groups.

Further, we tested a comprehensive model that consisted of personal (demographic factors and personality), medical, and lifestyle factors. This approach allowed us to identify independent determinants of QoL across diverse factors. Furthermore, the study was especially unique in identifying the role of activity trait (personality) among other variables.

Another strength of the study was the use of two QoL measures (i.e., 1-item HRQL measure and SWLS). Only a few diabetes-related studies have employed more than one measure of QoL in their study investigations (Jacobson, de Groot, & Samson, 1994; Currie et al., 2006). In addition, most of these studies compared two different measures that assess HRQL; therefore, our study is unique in comparing HRQL and LS. The result adds to the limited information on the differences between HRQL and LS.

5.3 Limitations of the research

Several limitations were identified in both studies. First, as mentioned in previous sections, these are cross-sectional studies. The significant relationships do not imply causality. Second, some variables (e.g., number of comorbidities) may have been biased due to the use of self-report measures. Third, this study is a secondary analyses; therefore, some measures may not have been optimal for QoL research (e.g., age-related HRQL measure and activity trait). Finally, our model didn't include psychosocial factors which are established determinants of QoL (Rubin & Peyot, 1999).

5.4 Recommendations for future research and practice

This study identified significant relationships between diverse factors and QoL. Future studies are needed to specify mechanisms (e.g., causal relationships) among the identified determinants and QoL. This study was a secondary analysis of a study focusing on physical activity, and some measures were not optimal for the aim of studying QoL (e.g., activity trait and HRQL measure). Future studies may benefit from assessing the Big-Five factor personality categorizes for personality, or employing both generic and diabetes-specific QoL measures. Despite the need for further studies, our findings are useful to identify subgroups who are at risk for impaired QoL.

Personality and quality of life

Activity trait (personality) was the strongest determinant of QoL across demographic, medical, and lifestyle factors in both T1D and T2D samples. To

enhance our understanding of personality, further study is needed to understand the relationship between personality and QoL.

First, studies are needed to identify which personality trait and/or subtrait is associated with QoL (Diener et al., 2003). The Big-Five factor personality categorizes people into five personality traits: extroversion, agreeableness, conscientiousness, neuroticism, and openness (Goldberg, 1992). Each trait is further divided into subtraits (e.g., activity and sociability) which describe specific characteristics of the person. Investigating traits and subtraits will allow us to capture the specific personal characteristics related to QoL and its determinants. This information will also facilitate our understanding of the mechanisms on how personality affects QoL.

Second, studies on the stability of personality are needed. Diener and colleagues (2003) reviewed studies on personality and subjective well-being (one concept of QoL), and discussed whether personality is changeable. This information is especially important in developing interventions around personality. Although our research (Study 1 and Study 2) and previous studies have identified personality as a determinant of QoL, it may not be a target if it is not changeable. Thus, for the effective application of personality, it is important to investigate the stability of personality.

Third, relationships between personality and psychosocial factors need further investigation. Cross-sectional studies have identified that specific domains of personality (e.g., neuroticism and extraversion) are associated with psychosocial factors (e.g., coping style, and depression; Deary & Frier, 1996;

Miyaoka, Miyaoka, Motomiya, Kitamura, & Asai, 1997). Interventions on these psychosocial factors (i.e., coping style, social support) have been successful for improving glycemic control and quality of life (Grey et al., 1998**;** Grey, Boland, Davidson, Yu, & Tamborlane, 1999; Grey & Berry, 2004; Karlsen, Idsoe, Dirdal, Rokne Hanestad, & Bru, , 2004). However, few studies have examined personality, psychosocial factors, and diabetes outcomes (i.e., QoL and glycemic control) in one study. If we were able to specify relationships between the personality domain, psychosocial factors, and diabetes outcomes, it may facilitate the application of personality in interventions.

Despite the need for more studies on personality, a personality assessment may be a useful screening tool to identify people who are at risk for impaired QoL; such a personality assessment has potential for tailoring interventions.

Age and HRQL

Our study identified a positive relationship between age and HRQL in the T2D sample. Although the reasons for the positive relationship between age and HRQL are speculative, the poorer HRQL among young adults with T2D is a very important finding. Today, people are diagnosed with T2D at an earlier age (Koopman, Mainous, Diaz, & Geesey, 2005). In addition, a recent study on adolescents in Alberta identified that more than 40% have at least two risk factors for developing chronic disease (Plotnikoff et al., 2009). It is recommended that practitioners should be aware that young adults with T2D in Alberta are at-risk for poor HRQL, and should give attention to identify underlying reasons and effective strategies for improving their QoL.

Medical factors in adults with type 2 diabetes

Insulin use, number of comorbidities and BMI were important determinants of both HRQL and LS. Our findings support the current medical practice to control complications and risk factors. In addition, our results suggest that T2D patients using insulin are at risk for poor QoL and may require additional support.

Lifestyle behaviours in adults with type 2 diabetes

In the T2D group, physical activity was the only variable among the three lifestyle behaviours (i.e., smoking, physical activity, and diet) that was not significantly associated with both HRQL and LS. The unique difference of physical activity among other lifestyle behaviours may have resulted from hypoglycemia which can be induced by physical activity in diabetics. Practitioners are encouraged to implement lifestyle behaviours (e.g., smoking cessation, physical activity, and healthy eating) to improve QoL of T2D adults, although it is acknowledged that not all individuals may not perceive QoL benefits from physical activity.

Demographic factors and LS in adults with type 1 diabetes

Demographic factors (i.e., marital status and income) were significantly associated with LS in the T1D group, and the median annual income of our T1D sample was lower compared to the median income of the Alberta population in 2005 (Statistics Canada, 2009). Previous studies identified that diabetes (especially during earlier life) negatively affects socioeconomic status (Milton et al., 2006; Boman & Bodegard, 2004; Ahlfield, Soler, & Marcus, 1985; Ng, Jacobs,

& Johnson, 2001). Our result imply that major health services targeting glycemic and cardiovascular risk factor control and lifestyle may not be sufficient to improve overall QoL of the T1D adults. Additional support for the socioeconomically disadvantaged individuals living with this disease may be warranted. For example, discrimination at the workplace has been an issue among diabetics. Greene (1999) suggests the necessity of legal approaches (i.e., policy development, cooperative relationships among different disciplines, and agency regulation) to resolve such inequities. Monitoring the current status of these actions may be beneficial to improve QoL of adults with diabetes in Alberta.

Medical and lifestyle behaviours in adults with type 1 diabetes

In the T1D group, medical factors (comorbidities, and BMI) and lifestyle behaviours (smoking and physical activity) were significantly associated with better HRQL. Although we didn't identify any significant relationships with these factors with LS, health practitioners should be encouraged to achieve good glycemic and cardiovascular risk factor control, and promote lifestyle interventions (e.g., smoking cessation and physical activity) among this population.

Differences between type 1 and type 2 diabetes adults

Despite some similarities in the identified determinants of QoL between the T1D and T2D samples, a host of differences were identified, especially for LS. Recognition of the differences in the determinants of QoL between the two diabetes populations should facilitate achieving the optimal QoL of diabetes populations, and overcoming the challenges of this disease.

5.5 Conclusion

Because of the dramatic increase in the prevalence of diabetes, there is an urgent need to understand the challenges of this disease. Our study contributes to diabetes care by adding evidence on the determinants of QoL in the adult population living with this disease. The study identified several themes that require further investigation and subgroups of diabetes population who may benefit from additional support.

