PREVALENCE, RISK FACTORS AND IMPACT OF DIABETES AMONG THE WESTERN CANADIAN MÉTIS

BY

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PREVALENCE, RISK FACTORS AND IMPACT OF DIABETES

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ABSTRACT

Although the prevalence of diabetes among Aboriginal North American Indian populations has been described as "epidemic", the epidemiology of the disease among the Métis has not yet been investigated. The source of data for this research was the Aboriginal Peoples Survey (APS). Analysis was conducted on the self-identified Métis populations of Manitoba, Saskatchewan and Alberta. Comparison groups included APS self-identified North American Indians of the same three provinces and the general Canadian population. Univariate, bivariate and multivariate statistical analyses were performed to describe the data set and test relationships among variables. Multiple logistic regression was performed to test etiological hypotheses regarding the determinants of diabetes and other chronic health conditions.

The crude diabetes prevalence among the Métis (6.1%) is slightly less than that reported by North American Indians (7.3%) and twice the general Canadian rate (3.0%). The pattern of diabetes among the Métis of western Canada is similar to that established among other North American Aboriginal populations. Risk factors include age, sex, obesity, level of physical activity, and socioeconomic indicators. The negative impact of diabetes upon the lives of those afflicted was demonstrated in this research. Métis participants with diabetes were more likely than those without diabetes: (1) to report their health status as poor; (2) to report activity limitations, difficulties with mobility and the need for assistance in activities of daily living; and (3) to report significantly higher prevalence of hypertension, heart problems and sight impairment.

The results of this research represent the first detailed analysis of diabetes among the Métis of western Canada. The APS data set has been useful in establishing diabetes as a significant problem among the Métis and in providing evidence of the patterning of diabetes in the population. However, the APS was subject to limitations which impacted on the quality of the derived results. Primary research within Métis communities must be conducted to verify the general trends demonstrated through this research and to establish an accurate picture of the epidemiology of diabetes among the Métis.

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CHAPTER ONE

INTRODUCTION

It is well understood that population health and disease patterns are tied to social, economic and political forces in addition to genetic, environmental and lifestyle factors. The historical context out of which contemporary Aboriginal North Americans' health and disease patterns arose is particularly important because few groups have experienced the same types of prolonged external pressures as they have. Historically, sustained contact with Europeans brought economic disruption, increased violence, epidemics of new diseases and social disorganization. The combined effects of these factors operating over several hundred years served to reduce population size through increased mortality and changes in marriage and fertility patterns. The consequences of "contact" are still being realized today. Aboriginal North American groups are in a disadvantaged position vis-à-vis general American and Canadian populations in many areas, including health. Aboriginal populations in both Canada and the United States consistently demonstrate higher all-cause mortality rates and lower life expectancies at birth compared to their respective national populations (Rhoades et al., 1987; Young, 1994). Prior to the 1960's a major contributor to Aboriginal peoples' morbidity and mortality was infectious diseases. The disease pattern of Aboriginal people has now become more similar to that of their respective national populations. Although Aboriginal people remain at increased risk for infectious diseases relative to non-Aboriginal people, chronic diseases, such as cardiovascular disease, some cancers, and diabetes, have now also become major contributors to morbidity and mortality (Young, 1994).

Background of the Study

The word epidemic has been used to describe the prevalence of diabetes among contemporary Aboriginal North American populations. Diabetes among Aboriginal North Americans is almost exclusively type 2, formerly referred to as non-insulin-dependent diabetes mellitus [NIDDM], which is characterized by an insidious, often asymptomatic onset, ketosis resistance, a lack of islet cell antibodies, and initial high concentrations of insulin, with diagnosis occurring later in life than for type 1 diabetes (Knowler et al., 1983). Prior to 1940 the prevalence of diabetes among Aboriginal Americans was reportedly low. West (1974) reviewed several reports published prior to 1940 in which the rarity of diabetes is cited among Oklahoma Indians, Indians of the Southwest, Alaska Natives and northern Canadian Eskimo and Indians. Whereas the prevalence of diabetes among Aboriginal North Americans was probably universally low prior to 1940, the prevalence is now highly variable. In the United States, the Pima Indians of Arizona have the highest recorded prevalence of diabetes among all populations for which the disorder has been reported; approximately 50% of Pima Indians aged 35 years and older have been diagnosed with diabetes (Knowler et al., 1990). The lowest prevalence of diabetes is found among Alaska Natives. In fact, the overall prevalence of diabetes among all Alaska Native groups is lower than the United States "all race" rate. (Variation among Alaska Natives exists, with the prevalence lowest among Alaskan Eskimo and higher among Alaskan Aleuts and Indians). However, according to recent surveys, the incidence of diabetes among all Alaska Natives is increasing, leading researchers to claim that diabetes is no longer a rare disease among this group (Schraer et al., 1988; 1993).

The study of diabetes among Canadian Aboriginal groups has proceeded more slowly than among American Indians. As late as 1987, Morrison and Mao acknowledged that little was known about the epidemiology of diabetes among Canadian Aboriginal people (1987). Young et al. (1990) completed the first national survey of previously diagnosed diabetes among the registered Indian and Inuit population of Canada. Diabetes prevalence was lowest among the Inuit and Indians of the Northwest and Yukon Territories and British Columbia and highest among Indians in Atlantic Canada. The prevalence of diabetes among Canada's Aboriginal peoples was determined to be 2-5 times higher than the general Canadian population in all provinces except British Columbia and the Northwest and Yukon Territories. The epidemiology of diabetes among Canada's other official Aboriginal group, the Métis, has not yet been investigated.

Factors accounting for the rapid increase in diabetes incidence among some Aboriginal groups since 1940 and the contemporary wide variability in diabetes prevalence is the subject of great debate among clinicians and academics. Both genetic and environmental factors have been implicated. Much of the information that is known about the etiology of diabetes among Aboriginal North Americans has come from the Pima Indians of Arizona who have participated in a longitudinal study of the determinants and consequences of diabetes since 1965. While research among other Aboriginal groups is limited and less complete, risk factors identified among the Pima have been determined for other groups as well. Identified risk factors for diabetes include parental diabetes (having one or more parents with diabetes), admixture status (groups with the greatest proportion of Aboriginal ancestry are at greater risk for diabetes than groups with greater proportions of non-Aboriginal ancestry), obesity, diet and physical activity levels.

The seriousness of diabetes is reflected in the severe forms of vascular complications common to the disease including retinopathy, nephropathy resulting in end-stage renal disease, peripheral neuropathy and vascular diseases. By 1982 the rate of diabetes-related mortality among Aboriginal Americans and Alaska Natives was twice the United States "all-race" rate (Gohdes, 1986); for the period 1984-1986 this rate had increased to 2.5 times that of the United States "all-race" rate (Gohdes et al., 1993). Mao and associates (1986) examined mortality among Canadian reserve populations (excluding the provinces of Newfoundland, New Brunswick and British Columbia, and the Territories) for the years 1977-1982. The risk of death from diabetes for Aboriginal women and men was 4.1 and 2.2 times that of Canadian women and men, respectively. These statistics are alarming considering the reported rarity of diabetes only forty years earlier.

Métis

There is no simple answer to the question "Who are the Métis?". In one sense the Métis can be defined as a group of people who emerged through the unions of Aboriginal North Americans and the British and French, primarily in relation to the fur trade. Taken to the extreme, the term Métis can be used to refer to all individuals of mixed Aboriginal and European/Euro-Canadian ancestry. However, this strictly biological definition fails to capture the social and historical context out of which the Métis emerged, and as Peterson and Brown (1985:5) suggest, it

> "seems to confuse or muddle an historically based political and ethnic identity with the genetic attributes of individuals, regardless of their ethnic or cultural identities."