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Appendix I

The purpose of this Appendix is to provide further information about: (1) the methods used in the two studies; and, (2) data analyses.

I.1 Study Procedure and Subjects

This study is a secondary analysis of data collected from the *Alberta Longitudinal Exercise and Diabetes Research Advancement* (ALEXANDRA) study. The ALEXANDRA study was a population-based, longitudinal study which aimed to understand the social-cognitive determinants of physical activity in the type 1 (T1D) and type 2 (T2D) populations. The study's baseline commenced in May 2002 and individuals were again assessed at six, and 18 months.

Study participants were adults (18 years and older) with diabetes living in the province of Alberta. The sample was recruited by two methods. The first recruitment strategy consisted of contacting individuals by mail. Members of the Canadian Diabetes Association registry living in the province of Alberta received a recruitment package consisting of the study questionnaire and consent form along with a newsletter published by the Canadian Diabetes Association, Alberta and NWT regions. Of all the adult members (aged 18 and older; N = 4,609) who were contacted 1,923 individuals (609 T1D, 1,307 T2D, 7 missing diabetes type) completed the phase 1 questionnaire (Plotnikoff et al., 2006). The response rate was 41.72%.

The second recruitment method was a random digit dialing (RDD) protocol developed by a university-based population research lab (Plotnikoff et al., 2006). 1,901 households were contacted and 300 individuals agreed to participate. Each contacted household was also asked to nominate a family member or a friend with diabetes who didn't live with them, an additional 301 participants were recruited. These people recruited by the telephone procedure (N = 601) received a postage-paid return questionnaire and consent form. No fewer than two reminder calls were made to non-responders 10 days after the mail-out (Plotnikoff et al., 2006). Since the study used multiple methods for recruitment, to avoid duplication, participants were asked to sign up only once.

In total 2,319 individuals (697 T1D and 1,614 T2D) completed the baseline assessment. Of the participants who completed the baseline assessment, 1,662 adults (510 T1D and 1,152 T2D) completed a 6-month follow-up questionnaire (Plotnikoff et al., 2006; Plotnikoff et al., 2007). Data from the baseline and 6-month assessments were used in this study.

I.2 Measures

The ALEXANDRA study used self-report questionnaires to collect data. Personal factors (i.e., demographic factors and personality), medical factors (i.e., type of diabetes, diabetes duration, diabetes medication and comorbidities), lifestyle behaviours (i.e., smoking, physical activity and diet), HRQL and LS were measured.

Demographic factors

Demographic factors were assessed based on Statistics Canada 2001 census (Statistics Canada, 2001). Age, gender, marital status, educational level and gross annual income were assessed (See Plotnikoff et al., 2006). Marital status and education were dichotomaized into (without partner = 0, with partner = 1) and (no university degree = 0, university degree = 1).

Personality

The activity trait (a subtrait of extroversion) was measured using five unipolar trait markers. The items asked participants to describe themselves by comparing with other persons of the same gender and age, and rating themselves on 5-point Likert scales from '1' (strongly disagree) to '5' (strongly agree) for each of the five personality trait markers (i.e., unadventurous, rambunctious, assertive, competitive, unenergetic, and active). These trait markers were initially developed by Goldberg (1992) and then identified by Saucier and Ostendorf (1999) to measure activity trait. Rhodes, Courneya and Jones (2004) reported a good ($\alpha = 0.78$) internal consistency of the 8-item (i.e., active, adventurous, rambunctious, daring, unenergetic, unadventurous, competitive, uncompetitive) version of our employed scale with university students.

Diabetes related variables

Diabetes type, duration of diabetes, and insulin use were assessed by self-report measures (Plotnikoff, Brez, & Hotz, 2000; Plotnikoff et al., 2007). Diabetes type was assessed by asking, "What type of diabetes have you been told you have?" Participants were asked to choose an answer from three choices: Type 1 or

juvenile or insulin dependent diabetes, Type 2 or mature onset or non-insulin dependent diabetes, and "I don't know"/ "not sure." Diabetes duration was assessed by asking, "At what age were you diagnosed with diabetes?" The age of diagnosis was subtracted from the participants' age. Diabetes medication was assessed by asking whether he or she is taking insulin or pills every day. Since insulin use was reported to be associated with low health-related quality of life (HRQL) in previous studies (Glasgow, Ruggiero, Eakin, Dryfoos, & Chobanian, 1997; Rubin & Peyrot, 1999), medication type was coded into dichotomous variables: non-insulin = 0 and insulin = 1.

Comorbidities

Presence of comorbidities was assessed by asking, "Has a doctor or nurse ever told you that you have the following: angina, heart attack, stroke, high blood cholesterol, and high blood pressure" with response options: "yes = 1" and "no = 0 (Plotnikoff et al., 2000). The number of diagnosed comorbidities was calculated.

Body Mass Index (BMI)

BMI was calculated from self-reported height and weight using the following formula: BMI = weight[kg] / height[m]^2.

Smoking

Smoking behaviour was assessed by asking current and past smoking habit (Plotnikoff, Hugo, & Cousineau, 2001). Participants were categorized into two groups: currently non-smoker = 0 and current smokers = 1.

Physical activity

Physical activity was assessed by a modified version of the *Godin Leisure-Time Exercise Questionnaire* (GLTQ; Plotnikoff et al., 2006). The GLTQ is widely used to assess physical activity and was assessed for its validity by various objective measures. GLTQ's correlations with maximum oxygen intake, accelerometry (Jacobs, Ainsworth, Hartman, & Leon, 1993) and motion sensors (Miller, Freedson, & Kline, 1994) were 0.56, 0.32, and 0.45 respectively. GLTQ's test-retest reliability has been reported to be 0.62 over one month period (Jacobs et al., 1993).

The GLTQ assesses a frequency and duration (minutes) of each physical activity intensity (i.e., mild, moderate, and strenuous; Godin & Shephard, 1985; Courneya, Jones, Rhodes, & Blanchard, 2004). The total weekly minutes of moderate and strenuous physical activity were calculated. Mild intensity physical activity was excluded from data analysis, as mild intensity physical activity is not included in the Canadian Diabetes Physical Activity guidelines (Canadian Diabetes Association, 2008). The responses were converted into weekly minutes of strenuous and moderate physical activity using the following formula: total weekly minutes of strenuous and moderate physical activity = weekly frequency for strenuous physical activity × duration of each strenuous physical activity (min) + weekly frequency for moderate physical activity × duration of each moderate physical activity (min).

Diet behaviour

Diet behaviour was assessed by the revised version of *Diabetes Self-Care Activities* (SDSCA) measure (Toobert, Hampson, & Glasgow, 2000). Participants were asked to indicate the number of days per week of following two general (i.e., following a healthy diet, following the eating plan), two specific (i.e., consuming recommended number of vegetable and fruits and eating high-fat foods) and one additional (i.e., spacing carbohydrates) diet behaviours. The mean score was calculated for general and specific diet scores. Z score was used for the analysis as recommended (Toobert et al., 2000).

Health related quality of life

HRQL was assessed by a single-item, question: "In general, compared to other persons your age, would you say your health is poor/ fair/ good/ very good/ excellent." This single-item measure of HRQL examining self-rated health has been widely employed (Molarius et al., 2007; Appels, Bosma, Grabauskas, Gostautas, & Sturmans, 1996; Idler & Benyamini, 1997) and is recommended especially for population surveys (Manor, Matthews, & Power, 2001). This measure has been validated in various clinical populations, such as primary care patients (DeSalvo et al., 2006), cancer patients (de Boar et al., 2004), type 2 diabetics (Barofsky, Erickson, & Eberhardt, 2004), and with other HRQL measures (DeSalvo et al., 2006) including multiple-item HRQL measures (Barofsky et al., 2004). The response score of 1 (poor) to 5 (excellent) was calibrated into scale of 0 (poor) to 100 (excellent; Hays, Sherbourne, & Mazel, 1993).

Life satisfaction

Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985) was employed to measure life satisfaction (LS). The SWLS items assess broad, rather than specific aspects of life (Courneya et al., 2000; Pavot, Diener, Colvin, & Sandvik, 1991). This scale has been validated in university students (Diener et al., 1985) and older adults (Pavot et al., 1991), and has been administered in clinical studies to assess LS (Dijkers, 1999; Courneya et al., 2000).

I.3 Data Screening

To avoid statistical errors, screening procedures were performed following the recommendations by Tabachnich and Fidell (2001, See Table I-1) except for the multivariate outliers.

Univariate descriptive analysis was performed for all the variables measured in the study. For nominal and ordinal variables (i.e., gender, marital status, education, income, activity trait, diabetes types, insulin use, comorbidities, smoking, diet behaviours, HRQL and LS) values outside scale ranges were checked for accuracy of data entry. No values outside the scoring range were identified (See Table I-2). Participants who indicated having T1D was confirmed with their self-report insulin use. Twelve cases that did not indicate insulin use were deleted from the analysis.

For continuous variables (i.e., age, BMI, and physical activity), mean, standard deviation and frequency distributions were examined. Outliers [values outside ±3.00 standard deviation (SD)] were checked for the accuracy of data

entry (Tabachnich & Fidell, 1989). Of the outliers, unrealistic values (e.g., age younger than 18 years old, older than 115 years old; Cornacchia, 2006) were not identified (See Table I-2).

Next, missing data were processed using the following steps. First, missing values were identified for each variable and the amount of missing data were quantified (See Table I-2). The cases missing scores for HRQL (5 cases) and all 5 items of LWSW (LS measure 8 cases) were deleted from the analysis. Income, activity trait, angina, heart attack, stroke, and high cholesterol were missing for higher than 5% of the cases. Second, the database was divided into two groups (i.e., missing data group and non-missing group). Variables missing for more than 5% of the cases (i.e., activity trait, angina, heart attack, stroke, and high cholesterol) were dummy coded into a missing (coded as 0) group. The other group (coded as 1) was labelled as a non-missing. These groups were compared on key independent variables (i.e., age, gender and diabetes type) and two dependent variables (i.e., HRQL and LS). Chi-tests were used for categorical (i.e., gender and diabetes type) and t-tests were used for continuous variables (i.e., age, HRQL and LS). The results are shown in Table I-3. There were significant differences between missing and non-missing groups for all variables. Therefore, two databases were created: (1) a database with all missing values imputed (Imputed database) and (2) non-imputed database (Original database). All analyses were performed separately for both databases as recommended by Tabachnich & Fidell (2001; See Table I-3).

In the Imputed database, missing values were imputed using three methods. Diabetes type was imputed using the Ng-Dasgupta-Johnson algorithm (Ng, Dasgupta, & Johnson, 2008). Categorical variables (i.e., education, income, insulin use, and comorbidities) were imputed by using the hotdeck approach (Cox & Cohen, 1985). The classes for the hotdeck approach were based on gender, diabetes type, and age (18-25, 26-35, 36-45, 46-60, 61-70, or 71-92 years old; Plotnikoff et al., 2006). Continuous variables (i.e., activity trait and diet behaviour) were imputed by mean substitution.

To minimize the impact of outliers, BMI was truncated into 3.29 SD value (Tabachnich & Fidell, 2001); physical activity (weekly minutes) was truncated into 630 minutes per week (Plotnikoff et al., 2007). Variables were also examined for skewness and kutosis. No transformation method was employed due to the large sample size (Tabachnick & Fidell, 2001; See Tables I-4-1 to I-4-4).

I.4 Data Analysis

Assumptions for multiple regression

A ratio of cases to independent variables were checked as suggested (Tabachnick & Fidell, 2001). The criteria were met in both T1D [490≥50+8×14 (the number of independent variables) =162] and T2D [1147≥50+8×14 (the number of independent variables) =162] groups.

Multicollinearity was checked by calculating correlation coefficients among independent variables. No correlation was above 0.70. Regression analyses were performed to assess normality, linerality and homoscedasticity.

Normal probability plot were used to assess normality. Scatterplots of predicted dependent variable and residual illustrated that the assumptions of linearity and homoscedasticity were met (Figure 1).

Several outliers were identified from the scatterplots. We further calculated Mahalanobis distance (multivariate outliers) for all cases. The percentages of cases outside the critical value of Mahalanobis distance were less than 7%. Considering the large sample size of this study, these cases were included in our analyses.

Assumptions for interaction analysis

Interaction variables are created by multiplying independent variables; therefore, the assumption of multicollinearity tends to be violated. To avoid collinearity among variables, interaction variables were created in three ways: (1) raw variables, (2) centered variables, and (3) residuals (Burrill, n.d.). These variables were entered into the multiple regression analysis and assessed for multicollinearity. The third option allowed to include all the variables in the regression model; thus, the residual variable was used for the analysis. Normality, linerality and homoscedasticity were assessed as mentioned in the previous section.

Comparing the multiple regression results between Imputed and Original databases

As described in the previous section, two databases (i.e., Imputed and Original database) were created. Table I-5 and I-6 show the result of multiple regression analysis of both databases. In HRQL, the independent variables that

were significantly associated with HRQL ($p<0.05$, $p<0.01$) were the same in both databases. The differences in beta coefficients were less than 0.05. In LS, the variables that were significant (at $p<0.01$ level) in the Imputed database were significant at $p<0.05$ or $p<0.01$ level in the Original database. The p-value of some variables (i.e., marital status, BMI and smoking in T2D sample; age, gender, and comorbidities in T1D sample) changed from not being significant to being significant (at $p=0.05$ level) in LS. The differences in beta coefficients were less than 0.05 except for income ($\Delta\beta=0.07$) and number of comorbidities ($\Delta\beta=0.06$) in T1D sample. Due to minimum differences between the two databases, the results of the Imputed database were used for the main reporting.