The Métis National Council (MNC) makes a distinction between 'métis' and 'Métis':

> "Written with a small 'm', métis is a racial term for anyone of mixed Indian and European ancestry. Written with a capital 'M', Métis is a sociocultural or political term for those originally of mixed ancestry who evolved into a distinct indigenous people during a certain historical period in a certain region in Canada" (MNC, 1984 cited in Peterson and Brown, 1985:6).
>
> More specifically, "the Métis people form 'a distinct indigenous nation with a history, culture and homeland in western Canada' consisting specifically of the descendants of those who were dispossessed by Canadian government actions from 1870 on." (Peterson and Brown,1985:6).

The health status of the Métis as a distinct Aboriginal group has not yet been investigated. As Aboriginal ancestry has been established as one of the major risk factors for diabetes, the Métis may be at increased risk compared to the non-Aboriginal Canadian population. At the present time nothing is known about the nature of this risk.

Aboriginal Peoples Survey

The source of data for this research was the Aboriginal Peoples Survey, a post-censal survey conducted by Statistics Canada in 1991. The Aboriginal Peoples Survey (APS) is the first survey conducted by Statistics Canada restricted to the Aboriginal populations of Canada. The purpose of the APS was to provide comprehensive data on the lives of Canada's Aboriginal peoples, specifically those individuals who claimed to identify with an Aboriginal group. The APS includes questions relating to employment, language, mobility, health, lifestyle and housing.

Analysis was conducted on the Métis populations of Manitoba, Saskatchewan and Alberta. Analysis was restricted to these three western provinces because the majority of the Métis population of Canada is concentrated in these provinces; close to seventy-five percent (75%) of individuals who self-identified as "Métis" on the APS reside in Manitoba, Saskatchewan and Alberta (Statistics Canada, 1993). Comparison groups included APS self-identified North American Indians living in Manitoba, Saskatchewan and Alberta and the non-Aboriginal Canadian population. Data for the non-Aboriginal Canadian population were derived from census reports, the 1991 General Social Survey and the 1994-95 National Population Health Survey.

Purpose of the Research

The purpose of this research was: (1) to determine the prevalence of diabetes, risk factors and complications among the Métis and North American Indians of Manitoba, Saskatchewan and Alberta; (2) to test hypotheses related to diabetes etiology among the selected Aboriginal study groups; (3) to evaluate the usefulness of the Aboriginal Peoples Survey data set for research on the health of Aboriginal Canadians.

Significance of the Research

As there has been no published research on the health and disease patterns of the Métis as a distinct Canadian Aboriginal population, this research will provide valuable baseline information on the epidemiology of diabetes among the Métis. Specifically, estimates of diabetes prevalence, risk factors and complications were generated which will add to our understanding of the burden and impact of diabetes among Aboriginal Canadians. Directions for future research were identified as a result of this work.

Research Questions

Epidemiology of Diabetes Mellitus

Descriptive data collected:

1. What is the self-reported prevalence of diabetes mellitus (DM) among self-identified Métis and North American Indians residing in Manitoba, Saskatchewan and Alberta and non-Aboriginal Canadians?

2. How is DM distributed among the selected study populations according to geographic regions, age-sex groups and socioeconomic classes?

Specific hypotheses tested:

3a. A variable was created combining age, ability to speak an Aboriginal language, and participation in traditional activities which served as an indicator of Aboriginal ancestry.

b. The prevalence of diabetes mellitus will be greatest among self-identified Aboriginal Canadians who are older, speak an Aboriginal language well enough to carry on a conversation, and participate in traditional activities.

4. Persons with diabetes mellitus are more likely to have greater Aboriginal ancestry, higher BMI (body mass index) and be less physically active.

5. Persons with diabetes mellitus are more likely to experience chronic co-morbid conditions.

6. Bill C-31 registrants will be at greater risk for diabetes than non-registrants and their removal from the non-status Indian population will decrease the prevalence of diabetes in the latter group.

Methodological Issues

7. What impact do self-reported data have on the accumulated scientific knowledge about the epidemiology of chronic disease?

8. What are the possible limitations of the design, methodology, and data of the APS and how does this impact upon the derived results?

Controversies and Limitations

Etiology

Type 2 diabetes mellitus is a complex disease with a multifactorial etiology involving genetic and environmental factors. Little is known about the etiology of diabetes among Aboriginal North American populations. The Pima are the only group among whom prospective research on the epidemiology of diabetes has been conducted, consequently most of our knowledge upon diabetes derives from this research. The role diabetes risk factors identified among the Pima play in the development of diabetes in other Aboriginal North American groups has not yet been well established. Most of the research conducted among other Aboriginal groups has involved investigation of the associations established through the Pima study. Such studies, completed among several Aboriginal populations, are important because they have provided further support for the associations between suspected risk factors and disease. However, in order to further our understanding of diabetes etiology, prospective studies among other Aboriginal groups besides the Pima will have to be conducted.

Most of the published data describing the extent of diabetes among Aboriginal North American populations are comprised of prevalence rather than incidence data. Prevalence is a measure of the number of individuals in a population who have a disease at a particular point in time. Prevalence is an especially important measure for chronic disease because it represents the burden of a particular condition in a population. Incidence is a measure of the number of new cases of disease which develop in a population over a period of time and can be used to make inferences about risk of disease. The differences are important. Incidence is the basic tool of etiologic studies because it provides a direct measure of risk. Prevalence does not necessarily indicate risk because it reflects both duration and incidence (Mausner and Kramer, 1985).

The above limitation is important in regard to those diseases not under genetic control. However, for genetic diseases inherited according to Mendelian principles, prevalence (a measure of the abnormal phenotype) is a function of genotype and therefore may be used to estimate the probability or risk of disease. Chronic diseases such as diabetes present a special challenge because although they aggregate in families, and may be inherited according to Mendelian principles, the majority have complex multifactorial etiologies. Thus, in addition to genotype, other factors influence the manifestation of the disease endpoint (Sing et al., 1985). Although estimates of developing disease are not as easily determined for chronic diseases, prevalence data remain an important source of information supporting a genetic etiology.

Much of the research on diabetes among Aboriginal North Americans has been conducted using cross-sectional surveys, in which data about risk factors and disease status are measured at the same time. Cross-sectional studies do not directly contribute to our understanding of the etiology of a disease because the temporal sequence of events which is necessary for drawing causal inferences cannot be established. The Aboriginal Peoples Survey is an example of a cross-sectional study; data on prevalence of disease, risk factors and complications were collected simultaneously. While inferences about causation cannot be drawn with the APS data set, testing for associations between diabetes and risk factors previously identified for other Aboriginal populations can be accomplished. As there has been no previous research on diabetes among the Métis, searching for associations between disease and risk factors is a fundamental first step.

Ascertainment

In order to determine the true prevalence of diabetes in a population, screening surveys using oral glucose tolerance tests would have to be performed (Young, 1994). Estimates of diabetes prevalence reported for many of the Aboriginal North American diabetes studies have been based on previous diagnosis, derived through review of medical records, self-reports of disease status or review of national registers. Prevalence estimates based on previous diagnosis often result in underestimates as only clinically diagnosed cases of diabetes are reported and undiagnosed cases, which may be discovered via screening surveys, remain undetected. Zimmet (1982) reports results of a number of screening surveys completed among various populations which indicated that for every reported case of diabetes, there existed at least one or two undiagnosed cases. Similar results were found for the United States National Health and Nutrition Examination Survey completed during 1976-1980 (Harris et al., 1987). As data collected for the APS are based on self-reporting, underestimates of diabetes prevalence may also result.