I. 5 References

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Table I-1. Checklist for screening data

1. Inspect univariate descriptive statistics for accuracy of input
    a. out-of-range values
    b. plausible means and standard deviations
    c. univariate outliers
2. Evaluate amount and distribution of missing data; deal with problem
3. Check pairwise plots for nonlinerality and heteroscedasticity
4. Identify and deal with nonnormal variables
    a. check skewness and kurtosis, probability plots
    b. transform variables (if desirable)
    c. check results of transformations
5. Identify and deal with multivariate outliers
    a. Variables causing multivariate outliers
    b. Description of multivariate outliers
6. Evaluate variables for multicollinearity and singularity

Table I-2. Description of scoring range, valid data and missing data for all variables

Variables	Scoring range		Valid	Missing data
	minimum	maximum	data	(%)*
Outcome variables				
HRQL	0 (poor)	100 (excellent)	1637	0
LS score	1	5	1629	8
Personal factors				
gender	1 (male)	2 (female)	1637	0
age	18	92	1637	0
marital status	0 (no partner)	1 (with partner)	1637	0
education	0 (no college degree)	1 (above college degree)	1632	5
annual income	1 (<$20,000)	6 ($100,000<)	1494	143 (8.7)
activity trait	1	5	1536	101 (6.2)
Medical factors				
diabetes type	1 (type1 diabetes)	2 (type2 diabetes)	1591	46
diabetes duration	0	81	1637	0
insulin treatment	0 (non-insulin)	1 (insulin)	1636	1
comorbidities	0	5		
angina	0 (no)	1 (yes)	1357	280 (17.1)
heart attack	0 (no)	1 (yes)	1348	289 (17.7)
stroke	0 (no)	1 (yes)	1328	309 (18.9)
high cholesterol	0 (no)	1 (yes)	1501	136 (8.3)
high blood pressure	0 (no)	1 (yes)	1559	78
BMI	14.45	72.59		
height(cm)	130	203	1637	0
weight(kg)	36	204	1637	0
Lifestyle factors				
currently smoking	0 (no)	1 (yes)	1637	0
physical activity	0	630	1637	0
Diet				
follow healthy diet	0	7	1636	1
follow eating plan	0	7	1605	32
fruits and vegetable	0	7	1634	3
high fat food	0	7	1636	1
space carbohydrate	0	7	1634	3

*Percentage are indicated if they are missing more than 5% of the total cases

Table I-3. Comparison analysis (T-test and Chi-test) of non-missing and missing groups

	non-missing	missing		
Total sample	Mean (SD) N= 1072	Mean (SD) N= 565	t (df)	p
HRQL score	56.3 (25.8)	51.8 (26.3)	-3.4 (1128)	0.00†
LS score	3.3 (0.8)	3.2 (0.9)	-3.0 (1635)	0.00†
age	58.2 (14.5)	63.7 (12.9)	7.8 (1635)	0.00†
	% (N)	% (N)	χ^2 (df)	p
gender female	46.6 (500)	53.5 (302)	6.6 (1)	0.01†
male	53.4 (572)	46.5 (263)		
diabetes type‡				
T1D	32.6 (349)	27.0 (140)		
T2D	67.4 (723)	73.0 (379)	4.9 (1)	0.03*
within T1D	Mean (SD) N= 349	Mean (SD) N= 140	t (df)	p
HRQL score	57.7 (26.3)	48.0 (27.0)	-3.6 (250)	0.00†
LS score	3.3 (0.84)	3.1 (0.9)	-2.7 (487)	0.01†
age	48.7 (15.7)	58.4 (16.2)	6.1 (487)	0.00†
	% (N)	% (N)	χ^2 (df)	p
gender female	54.2 (189)	50 (70)		
male	45.8 (160)	50 (70)	0.54 (1)	0.47
within T2D	Mean (SD) N= 723	Mean (SD) N= 379	t (df)	p
HRQL score	55.7 (25.5)	53.9 (25.6)	-1.1 (1100)	0.27
LS score	3.3 (0.9)	3.3 (0.9)	-1.2 (1100)	0.25
age	62.7 (11.4)	65.6 (10.8)	4.0 (1100)	0.00†
	% (N)	% (N)	χ^2 (df)	p
gender female	43.0 (311)	54.6 (207)	13.0 (1)	0.00†
male	57.0 (412)	45.4 (172)		

‡46 cases were missing diabetes type (i.e., 7 missing and 39 both type 1 and type 2 diabetes)
*p<0.05, †p<0.01

Table I-4-1. Descriptive analysis of the variables in type 1 diabetes sample (Imputed database)

variable	unit	skewness	kutosis	mean	SD
Outcome					
HRQL	0-100	-0.42	-0.65	54.81	26.93
LS	1-5	-0.31	-0.44	3.24	0.86
Personal factors					
age	year	-0.04	-0.79	51.50	16.42
income*	1-6	0.25	-0.92	3.40	1.54
activity trait	1-5	-0.30	0.53	3.27	0.62
Medical factors					
diabetes duration	year	0.56	0.09	21.57	12.77
comorbidities	0-5	0.99	0.28	1.10	1.20
BMI		1.03	1.61	26.21	4.48
Lifestyle factors					
PA	minutes	1.38	2.40	184.37	133.50
general diet	days/week	-1.33	1.74	5.53	1.50
specific diet	days/week	-0.98	0.94	5.13	1.45
spacing carbohydrate	days/week	-1.53	1.53	5.63	1.93
		category	%	category	%
gender		male	46.9	female	53.1
education		university degree −	56.3	university degree +	43.7
marital status		partner −	25.5	partner +	74.5
insulin use		insulin −	0.0	insulin +	100.0
smoking		smoking −	93.3	smoking +	6.7

*income: 1= <$20K, 2=$20k-39,999, 3=$40K-59,999, 4=$60K-79,999, 5=$80K-99,999, 6=100K<

Table I-4-2. Descriptive analysis of the variables in type 2 diabetes sample (Imputed database)

variable	unit	skewness	kutosis	mean	SD
Outcome					
HRQL	0-100	-0.34	-0.71	54.74	25.67
LS	1-5	-0.30	-0.41	3.31	0.85
Personal factors					
age	year	-0.36	-0.30	63.71	11.40
income*	1-6	0.57	-0.52	3.02	1.46
activity trait	1-5	-0.25	0.32	3.21	0.64
Medical factors					
diabetes duration	year	2.37	6.71	11.18	12.83
comorbidities	0-5	0.45	-0.17	1.60	1.15
BMI		0.85	1.13	29.09	5.69
Lifestyle factors					
physical activity	minutes	1.44	2.66	179.23	134.90
general diet	days/week	-1.33	1.65	5.29	1.66
specific diet	days/week	-0.81	0.43	5.28	1.35
spacing carbohydrate	days/week	-1.19	0.62	5.29	1.98
		category	%	category	%
gender		male	52.7	female	47.3
education		university degree −	65.1	university degree +	34.9
marital status		partner −	21.9	partner +	78.1
insulin use		insulin −	77.9	insulin +	22.1
smoking		smoking −	92.9	smoking +	7.1

*income: 1= <$20K, 2=$20k-39,999, 3=$40K-59,999, 4=$60K-79,999, 5=$80K-99,999, 6=100K<

Table I-4-3. Descriptive analysis of the variables in type 1 diabetes sample (Original database)

variables	cases	skewness	kutosis	mean	SD
Outcome					
HRQL	489	-0.42	-0.65	54.93	26.85
LS	489	-0.29	-0.47	3.25	0.86
Personal factors					
age	489	-0.04	-0.79	51.50	16.44
income*	444	0.25	-0.94	3.40	1.54
activity trait	465	-0.32	0.48	3.27	0.62
Medical factors					
diabetes duration	489	0.57	0.10	21.56	12.77
comorbidities	397	1.38	1.71	0.80	1.00
BMI	489	1.00	1.55	26.17	4.43
Lifestyle factors					
physical activity	489	1.38	2.40	184.41	133.63
general diet	479	-1.35	1.85	5.56	1.46
specific diet	489	-0.99	0.97	5.13	1.45
spacing carbohydrate	489	-1.54	1.56	5.63	1.93
		category	%	category	%
gender	489	male	47.0	female	53.0
education	488	university degree −	56.4	university degree +	43.6
marital status	489	Partner −	25.4	partner +	74.6
insulin	489	insulin −	0	insulin +	100.0
smoking	489	smoking −	93.3	smoking +	6.7

*income: 1= <$20K, 2=$20k-39,999, 3=$40K-59,999, 4=$60K-79,999, 5=$80K-99,999, 6=100K<

Table I-4-4. Descriptive analysis of the variables in type 2 diabetes sample (Original database)

variables	cases	skewness	kutosis	mean	SD
Outcome					
HRQL	1102	-0.37	-0.66	55.07	25.57
LS	1094	-0.32	-0.37	3.32	0.85
Personal factors					
age	1102	-0.36	-0.25	63.69	11.27
income*	1012	0.54	-0.54	3.05	1.45
activity trait	1031	-0.21	0.08	3.21	0.64
Medical factors					
diabetes duration	1102	2.42	6.95	11.07	12.86
comorbidities	831	0.68	0.32	1.33	1.07
BMI	1102	0.86	1.24	29.06	5.63
Lifestyle factors					
physical activity	1102	1.42	2.54	180.70	136.25
general diet	1081	-1.34	1.74	5.33	1.63
specific diet	1099	-0.80	0.39	5.29	1.34
spacing carbohydrate	1099	-1.19	0.65	5.31	1.97
		category	%	category	%
gender	1102	Male	53.0	female	47.0
education	1098	university degree −	65.3	university degree +	34.7
marital status	1102	partner −	21.4	partner +	78.6
insulin use	1101	insulin −	79.7	insulin +	20.3
smoking	1102	smoking −	93.1	smoking +	6.9

*income: 1= <$20K, 2=$20k-39,999, 3=$40K-59,999, 4=$60K-79,999, 5=$80K-99,999, 6=100K<

Table I-5. Comparison of the multiple regression results in type 1 diabetes sample (Imputed vs Original database)

Health-related quality of life

	Model 1 β (Imputed/Original)	**Model 2** β (Imputed/Original)	**Model 3** β (Imputed/Original)	**Model 4** β (Imputed/Original)
Personal factors				
age	-.11*/-.09*			.02/.04
gender	.03/.04			-.01/.01
marital status	.06/.03			.06/.06
education	.08/.07			.02/.04
income	.03./.07			-.01/.01
activity trait	.38†/.38†			.28†/.33†
Medical factors				
diabetes duration		-.07/-.08		-.05/-.07
insulin		-/-		-/-
comorbities		-.31†/-.27†		-.27†/-.23†
BMI		-.16†/-.16†		-.12†/-.11*
Lifestyle factors				
smoking			-.14†/-.13†	-.14†/-.14†
physical activity			.29†/.28†	.16†/.15†
diet-general			-.04/-.04	-.07/-.01
diet-specific			.03/.03	.02/.02
diet-spacing			.11*/.12*	.09/.04
Adjusted R^2	0.17†/0.17†	0.16†/0.12†	0.11†/0.10†	0.29†/0.30†

*p<0.05, †p<0.01

Table I-5. (cont'd) Comparison of the multiple regression results in type 1 diabetes (Imputed vs Original database)

Life satisfaction

	Model 1 β (Imputed/Original)	**Model 2** β (Imputed/Original)	**Model 3** β (Imputed/Original)	**Model 4** β (Imputed/Original)
Personal factors				
age	.09/.10*			.10/.12*
gender	.08/.09*			.07/.12*
marital status	.12†/.09*			.11*/.11*
education	.02/.01			-.01/-.02
income	. 16†/.20†			.16†/.23†
activity trait	.30†/.29†			.27†/.30†
Medical factors				
diabetes		.06/.08		.03/.03
duration				
insulin		-/-		-/-
comorbities		-.11*/-.09		-.09/-.03
BMI		-.09/-.05		-.03/.05
Lifestyle factors				
smoking			-.07/-.07	-.03/-.04
physical activity			.08/.09	.00/.00
diet-general			.06/.04	.03/.05
diet-specific			.08/.09	.06/.08
diet-spacing			.03/.03	.03/.07
Adjusted R^2	0.13†/0.13†	0.02†/0.01†	0.03†/0.03†	0.14†/0.19†

*p<0.05, †p<0.01

Table I-6. Comparison of the multiple regression results in type 2 diabetes sample (Imputed vs Original database)

Health-related quality of life

	Model 1 β (Imputed/Original)	**Model 2** β (Imputed/Original)	**Model 3** β (Imputed/Original)	**Model 4** β (Imputed/Original)
Personal factors				
age	.14†/.15†			.11†/.12†
gender	.03/.04			.04/-.02
marital status	.02/.01			.00/-.03
education	.03/.03			.00/-.01
income	.11†/.13†			-.08†/.11†
activity trait	.33†/.34†			.25†/.27†
Medical factors				
diabetes		.00/-.01		-.03/-.04
duration				
insulin		-.14†/-.14†		-.12†/-.11†
comorbities		-.21†/-.20†		-.21†/-.21†
BMI		-.29†/-.29†		-.20†/-.18†
Lifestyle factors				
smoking			-.10†/-.11†	-.10†/-.08*
physical activity			.14†/.14†	.10†/.07*
diet-general			.15†/.13*	.04/.04
diet-specific			.05/.05	.02/.04
diet-spacing			-.02/-.01	-.02/.03
Adjusted R^2	0.14†/0.15†	0.16†/0.17†	0.06†/0.06†	0.27†/0.28†