Ethnicity is another variable for which self-reporting may have significant effects on the results of this research. Individuals participating in the APS were asked to indicate the Aboriginal group with which they identified. Possible responses included "North American Indian", "Inuit", "Métis" and "Another Aboriginal group". As stated previously, Aboriginal ancestry is one of the suspected risk factors for diabetes. Because much confusion exists as to the use of the ethnic classification, "Métis", highly variable proportions of Aboriginal ancestry will probably be represented by those self-identifying as "Métis". Individuals self-identifying as "Métis" may have based their identification on biological or socio-cultural/historical grounds or a mixture of both. Thus, the category "Métis" may include individuals who can trace their ancestry back to the Métis origins at Red River (or earlier), to those for whom admixture occurred in this generation (Sawchuk, 1978). There is no possible way to determine genealogy from the APS data. However, a variable was constructed which may prove useful as a surrogate for admixture status. Future research on diabetes among the Métis should include genealogical analysis in order that ancestry be used as an explanatory variable.

Sampling Methodology

The sample design used for the APS was not self-weighting but involved stratified multi-staged sampling, resulting in unequal probabilities of selection. Weights were applied to each record in the data set to account for sampling probability, non-response and non-coverage. The final weights are in place so that the APS sample is representative of the census Aboriginal population, excluding those reserves and communities that were incompletely enumerated. The effects of the application of weights on the reliability of the results was explored.

Missing Data

Some of the factors implicated in diabetes etiology are not well represented in the APS data set. For example, individuals participating in the APS were asked if they had been told by a health care professional that they had diabetes. No distinction was made between type1 and type 2 diabetes, neither was there a question asking if insulin or other medications were required to manage diabetes. Diabetes in Aboriginal populations is almost exclusively type 2 (Young, 1994). In addition, type 1 diabetes is rare in many populations and type 2 diabetes represents approximately 85-95% of all diabetes cases in developed countries (Zimmet, 1982). An assumption will be made that the vast majority of cases of diabetes reported in the APS will be type 2; therefore all reported cases of diabetes will be included in the analysis as type 2.

Aboriginal ancestry has been identified as a risk factor for onset of diabetes. No information specific to proportion of Aboriginal ancestry is available in the APS data set. As stated previously, a composite variable was constructed which was intended to act as a measure of admixture.

Very little dietary data were collected for the APS. Although diet is implicated in diabetes etiology, the precise role of specific foods is not well understood, primarily due to the complex nature of the research on the relationship between diet and disease (Young, 1994). Mausner and Kramer (1985) cite two problems in determining disease etiology that may have relevance at this point. First is the differential effect of factors on incidence and course of disease. High carbohydrate ingestion is known to exacerbate the course of illness, but its impact as an independent variable in diabetes incidence may not be as significant (Barceló, 1996). Another problem concerns the long latent period in chronic illnesses; it is difficult to link antecedent events (e.g., childhood dietary patterns) and outcome (e.g., adult onset diabetes) when duration of latent period entails years. The lack of dietary information available in a cross-sectional study, such as the APS data set should not present a large problem because causal relationships cannot be established.

Another identified diabetes risk factor is parental diabetes status. No data on this variable are available in the APS data set. Future research on the Métis should include this vital aspect of diabetes etiology.

Finally, the APS data set does not contain variables specific to some important diabetes-related complications (e.g., kidney disease, specific cardiovascular conditions, opthalmologoic complications, amputations). Diabetes-related complications were inferred through cross-tabulation of diabetes and other health problems (e.g., hypertension, arthritis) by self-reported disability levels.

Strengths

Notwithstanding the above limitations, the study of diabetes among the Métis through analysis of the APS provided a significant and original contribution to the knowledge on diabetes among Aboriginal North American populations. Because a large sample of Aboriginal people from across Canada were included in the APS, analysis of the data set affords the potential to capture a true national picture of the extent and magnitude of the health status of Canada's Aboriginal peoples. The study completed by Young and associates (1990), although comprehensive and significant in its contribution to diabetes epidemiology, involved only a portion of Canada's Aboriginal population (i.e., registered Indians and Inuit). The APS includes all of Canada's officially recognized Aboriginal groups: North American Indians (registered and unregistered), the Inuit and the Métis. Because 75% of the Métis reside in Manitoba, Saskatchewan and Alberta, a comprehensive picture of diabetes among Canada's Métis was achieved. In summary, analysis of the APS provided the opportunity for investigation of diabetes epidemiology among Canada's Aboriginal populations on a scale which could not be achieved through independent surveys.

CHAPTER TWO

REVIEW OF THE LITERATURE

Epidemiology of Type 2 Diabetes among Aboriginal North American Populations

Prevalence

The first estimates of diabetes prevalence among Aboriginal North American populations were published in the 1940's and research among various tribes has continued to the present time. Wide variation in contemporary prevalence has been demonstrated among Canadian and American Aboriginal populations. Comparisons of estimates across culture group, geography, lifestyle, physical characteristics and ancestry have been completed in an attempt to unravel diabetes etiology. However, comparisons across populations are hampered by the use of different study methodologies and diagnostic criteria. Published estimates of prevalence among Aboriginal North American populations have been derived from retrospective analyses of health records, which provided the numbers of living individuals diagnosed with diabetes at the time for the review, and from screening surveys. The limitations of basing prevalence estimates on previous diagnosis were discussed in the preceding chapter. Screening surveys have the potential to provide more accurate estimates of prevalence because they allow for the determination of known and newly diagnosed cases through measurement of participants' blood glucose levels. However, a potential problem of screening surveys is selection bias. A selection bias can result when volunteer samples are used (Abramson, 1984). Many samples upon which screening for diabetes has been completed have been volunteer. It is possible that those who volunteer are systematically different from those who do not participate. A selection bias can affect the representativeness of the sample and therefore, the validity of the derived results.

Another potential problem affecting the comparability of published prevalence estimates concerns use of different diagnostic criteria. Interpretation and comparison of estimates is hampered through the use of different measures of plasma glucose (i.e., casual plasma glucose, fasting plasma glucose, and oral glucose tolerance testing). Most recent work has adhered to the standard criteria set out by the National Diabetes Data Group (NDDG) (1979) and the World Health Organization (1985), making comparisons more meaningful. (New criteria for the diagnosis of diabetes mellitus have recently been released by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 1997). Even when different methodologies and diagnostic criteria are considered, significant differences in the prevalence of diabetes exist between countries, and between different groups within the same country (Zimmet, 1982).

Canada

Young and associates (1990) estimated the prevalence of diabetes among Canada's registered Indian and Inuit populations and tested hypotheses related to diabetes etiology. Data were obtained from the Medical Services Branch (MSB), the federal agency responsible for health services to Canada's registered Indian and Inuit populations. Estimates of diabetes prevalence were based on previously diagnosed cases of diabetes. As data were not available for all eligible Aboriginal communities, the authors estimate that the communities for which data were available represent approximately 76% of the total Inuit and on-reserve registered Indian population of Canada.

Age-sex adjusted prevalence was determined to be greatest among Indians of Atlantic Canada (8.7%) and Ontario (7.6%), moderate for Indians from Saskatchewan, Quebec, Alberta and Manitoba, (3.9%-5.7%) and lowest for Indians and Inuit of the Northwest and Yukon Territories and British Columbia (0.3%-0.9%).