*p<0.05, †p<0.01

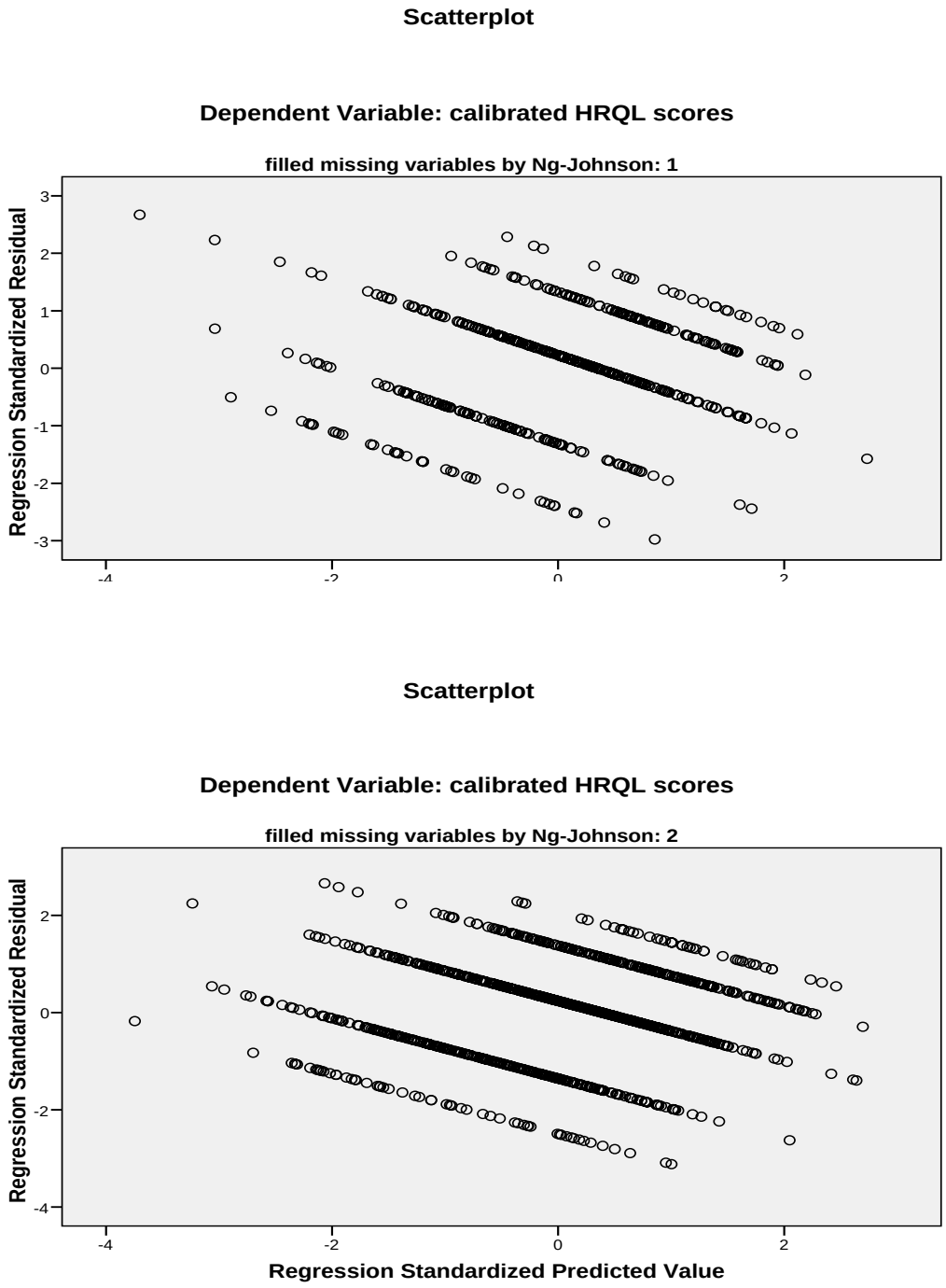
Table I-6. (cont'd) Comparison of the multiple regression results in type 2 diabetes sample (Imputed vs Original database)

Life satisfaction

	Model 1 β (Imputed/Original)	**Model 2** β (Imputed/Original)	**Model 3** β (Imputed/Original)	**Model 4** β (Imputed/Original)
Personal factors				
age	.21†/.22†			.17†/.19†
gender	.08†/.09†			.07*/.10†
marital status	.08†/.09†			.06*/.07
education	.07†/.07*			.05/.05
income	.11†/.13†			.09†/.12†
activity trait	.30†/.30†			.25†/.26†
Medical factors				
diabetes		.04/.05		-.01/.00
duration				
insulin		-.11†/-.11†		-.09†/-.07*
comorbities		-.08†/-.11†		-.09†/-.13†
BMI		-.18†/-.19†		-.06*/-.05
Lifestyle factors				
smoking			-.10†/-.09†	-.07*/-.06
physical activity			.04/.04	.01/-.02
diet-general			.22†/.26†	.10*/.15†
diet-specific			.02/.01	.01/-.04
diet-spacing			.03/-.03	.00/.05
Adjusted R^2	0.15†/0.17†	0.05†/0.06†	0.06†/0.07†	0.18†/0.21†

*p<0.05, †p<0.01

Figure I-1. **Scatter plot of the residuals from the regression analysis**



Appendix II: Questions related to this study (from the ALEXANDRA study questionnaire)

I. Personal factors

I-1. Demographic factors

1. Age ( ) years
2. Male ____ Female
3. Marital Status:

Never Married/ Married/ Common Law/ Widowed/ Separated or Divorced

4. Education:

Some Grade School/ Completed College/University/ Some High School/ Some Graduate School/ Completed High School/ Completed Graduate School/ Some University/College

5. Employment Status:

Homemaker/ Retired/ Full-Time Paid/ Temporarily Unemployed/ Part-Time Paid/ Volunteer

6. Gross Annual Family Income:

<$20,000/ $20,000-39,999/ $40,000-59,999/ $60,000-79,999/ $80,000-99,999/ Over $100,000

I-2. Personality

The following is a list of words used to describe people's personality. Describe yourself as you are in general or typically at the present time, not as you wish to be in the future, as compared with other persons you know of the same sex and roughly the same age.

1. Sociable

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

2. Unadventurous

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

3. Rambunctious

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

4. Assertive

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

5. Competitive

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

6. Optimistic

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

7. Unenergetic

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

8. Withdrawn

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

9. Active

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

II. Medical factors

II-1. Diabetes-related variables

1. At what age were you diagnosed with diabetes? ( ) years
2. What type of diabetes have you been told you have? (Please indicate one answer).
   - ■ Type 1 or juvenile or insulin dependent diabetes
   - ■ Type 2 or mature onset or non-insulin dependent diabetes
   - ■ I don't know/ not sure
3. The next questions ask about your prescribed medication habits. Please circle one response for each question. Non applicable=N/A
   1) Are you currently on diabetes medication? Yes/ No
   2) Are you taking diabetes insulin everyday for your diabetes now? Yes/ No
   3) Are you taking diabetes pills everyday for your diabetes now? Yes/ No

II-2. Comorbidities

We would like to know a little about you medical and health background.
Has a doctor or nurse ever told you that you have the following: (please check all that apply)

a. Angina Yes/ No
b. Heart attack Yes/ No
c. Stroke Yes/ No
d. High blood cholesterol Yes/ No
e. High blood pressure Yes/ No

II-3. BMI

1. Weight in pounds ( ) or in kilograms ( )
2. Height in feet/inches ( ) or meters/centimeters ( )

III. Lifestyle behaviours

III-1. Smoking

The next questions ask about your smoking habits (if applicable). Please circle one response for each question.

Do you currently smoke cigarettes?
Yes. How many cigarettes do you usually smoke per day?
No. Have you ever smoked cigarettes? Yes/ No

III-2. Physical activity

For this first question, we would like you to recall your average weekly participation in physical activity over the past month. How many times per week on average did you do the following kinds of physical activity during your free time over the past month?

When answering these questions please:
Consider your average over the past month.
Only count physical activity sessions that lasted 10 minutes or longer in duration.
Do not count physical activity that was done as part of your employment or household.
Note that the main difference between the three categories below is the intensity of the physical activity.

Please write the average amount of times per week in the first column and the average length of time in the second column.