Comparisons across language family, culture area and geography were completed to explain rate variability. Regression analyses were completed on the national sample as well as within Algonkian, Athapaskan, and Eskimoan language families. Among the national sample, the six best predictors of diabetes were latitude (rates are higher in southern than northern latitudes), and the following composite language phylum-culture area variables: Northeast-Algonkian, Northeast-Iroquoian, Subarctic-Algonkian, Plains-Siouan, and Plains-Algonkian. The authors conclude that both environmental and genetic mechanisms are involved in diabetes etiology. Specifically, the variable latitude represents the extent of the influence of broader Canadian society and subsequent changes to Aboriginal lifestyle. The composite language phylum-culture area variables represent language families in specific culture areas, where language family serves as an index of genetic relationship.

The pattern of variation reported by Young and associates (1990) has been documented in other studies. The overall prevalence of diabetes among 30 Cree/Ojibwa communities (Algonkian) in northern Ontario and Manitoba was 2.8%, based on previous diagnosis. Considerable variation by age-group was evident; 5.3% of those aged 25-44 were diagnosed with diabetes, 12.6% of those aged 45-64, and 9.6% of those aged 65 years and older (Young et al., 1985). Montour and Macauley (1985) completed a chart review in 1981 on 544 registered Mohawk Indians aged 45-64 years, from the Kahnawake reserve in Quebec. Diabetes prevalence among this group was estimated to be 12%. Evers and colleagues (1987) report a diabetes prevalence of 9.8%, based on previous diagnosis, for Indians living in two southwest Ontario Indian communities composed of Oneida, Chippewa and Muncey bands. Similar age variation was noted, with prevalence ranging from 1% among those aged 15-24 years to 44% for those aged 75 years and over. Young and associates (1992) estimated diabetes prevalence among the Inuit of Northwest Territories and Athapaskan tribes of Northwest and Yukon Territories to be less than one percent, based on previous diagnosis.

Fox, Harris and Whalen-Brough (1994) estimated the overall prevalence of diabetes among Cree and Ojibway registered Indians from 28 communities in northern Ontario to be 4%. Estimates were based on a registry of previously diagnosed cases. Considerable age variation was found, with less than 1% of those aged 15-24 having received a diagnosis of diabetes to 18% of those aged 55-64 years, and 15% of those aged 65 years and over. Pioro, Dyck and Gillis (1996), estimated diabetes prevalence among Saskatchewan reserve residents based on a survey conducted by the Saskatchewan region of Medical Services Branch (MSB) on numbers of diagnosed cases of diabetes among all Saskatchewan reserves. The crude diabetes prevalence for reserve residents aged 20 years and over was 6.2%. Age-specific prevalence ranged from 1% among those aged 20-29 years, to 23% for those aged 60-69 years, and 17% for those aged 70 years and over. Harris and colleagues (1997) completed a community-wide prevalence survey using oral glucose tolerance tests in a remote northern Ontario reserve community. The overall crude prevalence among participants aged 10 years and older was 17.2%. Age-sex-specific rates ranged from approximately 4% among females aged 10-19 years, to 54% and 45% for females and males, respectively, aged 50-59 years, and approximately 50% for males and 45% for females aged 60 years and over.

United States

Variation in diabetes prevalence among American Indians is also found along geographic and tribal lines. Diabetes estimates have been derived for significantly greater numbers of tribes than is the case in Canada. The large literature will not be reproduced here; rather patterns will be outlined. Valway and associates (1993) analyzed Indian Health Service (IHS) out-patient data for 1987 to derive national and regional estimates of known cases of diabetes among users of IHS facilities (IHS is the federal agency responsible for Indian health services in the United States). Data were collected from 432 IHS facilities across the United States, which provide health services to approximately 86% of the estimated total 1987 IHS service population.

The age-adjusted prevalence of diabetes among American Indians and Alaska Natives was 69/1000 for all age-groups and 88.7/1000 for those aged 15 years and older. The lowest prevalence was 15.3/1000 for Alaska, while the highest was 119.2/1000 for the Tucson area. The risk of diabetes was greater for American Indians compared to the general United States population, nationally and in all IHS areas except Alaska where the risk for diabetes was lower for Natives. The rates were generally greatest among tribes of the southwest with the exception of the Navajo area where rates are lower than those found among other southwest tribes. These trends are confirmed in previous tribe-specific studies

(Bennett et al., 1976; Carter et al., 1989; Sugarman and Percy, 1989; Knowler et al., 1981, 1990). Prevalence was also high for Indians of North and South Dakota and Minnesota and was confirmed in other studies (Brosseau et al., 1979; Brosseau, 1993; Lang, 1985; Rith-Najarian et al. 1993). Lower prevalence of diabetes is found among Indians in the Portland (Northwest United States) and Alaskan areas, also confirmed by previous research (Freeman et al., 1989; Schraer et al., 1988).

Pathogenesis

Prospective studies among high risk populations for type 2 diabetes mellitus indicate that in subjects with normal glucose tolerance, both hyperinsulinemia [Nauruans (a Micronesian population), Pima, Mexican Americans] and insulin resistance (Pima) predicted the development of diabetes (Haffner et al., 1990; Zimmet, 1992; Knowler, 1993). Some controversy exists as to whether insulin resistance or hyperinsulinemia represents the primary metabolic defect leading to the development of overt diabetes. Through prospective studies among non-diabetic Pima, it was discovered that the earliest detectable metabolic abnormality among those who eventually developed diabetes was insulin resistance. Insulin resistance was similarly found to be the earliest detectable metabolic abnormality among a group of glucose-tolerant Mexican Americans (Gulli et al., 1992). Should the primary metabolic defect involve insulin resistance, then hyperinsulinemia results as a compensatory response in an attempt to maintain glucose homeostasis. The transition from normal glucose tolerance through to diabetes is due to the development of an insulin secretory defect; beta cells lose their ability to respond to insulin resistance by producing compensatory amounts of insulin.

Zimmet (1992) cites numerous animal model studies which provide support for hyperinsulinemia as the initial defect. Should excess insulin represent the primary endocrine defect then insulin resistance may occur as a response to hyperinsulinemia through a down-regulation of both insulin-receptor and post-receptor events (Gulli, 1992). Whatever the initial defect, a cycle develops between insulin resistance and hyperinsulinemia in an attempt to maintain normal glucose homeostasis. Eventually, pancreatic decompensation occurs resulting in diabetes.

Etiology

Insulin Resistance Syndrome - Syndrome X

The most recent theory concerning the etiology of diabetes is that it is part of a constellation of disorders that have as the underlying cause insulin resistance. Reaven (1988) described "Syndrome X" (also termed Insulin Resistance Syndrome - IRS) as the association of insulin resistance, hyperglycemia, hyperinsulinemia, dyslipidemia (increased very-low-density-lipoprotein [VLDL] triglyceride and decreased high-density lipoprotein cholesterol [HDL-chol], and hypertension. Reaven claimed that these changes tend to occur in the same individuals and that they are important in the etiology of coronary artery disease (CAD).

According to Reaven (1988), resistance to insulin-stimulated glucose uptake is a common problem. Reaven and associates measured glucose uptake in normo- and hyperglycemic subjects. Little difference was found in the level of insulin resistance between those with impaired glucose tolerance (IGT) and those with diabetes. Interestingly, there was a threefold difference in glucose uptake among those with normal glucose tolerance. In fact, some individuals with normal glucose tolerance were as insulin resistant as those with IGT. Thus, by itself, insulin resistance is not sufficient to produce diabetes; changes in the functioning of pancreatic beta-cells are also required. Insulin resistant individuals demonstrating normal glucose tolerance were able to compensate by secreting more insulin. This is why individuals with varying degrees of insulin resistance can have similar degrees of glucose tolerance. However, according to Reaven, there is a price to be paid for hyperinsulinemia -- namely the development of hypertension and CAD.

The Insulin Resistance Syndrome has not received unqualified support in the literature. Both hyperinsulinemia and insulin resistance have predicted the development of diabetes in high-risk populations. However, support for an association between insulin resistance and hypertension is not strong. Most studies demonstrating a relationship are cross-sectional, preventing judgement on whether insulin resistance predated hypertension (Zimmet, 1992). Considerable support, however, is mounting for a relationship between hyperinsulinemia and CAD. Support for increased risk of coronary heart disease related to hyperinsulinemia and insulin resistance comes from studies among Mexican Americans living in San Antonio (Ferrannini et al., 1991; Haffner et al., 1992), Australian Aborigines and some European and migrant Asian Indian populations (Zimmet, 1993). However, evidence challenging the association between insulin resistance and coronary heart disease (CHD) comes from the Pima Indians, the Maricopa and Tohono O'odham (Papago) of Arizona (Howard et al., 1996). The Pima, along with 12 other American Indian tribes from Arizona, Oklahoma and North and South Dakota have participated in The Strong Heart Study, the purpose of which is to examine CHD and its risk factors in American Indians.

While prevalence of diabetes was high in all three centres (40% of those aged 45-75 in the Dakotas and Oklahoma; 70% for the same age grouping in Arizona), low rates of hypertension and dyslipidemia were found. Rates of CHD were significantly lower among Arizona Indians compared to Indians from the Dakotas and Oklahoma. Possible explanations for the low rates of CHD among the groups with the highest diabetes prevalence include smoking habits and variation in genetic admixture. The frequency of smoking was significantly higher among Indians in the Dakotas and Oklahoma, and Indians from the Arizona centre reported less Caucasian genetic admixture (based on participant-reported grandparent ethnicity) (Howard et al., 1996). Stern (1995) surmises that the diabetes-cardiovascular link may be a characteristic of Caucasian populations.

Genetic Susceptibility

Although diabetes has been established as a complex genetic disorder, the precise genetic defect(s), the mode of inheritance, and the numbers of genes involved have not yet been established. Evidence for genetic susceptibility to diabetes has been drawn from high-prevalence populations. Among the Pima, the Seminoles of Florida and Oklahoma and the Nauruans, the frequency distributions of fasting and 2-hour glucose were determined to be bimodal which is suggestive of a single-gene mode of inheritance (Rushforth et al., 1971; Elston et al., 1974; Zimmet, 1979). Glucose distributions in most other Aboriginal American and Caucasian populations are unimodal suggesting multiple-gene mode of inheritance (Zimmet, 1979; Young, 1994). Among the Pima the distribution of *in vivo* insulin action was determined to be a mixture of three overlapping Normal distributions suggesting a single-gene codominant mode of inheritance (Bogardus et al., 1989). In addition, family membership was found to be a more important determinant of *in vivo* insulin action among the Pima than "environmental" factors such as weight gain, aging and decreased physical activity (Lillioja et al., 1987).

Further evidence for a genetic risk derives from population studies within which the prevalence of diabetes among subsets with different proportions of Aboriginal ancestry was compared. If the high prevalence of diabetes in Aboriginal North Americans is the result of a gene(s) which increase susceptibility to diabetes, then those groups with less Aboriginal ancestry would be expected to have lower prevalence of diabetes while groups with the greatest proportion of Aboriginal ancestry would be expected to have the highest prevalence (Knowler et al., 1990).

Brosseau and associates (1979) report a strong hereditary tendency for diabetes among the Three Affiliated Tribes of North Dakota (Arikara, Mandan and Hidatsa). Among full inheritance Indians (8/8), 22% were diagnosed with diabetes; 15% of those claiming between 4/8 and 8/8 had been diagnosed with diabetes, and 4% of those claiming less than 4/8 Aboriginal ancestry were diabetic. No noticeable differences in the lifestyles or environments of these groups were evident. The medical records of the Three Affiliated Tribes were reviewed again in 1988. Among those diagnosed with diabetes, 92% were of greater than one-half Aboriginal ancestry (Brosseau, 1993). Aboriginal ancestry was positively associated with diabetes prevalence among the Cherokee of North Carolina (Stein et al. 1965; Farrell et al., 1993), Oklahoma Indians (Lee et al., 1985), Muskogee Creek Indians of Oklahoma (Weiss et al. 1989), Alaskan Eskimo, Indians and Aleuts (Schraer et al., 1988) and the Pima and Papago (Knowler et al., 1988).

A portion of the gene pool (approximately 30%) of Mexican Americans is derived from Native American sources (Reed, 1974; Hanis et al., 1991; Long et al., 1991). If the excess prevalence of diabetes in Native Americans has a genetic component, then diabetes prevalence in Mexican Americans should correspond to the degree of Native American ancestry. Gardner and associates (1984) studied the relationship between diabetes prevalence, obesity and degree of Native ancestry among Mexican Americans and non-Hispanic whites in San Antonio, Texas. The prevalence of diabetes increased as the degree of Native American ancestry increased.

Additional evidence supporting genetic involvement in diabetes etiology includes the high concordance rate of disease among monozygotic compared to dizygotic twins, familial aggregation in high prevalence populations, the high risk of diabetes in offspring of two parents with diabetes, and genetic marker studies (Zimmet, 1979,1992; Young, 1994).

Obesity

The association between obesity and diabetes is well established. Obesity refers to excess adipose tissue and it is suggested that use of the term be reserved for those situations in which there is evidence that the amount of body fat exceeds predetermined values (e.g., 25 percent of total body weight in men and 30 percent in women) (Kuczmarski, Carroll, Flegal, and Troiano, 1997). In many research studies the term obesity is confused with the term overweight, which refers to body weight for height that is in excess of reference values determined through population studies (Kuczmarski et al., 1997).

Many measures of overweight and obesity have been used in diabetes research. One easily obtained measure of overweight is the body mass index or BMI. The BMI is a measure of height for weight and is obtained by dividing body weight in kilograms by height in meters squared (i.e., BMI= kg/m^2). Measures of adiposity include percentage body fat (PBF) assessed by bioelectric resistance, computerized axial tomography (CAT) scans, triceps and subscapular skinfold thickness, waist circumference, and the waist- to-hip and waist-to-thigh ratios.

Although BMI is highly correlated with body fat, the BMI is not a true measure of obesity. Nevertheless, among a number of populations weight associated with a BMI of greater than 30 is generally a result of excess adiposity. Therefore individuals with a BMI of greater than 30 can generally be considered obese (Kuczmarski et al., 1997).

On the basis of data collected through population studies, BMI has been categorized to reflect healthy weights and weights associated with increased risk for ill health and disease. According to Canadian guidelines, a BMI of less than 20 may be associated with health problems for some people; a BMI between 20 and 25 is considered a good weight for most people; a BMI between 25 and 27 may lead to health problems in some people; and a BMI of greater than 27 is associated with increased risk of developing health problems. These guidelines are intended to assess body weight for adults aged 20 through 65 and do not apply to infants, children, adolescents, pregnant or breastfeeding women or adults over the age of 65 (Health and Welfare Canada, 1988). [A World Health Organization Expert Committee recently made recommendations regarding the use of anthropometry at different ages to assess health, nutrition and social well-being (de Onis and Habicht, 1996)].