Do this for all three categories below, Strenuous, Moderate, and Mild

A. Strenuous physical activity
(heart beats rapidly, sweating)
(e.g. running, jogging, hockey, soccer, squash, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling, vigorous aerobic dance classes, heavy weight training)

B. Moderate physical activity
(not exhausting, light perspiration)
(e.g. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, skiing, dancing)

C. Mild physical activity
(minimal effort, no perspiration)
(e.g. easy walking, archery, fishing, bowling, lawn bowling, shuffleboard, horseshoes, golf, snowmobiling)

III-3. Diet behaviour
The next questions ask about your eating habits over the past week. Please circle responses for each question (i.e. the number of days). Non applicable= N/A

1) Have you followed a healthy diet?
0 1 2 3 4 5 6 7
2) Did you eat five or more serving of vegetables and fruits?
0 1 2 3 4 5 6 7
3) Did you eat high fat foods such as processed meat or full-fat dairy products?
0 1 2 3 4 5 6 7
4) Did you space carbohydrates (e.g. bread, rice, potatoes) evenly through the day?
0 1 2 3 4 5 6 7
5) On average, over the past month, how many days per week have you followed your eating plan?
0 1 2 3 4 5 6 7

IV. HRQL

In general, compared to other persons your age, would you say your health is: poor/ fair/ good/ very good/ excellent

V. LS

The following five statements are very broad and require you to think about your life in general without reference to any particular area of your life. The questions ask about how you feel about your life right now. You may agree or disagree with each of the five statements by placing a number between 1 and 5 on the line beside each statement. Please be open and honest in your responding and use the following scale to guide your responses.

1. In most ways my life is close to my ideal

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

2. The conditions of my life are excellent

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

3. I am satisfied with my life

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

4. So far I have gotten the important things I want in life

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

5. If I could live my life over, I would change almost nothing

(Strongly disagree/ Disagree/ Neither agree or disagree/ Agree/ Strongly agree)

Appendix III: A copy of the ALEXANDRA study questionnaires

Appendix IV: The ethics approval of the ALEXANDRA study

Appendix V: The consent form used in the ALEXANDRA study

The next questions ask about your smoking habits (if applicable). Please circle one response for each question.

1. Do you <u>currently</u> smoke cigarettes?

   ☐ Yes → How many cigarettes do you usually smoke a day? _____

   ☐ No → Have you ever smoked cigarettes? Yes No

We would like to know a little about your medical and health background.

1. Has a close blood relative (e.g. a parent, brother, or sister) ever had heart disease (e.g. heart attack, stroke, and/or angina) before the age of 60?

   ☐ Yes ☐ No

2. Has a doctor or nurse ever told you that you have had the following: *(please check all that apply)*

   a. Angina ☐ Yes ☐ No

   b. Heart attack ☐ Yes ☐ No

   c. Stroke ☐ Yes ☐ No

   d. High blood cholesterol ☐ Yes ☐ No

   e. High blood pressure ☐ Yes ☐ No

3. At what age were you diagnosed with diabetes? _____years

4. What type of diabetes have you been told you have? (Please indicate one answer).

   ☐ Type 1 or juvenile or insulin dependent diabetes

   ☐ Type 2 or mature onset or non-insulin dependent diabetes

   ☐ I don't know / not sure

5. Are you taking insulin everyday for your diabetes now?

   ☐ Yes ☐ No

6. Are you taking diabetes pills everyday for your diabetes now?

☐ Yes ☐ No

7. Did you start taking insulin every day during the first year of learning you had diabetes?

☐ Yes ☐ No

8. Did you start taking diabetes pills every day during the first year of learning you had diabetes?

☐ Yes ☐ No

Section K

This final part of the questionnaire is needed to help understand the characteristics of the people participating in this study and is very important information. All information received is held in strict confidence and its presentation to the public will be group data only.

1. Age _____ (years)

2. Male _____ Female _____

3. Ethnic Origin: Canadian _____ European _____
   Arab _____ Aboriginal _____
   Asian _____ Latin, South American _____
   African _____ Other (please specify) _____

4. Marital Status: Never Married _____ Married _____
   Common Law _____ Widowed _____
   Separated or Divorced _____

5. Education:

Some Grade School	_____	Completed College / University	_____
Some High School	_____	Some Graduate School	_____
Completed High School	_____	Completed Graduate School	_____
Some University / College	_____		

6. Gross Annual Family Income:

<$20,000	_____
$20,000-39,999	_____
$40,000-59,999	_____
$60,000-79,999	_____
$80,000-99,999	_____
Over $100,000	_____

7. Employment Status:

Homemaker	_____	Retired	_____
Full-Time Paid	_____	Temporarily Unemployed	_____
Part-Time Paid	_____	Volunteer	_____

8. Height and Weight Information:

Weight in pounds _____ or in kilograms _____

Height in feet/inches _____ or meters/centimeters _____

Thank you for your participation today!
We will be mailing you another questionnaire in six months time.

Please remember to return one signed copy of the consent form with your completed questionnaire.

Section B

1. For this first question, we would like you to recall your average weekly participation in physical activity over the past month. How many times per week on average did you do the following kinds of physical activity during your free time over the past month?

   When answering these questions please:

   - Consider your average over the past month
   - Only count physical activity sessions that lasted 10 minutes or longer in duration.
   - Do not count physical activity that was done as part of your employment or household chores.
   - Note that the main difference between the three categories below is the intensity of the physical activity.
   - Please write the average amount of times per week in the first column and the average length of time in the second column.
   - Do this for all three categories below, Strenuous, Moderate, and Mild

	Times Per Week	Average Time Per Session (minutes)
A. Strenuous physical activity (heart beats rapidly, sweating) (e.g., running, jogging, hockey, soccer, squash, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling, vigorous aerobic dance classes, heavy weight training)		
B. Moderate physical activity (not exhausting, light perspiration) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, skiing,dancing)		
C. Mild physical activity (minimal effort, no perspiration) (e.g., easy walking, archery, fishing, bowling, lawn bowling, shuffleboard, horseshoes, golf, snowmobiling)		

2. Is the amount of activity you did in the past month less, more, or about the same as your usual physical activity habits?

I am now much less active	*I am now less active*	*I am now about the same*	*I am now more active*	*I am now much more active*
1	2	3	4	5

3. In the past month, was your participation in physical activities limited by a health condition, injury, or disability?

☐ No ☐ Yes If yes: How much did this limit you from getting physical activity?

Slightly	*A little*	*Somewhat*	*Quite a lot*	*Completely*
1	2	3	4	5

Check the type(s) of health conditions that affect your ability to participate in physical activity:

_____ Arthritis
_____ Knee problems
_____ Hip problems
_____ Heart condition
_____ Cancer
_____ Other, specify

4. During the past 6 months, have you spent more than one week confined to a bed or chair as a result of an injury, illness, or surgery?

☐ No ☐ Yes If yes, how many weeks in the last 6 months were you confined to a bed or chair? _____weeks

5. Do you have difficulty doing any of the following activities:

Getting in or out of a bed or a chair?	☐ No	☐ Yes
Walking across a small room without resting?	☐ No	☐ Yes
Walking for 10 minutes without resting?	☐ No	☐ Yes

6. In general, compared to other persons your age, would you say your health is:

Poor	*Fair*	*Good*	*Very Good*	*Excellent*
1	2	3	4	5

Section H

Please pay careful attention to the bold word at the beginning of each scale and circle the words that best tell how you feel about doing regular physical activity over the next 6 months. Please circle one answer for each of the following six questions.

For me regular physical activity over the next 6 months will be:

1.	Quite **enjoyable**	Slightly enjoyable	Neutral	Slightly unenjoyable	Quite **unenjoyable**
2.	Quite **useful**	Slightly useful	Neutral	Slightly useless	Quite **useless**
3.	Quite **wise**	Slightly wise	Neutral	Slightly foolish	Quite **foolish**
4.	Quite **interesting**	Slightly interesting	Neutral	Slightly boring	Quite **boring**
5.	Quite **relaxing**	Slightly relaxing	Neutral	Slightly stressful	Quite **stressful**
6.	Quite **beneficial**	Slightly beneficial	Neutral	Slightly harmful	Quite **harmful**

The following five statements are very broad and require you to think about your life in general without reference to any particular area of your life. The questions ask about how you feel about your life right now. You may agree or disagree with each of the five statements by placing a number between 1 and 5 on the line beside each statement. Please be open and honest in your responding and use the following scale to guide your responses.