A strong association between generalized obesity and type 2 diabetes mellitus has been reported in many populations (Barceló, 1996). Interestingly, a centralized body fat distribution (i.e., excess adiposity above the waist) is associated with increased prevalence and incidence of type 2 diabetes, and may be more predictive for the incidence of type 2 diabetes than overall obesity among some Native American, Mexican American and Caucasian populations (Warne et al., 1995; Haffner, Mitchell et al., 1992).

Kelly West (1978), a highly influential figure in research on the epidemiology of diabetes among Native Americans, believed that obesity was the main factor responsible for high diabetes prevalence in Native Americans. He concluded that the duration of obesity was an important risk factor because rates of diabetes rose with each decade of obesity. While it is generally agreed that obesity is an important determinant of diabetes, it has been demonstrated that obesity is not solely responsible for the excess prevalence of diabetes in Native Americans. The prevalence of diabetes among even the most lean Pima, Nauruans and Mexican Americans was greater than that of equally lean Caucasian comparison populations (Zimmet, 1979; Knowler et al., 1991; Stern et al., 1993). More recently it was demonstrated that after adjusting for fasting insulin and glucose, the effect of obesity was no longer statistically significant on the development of diabetes among San Antonio Mexican Americans, the Pima and Nauruans, suggesting that the effect of obesity may be mediated by insulin resistance (Haffner et al., 1990).

Diet and Physical Activity

No consistent relationships between specific dietary components and onset of diabetes have been established. Investigation of the role of refined carbohydrates in diabetes etiology has proved inconclusive. The role of dietary fat has also been investigated, and among Colorado Mexican Americans increased consumption of saturated fats was linked to the development of diabetes. Zimmet claims that dietary fat may worsen insulin resistance leading to glucose intolerance (1979;1992).

According to Zimmet (1992), physical activity may prevent onset of diabetes by improving insulin resistance and that the role of physical inactivity in development of diabetes may have been underestimated because of the focus on obesity. Zimmet cites several cross-sectional studies in which a positive association was found between physical inactivity and prevalence of diabetes because diabetes prevalence was lower among physically active men, independent of age, obesity and urban living. Among the Pima, physical activity was found to be independently associated with diabetes after controlling for current body mass index (BMI), sex, age and parental diabetes (Kriska et al., 1991).

These reports are promising because they suggest that the onset of decompensation may be affected by dietary intake of fat and physical inactivity and thus may be prevented by decreased fat intake and increased physical activity. Further research on these variables needs to be completed.

Diabetes among Aboriginal North American populations appears to be a complex genetic disorder, the expression of which is influenced by environmental factors. As a hybrid population of Aboriginal origin, inferences on the risk of diabetes for the Métis are drawn from research completed on other Aboriginal populations. Further evidence of the importance of conducting diabetes research among the Métis comes from the Mexican American population of the United States.

Mexican Americans

Mexican Americans are a diverse population whose ancestors include Native American Indians of Mexico and the southwestern United States, the Spanish, who conquered Mexican Natives beginning in the early 16th century, and Blacks who were also involved in the colonization of Spanish territories. A further contributor, beginning in the 1800's, was the "Americans" who were predominantly of western European origin (Samora et al., 1977; Weber, 1973).

Mexican Americans comprise a large portion (62.6%) of the larger Hispanic American ethnic group which also includes individuals of Puerto Rican, Cuban and Central and South American origins. Over 80% of Mexican Americans reside in the five southwestern states of Texas, California, New Mexico, Colorado and Arizona (Stern, 1993; Martinez, 1993).

Prevalence of Diabetes

Hispanic Americans comprise the second largest and fastest growing minority group in the United States. In spite of the size of the Hispanic American population, research upon their health status only began to be conducted within the past 15 years and, among the foci of research, chronic disease has been prominent. Mexican Americans have a two- to three times excess prevalence of diabetes compared to non-Hispanic whites (Stern, 1993). Estimates of diabetes prevalence have been derived from community-based screening studies in which blood glucose levels were measured in addition to other aspects of a physical examination, and self-reported data. Studies were completed in San Antonio, Texas (Gardner et al., 1984; Hazuda et al., 1986; Stern et al., 1988; Haffner et al., 1990), Laredo

Texas (Stern et al., 1981), Starr County, Texas (Hanis et al., 1983), New Mexico (Samet et al., 1988) and San Luis Valley, Colorado (Hamman et al., 1989). While all of the above reported studies reported an excess prevalence of diabetes, the use of different sampling methods, ethnic and diagnostic criteria may affect comparability and ability to generalize to other populations. Notwithstanding these concerns, the results from the multi-phased San Antonio Heart Study, and the Starr County and San Luis Valley studies, which used random sampling strategies and the oral glucose tolerance test for diagnoses, demonstrate a consistent excess prevalence of diabetes among Mexican Americans compared to non-Hispanic whites.

Genetic Susceptibility

The bulk of research on diabetes etiology among Mexican Americans has been conducted on the San Antonio Heart Study cohorts. Results of the San Antonio Heart Study provide confirmation of the results concerning etiology of diabetes among the Pima. Hyperinsulinemia and insulin resistance, independent of obesity, have also been demonstrated in non-diabetic Mexican Americans (Haffner et al., 1986,1988; Haffner, 1987). In addition, insulin resistance appears to precede defects in insulin secretion among Mexican Americans (Gulli et al., 1992).

Gardner and associates (1984) investigated the relationship between Aboriginal admixture and diabetes prevalence in three different types of neighbourhoods in San Antonio, Texas using skin color measurements as indices for Aboriginal admixture. The proportion of Aboriginal admixture decreased from barrio to suburbs (barrio=46%; transitional neighbourhood=27%; suburb=18%) as did the prevalence of diabetes, suggesting an association between admixture and diabetes prevalence. However, the apparent association cannot be considered conclusive because there may be other factors associated with lower socioeconomic status that could also contribute to excess diabetes.

A similar study was completed using serological data among a sample from the San Antonio study. In an attempt to separate the possible confounding effects of socioeconomic status (neighbourhood) and disease status on admixture (genetic variation), a nested gene diversity analysis was completed. The total gene diversity in the sample (n=1,237) was separated into four components: (1) gene diversity between the two sexes; (2) gene diversity between neighbourhoods within sex; (3) gene diversity between disease groups within neighbourhood; and (4) gene diversity between individuals within disease-neighbourhood-sex group. Most of the genetic diversity occurred between individuals within stratum, but the next greatest diversity was found between disease status groups. Thus, the genetic diversity of San Antonio Mexican Americans, when classified by disease status, was greater than the diversity that existed when classified by neighbourhood. The genetic differences between individuals with diabetes and individuals without diabetes rather than differences between neighbourhood groups may therefore be responsible for the distribution of diabetes (Chakraborty et al., 1986).

An interesting study was completed investigating an association between diabetes and specific genetic markers. Restriction-fragment-length polymorphisms of the insulin-receptor gene were characterized in a case-control design involving Mexican American and non-Hispanic whites diagnosed with diabetes and age-sex-ethnicity matched controls of the San Antonio Heart Study. Three alleles (A,B,C) were identified and the C allele was found exclusively among the Mexican Americans. Interestingly, the C allele has previously only been found among the Pima. Few differences in genotype frequency were observed between those with diabetes and controls except for the CC genotype which occurred twice as often among Mexican Americans with diabetes than among controls (not statistically significant). The control group with the CC genotype was younger than the diabetic CC group, and after adjusting for age, the odds of diabetes for Mexican Americans with the CC genotype was 4.71 times greater than for those without the genotype. The C allele may be associated with diabetes or may serve as a marker of Native American admixture. Further research is warranted because the allele is part of a gene that functions in carbohydrate metabolism (Raboudi et al., 1989).

The "environmental" risk factor most studied among Mexican Americans has been obesity. As noted in a previous section, obesity has not been shown to completely account for the differences in diabetes prevalence between Mexican Americans and non-Hispanic whites.

Thus, it appears that Mexican Americans, as hybrids of Aboriginal American populations, have an increased genetic susceptibility to development of diabetes. The identification of risk factors among Mexican Americans has implications for research among the Métis. The Métis, like Mexican Americans, are a hybrid population of mixed Aboriginal and non-Aboriginal ancestry, which may place them at greater risk for diabetes than the general Canadian population.

The Métis

In the 19th century the Métis emerged as a distinct people with a nationalist identity which was formed in response to threats to an established way of life. In 1869 the Métis formed a provisional government and negotiated the terms under which Manitoba would enter Confederation. However, it soon became clear to the Métis that the Canadian government was not willing to honour the terms of the agreement and many steps were taken to secure their rights. The final attempt was the Northwest Rebellion in 1885. After their defeat at Batoche in 1885, the Métis were seen as traitors and troublemakers and were refused recognition as distinct people. Sir John A. McDonald is reported to have said:

> "If they are Indians, they go with the tribes;
> if they are half-breed they are white, and they
> stand in exactly the same relation to...Canada
> as if they were altogether white"
> (Métis National Council, 1992:11).

Thus the dream of "The New Nation" was not to be realized and the assimilationist policies and prejudicial attitudes of the time forced the Métis people into a life of marginality and poverty.

When the Canadian constitution was amended in 1982 the Métis were, for the first time, constitutionally recognized as one of Canada's Aboriginal peoples. This was a significant determination because such recognition is essential for acquisition of rights and access to governmental resources. However, the constitution is not specific regarding the Métis and there remains confusion as to who qualifies as Métis and the rights and claims to which they are entitled (Fleras and Elliot, 1989; Royal Commission on Aboriginal Peoples, 1996). According to the Métis National Council (MNC), the relationship between the Métis and the federal government has not changed in spite of constitutional recognition (1992).

Métis Identity

The Métis have been described as the personification of the modifications of culture and environment that occurred as a result of contact between Europeans and Aboriginal peoples (Sealey, 1978), and the literature is replete with descriptors of Métis life which reflect the meeting of distinct cultures: adaptation, mixing, combination, fusion, blending, accommodation, compromise, adjusted, and amalgamation.

Confusion over the use of the term "Métis" is not new. According to Foster (1978), confusion existed even prior to 1870. He claims that the "classical image of the Métis" at that time was the "French-speaking, Roman Catholic, non-Indian native, buffalo hunters of the Red River Settlement" (p.80). However, there were other individuals of mixed Aboriginal and European ancestry, (i.e., those Foster labels 'non-Indian natives'), who did not fit the classic image. For example, the English-speaking Protestant buffalo hunters, the French and Saulteaux-speaking Roman Catholic voyageur-farmers, and the English-speaking farmer-tripmen (and their descendants). Terms found in the literature to describe these people include "Scots Halfbreed", "English Métis", "*Métis écossais*", and "Country-born". Foster (1985) further claims that the issue of Métis origins (and consequently identity) is so complex that the existence of Euro-Canadian and Aboriginal ancestry is not a sufficient explanation in itself. Rather, one must first identify populations from which Métis communities could have arisen and determine the factors responsible for the emergence of a distinct identity at that particular place and time.

Thus, an analysis of the historical context out of which Métis populations arose is crucial to achieving a meaningful understanding of contemporary Métis identity. Because the Métis emerged as a consequence of the fur trade in North America, historical analysis will focus on the major trading traditions (i.e., the St. Lawrence-Great Lakes, Hudson's Bay Company, and North West Company).

History

The nationalist identity which appeared among Manitoba Métis in 1869-70 signalled the political maturation of the group and not the emergence of a distinctive Métis culture. A distinct ethnic identity began to be formed along the St. Lawrence and in the Upper Great Lakes two centuries prior to the political maturation and eventual defeat of the Métis in 1885 (Peterson, 1978).

New France

In the 17th century the French government encouraged intermarriage between Aboriginal people and the French in New France. The French government considered the St. Lawrence-Great Lakes fur-trading areas a means of imperial expansion and realized that political and commercial success was dependent upon establishing social ties of kinship with the Aboriginal people (Foster, 1978). France was also concerned with bolstering their colonial population to create a large workforce. Samuel de Champlain reportedly told Aboriginal leaders: "Our young men will marry your daughters, and we shall be one people" (Dickason, 1985:20). Although ideas about the hierarchical ordering of races prevailed during this period, evangelization and assimilation appeared to take precedence over issues of racial differences. The charter for the Company of New France included the following provision:

> "the Savages who will be led to the faith and to profess it will be considered natural Frenchmen..."(Dickason, 1985:22).

While the missionary presence was strong and the idea of creating "one race" an overriding concern, the demands of the fur trade were such that intermarriage was a necessity. The Aboriginal peoples of the area preferred this relationship as intermarriages formed the basis for trading alliances. Equally important however was the vital survival role Aboriginal women played for the French through family ties and skills such as interpreters, transporters, guides, and "domestic" tasks (e.g., dressing furs, drying meat, making moccasins) (Dickason, 1985; McMillan, 1988). Intermarriage was so successful in New France during the period 1607-1675 that all but a few families were believed to have "Indian blood in their veins" (Dickason, 1985:47). Pierre-Antoine-Simone Maillard ('Apostle to the Micmacs') wrote in 1753 that within 50 years he expected the French colonists to be "so mixed with the Micmacs and Malecites that it would be impossible to distinguish them" (Dickason, 1985:24).

An unexpected development in New France however, was the appeal of the Aboriginal way of life for some Frenchmen. The fur trade lured some men (the *coureurs de bois*) westward toward the interior where they established stable unions with Aboriginal women. By 1680, one-fifth (800) of the French male population between the ages of 20 and 60 left the colony for the fur fields of the interior (Peterson and Brown, 1985). Male children frequently became involved in the fur trade with their fathers and as a result the voyageurs became increasingly of mixed ancestry (McMillan, 1988).

The children of the unions between Aboriginal women and French men in New France did not develop separate identities but instead identified with either their Aboriginal or European heritage. One of the main reasons was France's "one race" policy of the 17th century. The pre-occupation with a workforce ensured that children from mixed unions would be kept within the community and raised as French. Assimilation into the community was enhanced by the missionary presence. Foster (1978) claims that children of mixed European and Indian ancestry were classified according to their mother's way of life. If the mother resided with the Indian band, the child was considered "Indian". If, however, the mother and child resided in the colony or trading post for an extended time, the child was considered "*Canadien*" or "*Scots*". Towards the end of the 17th and early part of the 18th centuries, the conditions which may have been advantageous to bi-racial children and which may have fostered a separate identity changed. Opportunities in the fur trade became limited. Peace with the Iroquois enabled greater access to the west and the locus of the fur trade moved away from Montreal to the Upper Great Lakes (Peterson, 1978). Occupational opportunities in the colony, particularly prestigious ones, required identification with the French (Dickason, 1985). While the emergence of a separate identity did not occur in the far east, a distinct identity was clearly detected in the Upper Great Lakes area.