		Strongly disagree	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**
7.	In most ways my life is close to my ideal.	1	2	3	4	5
8.	The conditions of my life are excellent.	1	2	3	4	5
9.	I am satisfied with my life.	1	2	3	4	5
10.	So far I have gotten the important things I want in life.	1	2	3	4	5
11.	If I could live my life over, I would change almost nothing	1	2	3	4	5

2. Please check the description that best describes your total physical activity behaviour that you get during your leisure time, household chores, and worktime. Regular physical activity equals doing physical activity at least 4 days a week, for 30 minutes each day, at a moderate intensity of a brisk walking pace (or faster).

I presently ***do not get*** regular physical activity and do not plan to do so in the next 6 months.

I presently ***do not get*** regular physical activity, but I have been thinking about doing so within the next 6 months.

I presently ***do not get*** regular physical activity, but I plan to in the next 30 days.

I presently ***get*** regular physical activity, but I have only begun doing so within the past 6 months.

I presently ***get*** regular physical activity and have been doing so for longer than 6 months.

The following is a list of words used to describe people's personality. Describe yourself as you are in general or typically at the present time, not as you wish to be in the future, as compared with other persons you know of the same sex and roughly the same age.

Please circle the number indicating how much you agree each trait accurately describes you, using the following rating scales:

		Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
3.	Sociable	1	2	3	4	5
4.	Unadventurous	1	2	3	4	5
5.	Rambunctious	1	2	3	4	5
6.	Assertive	1	2	3	4	5
7.	Competitive	1	2	3	4	5
8.	Optimistic	1	2	3	4	5
9.	Unenergetic	1	2	3	4	5
10.	Withdrawn	1	2	3	4	5
11.	Active	1	2	3	4	5

Section K

The next questions ask about other health behaviours. Please circle one response for each question.

		Yes, for more than 6 months	Yes, for less than 6 months	No, but I intend to within the next 30 days	No, but I intend to within the next 6 months	No, and I do not intend to within the next 6 months
1.	Do you normally choose to buy low-fat versions instead of high-fat versions of food?	1	2	3	4	5
2.	Do you normally cook your meals using techniques to reduce fat?	1	2	3	4	5
3.	Do you normally prepare your food at the table in ways that reduce fat?	1	2	3	4	5
4.	In general, do you consistently avoid eating high-fat foods?	1	2	3	4	5

The next questions ask about your eating habits over the past week. Please circle one response for each question (i.e., the number of days). Non applicable = N/A

On how many of the last seven days:

5.	Have you followed a healthy diet?	0	1	2	3	4	5	6	7	
6.	Did you eat five or more servings of vegetables and fruits?	0	1	2	3	4	5	6	7	
7.	Did you eat high fat foods such as processed meat or full-fat dairy products?	0	1	2	3	4	5	6	7	
8.	Did you space carbohydrates (e.g. bread, rice, potatoes) evenly through the day?	0	1	2	3	4	5	6	7	
9.	On average, over the past month, how many days per week have you followed your eating plan?	0	1	2	3	4	5	6	7	N/A

The next questions ask about your prescribed medication habits. Please circle one response for each question. Non applicable = N/A

10. Are you currently on diabetes medication? Yes No

11 On how many of the last seven days did you take your recommended diabetes medication? 0 1 2 3 4 5 6 7 N/A

12. Do you take aspirin each day?

Yes. How long have you been doing so: _____months OR _____years

No

13. Are you taking insulin everyday for your diabetes now?

Yes No

14. Are you taking diabetes pills everyday for your diabetes now?

Yes No

15. Weight Information: Weight in pounds _____ or in kilograms _____

The next questions ask about your smoking habits (if applicable). Please circle one response for each question.

16. Do you currently smoke cigarettes?

Yes → How many cigarettes do you usually smoke per day? _____

No → Have you ever smoked cigarettes? Yes No

Thank you for your participating in this important research. As a way of thanking you for completing this questionnaire, we would like to offer you a personal report of your physical activity results in comparison to others with diabetes. If you are interested in receiving this personal report, please check the box below and include your mailing address and it will be sent to you free of charge.

***Yes**, please send me a report of my own results and mail to:*

_____

_____

_____

Health Research Ethics Board

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HEALTH RESEARCH ETHICS APPROVAL

Date:	January 2005
Name of Applicant:	Dr. Ronald Plotnikoff
Organization:	Univeristy of Alberta
Department:	Centre for Health Promotion Studies & Physical Education and Recreation
Project Title:	**Exercise Behaviour of Community Adults with Type 1 and Type 2 Diabetes: The Determinants of Exercise Behaviour Change**

The Health Research Ethics Board (HREB) has reviewed the protocol for this project and found it to be acceptable within the limitations of human experimentation. The HREB has also reviewed and approved the subject information letter and consent form, if applicable.

The approval for the study as presented is valid for one year. It may be extended following completion of the yearly report form, which will be sent to you in your renewal month. Any proposed changes to the study must be submitted to the Health Research Ethics Board for approval. Written notification must be sent to the HREB when the project is complete or terminated.

Dr. Glenn Griener
Chair of the Health Research Ethics Board
(B: Health Research)

File number: B-010203-HPS

UNIVERSITY OF ALBERTA

CONSENT TO THE DISCLOSURE OF INDIVIDUAL IDENTIFYING HEALTH INFORMATION (AUTHORIZED BY SECTION 34 OF THE *Health Information Act*)

I, _____. authorize individual identifying diagnostic, treatment and care information of myself to be disclosed as part of a group summary by Alberta Health & Wellness, in accordance with section 34 of the *Health Information Act*, to Ron Plotnikoff, PhD for the following purpose:

> To examine the relationship between physical activity and nutrition behaviours with diagnostic, treatment and care information of groups of diabetes study participants. This information may help guide the development of effective programs and policies to improve the quality of life for people with diabetes.

All information received from Alberta Health & Wellness will be kept confidential and will be in a group summary organized by age and sex groups. At no time will individual participant information or records be released. Identification codes, not participants' names are used to organize and track information and data for this study; hence, there are no potential confidentiality risks to individuals who consent to provide this information. This consent will expire in 5 years time on the first day of December 2007, which is the same time that all corresponding diabetes study data will be destroyed by the Principal Investigator, Dr. Ron Plotnikoff.

I understand why I have been asked to disclose my individual identifying information, and am aware of the risks or benefits of consenting, or refusing to consent, to the disclosure of this information. I understand and consent that the results of the project may be published provided that I cannot be identified in any way from the materials published. I understand that I may withdraw this consent at any time and that this will not affect my participation in the diabetes study.

Dated this _____ of _____. _____
(day) (month) (year)

_____
Signature

_____ __ __ __ __ __ - __ __ __ __
Name (printed) Alberta Health Care Number:

_____ _____
Witness (*Canadian citizen over 18 years of age*) Witness Name (print)

☐ I prefer to <u>not consent</u> to providing my individual identifying health information.