Upper Great Lakes

Peterson reports that voyageurs and missionaries travelled to the straits of Lakes Huron and Michigan as early as the 1630's. In 1695, sixty dwellings and the first generation of "Métis" were found in the area. Accurate enumeration of the Métis population is not possible, however, because most marriages occurred *á la façon du pays* (in the custom of the country), which meant that they were contracted verbally without an official religious or administrative presence. Peterson (1978) offers two towns as evidence of a growing Métis population. According to the Michilimackinac register and tax records, the Métis comprised a significant proportion of the population up to 1820. Also, when three generations of Green Bay residents were traced from 1765 to 1829 a growing Métis population was found. For example, in 1795, 81% of all male householders had married Indian or Métis women. By 1816, 87% of 84 households were Métis.

The Métis of the Upper Great Lakes "borrowed and adapted" aspects of both ancestral cultures in the areas of architecture, dress, cuisine, transportation, medical practices, languages, beliefs, and entertainments such that they became distinct from neighbouring Indians and European society at Quebec. The Métis of the Great Lakes considered themselves distinct as well, as evidenced by their labelling of outsiders as "Indian" or "White". The term "Métis" and its English equivalent "Halfbreed" emerged by the second decade of the 19th century in the St-Lawrence-Great Lakes tradition and was not meant to be complimentary. However, some families began to use it to describe themselves. On the other hand, the terms chicot, bois brulé, gens de libre, Canadese or Canadian, synonyms of Métis, were in frequent use. The terms referred, not to race, but to occupational attributes (Foster,1978; Peterson,1978).

The Métis developed a distinct identity in the Great Lakes, because they were able to monopolize one aspect of the fur-trading system -- the broker role. As brokers they operated as intermediaries between Central Algonkian and Siouan bands to the northwest and the Europeans to the east. Peterson (1978) claims that Métis identity did not derive from participation in the fur trade per se, but from this intermediary role where the broker functioned not only in trading of material goods but as a buffer between increasingly inimical cultures.

By the 1830's the Métis broker role was becoming less important and the Métis people were either forced to migrate northwest, to other trading stations, or to Aboriginal kin. Fur stocks were becoming depleted, Indians were being removed from the lands they inhabited, and land speculators, farmers, and businessmen who settled in the area did not require the services of Métis brokers.

The beginnings of a distinct identity, based primarily on occupation and distinguished by aspects of material culture, emerged in the Great Lakes. The Métis that remained in the area either lived with Aboriginal kin or led impoverished lives. The Métis that migrated to the Red River region encountered other groups of mixed ancestry and eventually became allies in defence of their culture and lifestyles.

Hudson's Bay and Red River Settlement

In 1670, Charles II of England granted the Hudson's Bay Company trading monopoly over that part of North America known as Rupert's Land (i.e., parts of what is now Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and Northwest Territories). For the first half century the Company operated what was known as the "coast-side factory system", which meant that Indians brought furs to the trading posts that were set up on the mouths of rivers that fed the Bay. As there was no penetration of the interior by the Hudson's Bay until the latter quarter of the 18th century, trade with the Indians of the interior was conducted primarily by the Cree and Assiniboine who acted as middlemen (Sealey, 1978; Foster, 1978; Miller, 1991).

Unlike the situation in New France, the Hudson's Bay Company lacked a missionary presence for the first century and a half of its existence. Whereas social assimilation was a goal in New France, the operation in the Hudson's Bay was purely economic. In the beginning years the Hudson's Bay Company was against miscegenation, however, over time the practice was not condemned as they realized it was necessary for trade. As in the St. Lawrence-Great Lakes tradition, distinctions were made between Indians, Europeans and their children based on way of life. If mothers remained with the band the children were labelled either "Indian" or "Native", however, if mothers resided in trading posts the children were called "English". Even up to the early 19th century no separate term distinguishing offspring of mixed ancestry emerged. Whereas, in the St. Lawrence-Great Lakes the terms "Métis" and "Halfbreed" emerged, individuals in the Hudson's Bay tradition remained either "Native" or "English". Separate labels distinguishing individuals of mixed ancestry emerged in Red River (Foster, 1978; Lussier, 1978).

The population of "mixed-bloods" in the Red River Valley increased during the late 18th and early 19th centuries. *Canadien* traders moved into the interior from Montreal from 1770 onward and with Scottish-Canadians formed the North West Trading Company. Intermarriage was encouraged for men of the North West Company. As the fur trade declined in the Great Lakes area, many Métis migrated northwest. Also, in response to competition from the North West Company the Hudson's Bay Company was forced to extend its operation inland and as a result many "Natives" located in Red River (Miller, 1991).

Two distinguishable, though similar, groups developed in Red River during the first half of the 19th century: The "Métis", the offspring of Indians and the French Canadians of the North West Company; and the "Countryborn", the offspring of Indians and the Scottish and English (Miller, 1991). The "Métis" hunted buffalo and acted as provisioners to the

North West Company, whose operation extended from Montreal to posts in the Athabasca region (McMillan, 1988). As migration to Red River increased, differences, based on lifestyle, emerged among the inhabitants. Families were primarily involved in trading and buffalo hunting, however, some farmed small river lots, became merchants, worked as fishermen in the north, while others worked on the York boats for the Hudson' Bay Company. The "Métis" and "Countryborn" could not be distinguished along occupational lines, as both participated in similar economic pursuits. Foster (1978) claims that the term "Métis" was first applied to the provisioning buffalo hunters of the region. However, over time, all came to identify themselves as "Métis" and were considered to be a single collectivity by outsiders. Thus the term Métis did not appear to be restricted to the Red River settlement.

An identity based on shared lifestyles and distinctive aspects of material culture was evident in Red River by the early 19th century. However, it wasn't until inhabitants of the region felt a threat to their lifestyles that a nationalist movement began. Nationalist sentiments were encouraged by the rivalry between the Hudson's Bay and Northwest Companies. In 1812, the Hudson's Bay Company granted Lord Selkirk land along the Red River for an agricultural colony. The settlement lay in the centre of the North West Company trading route. The Nor'westers are credited with fuelling nationalist fires among the Métis by emphasizing the economic threat and the loss of freedom associated with the takeover of Métis land. In 1816, the Métis attacked Bay posts and clashed with settlers. Twenty-one settlers died in what became known as the Battle of Seven Oaks. Plans for the settlement were abandoned. The event was significant to the emerging Métis identity (McMillan, 1988; Miller, 1991).

By 1821 the North West Company could no longer compete with the Hudson's Bay Company and the two Companies merged. As a result many former employees of the Bay settled in Red River. As there were no further attempts at colonization for the next half century, the Métis population grew. The years from 1820 to the 1860's were good for the Métis because there was great demand for buffalo hides in the United States. The annual buffalo hunt became crucial to both Métis economy and identity.

The second nationalist victory for the Métis occurred in 1849 and concerned a Métis trader (Guillaume Sayer) who was trading with Americans. The Hudson's Bay attempted to enforce their trading monopoly by prosecuting Sayer, however, charges were dropped when armed Métis supporters gathered at the courtroom. That the Métis saw this as a victory for self-determination was evident by their declaration of free trade: "La commerce est libre" (Sealey,1978; McMillan,1988; Miller,1991).

The fortunes of the Métis began to change by 1870. In 1869, the new Canadian government acquired Rupert's Land from the Hudson's Bay Company. A governor for Rupert's Land was appointed by the Canadian government that same year and was sent to Rupert's Land to establish a temporary government. At the same time a survey party was sent to Rupert's Land to prepare for settlers. The Métis realized that their land-holding system was in jeopardy and challenged the surveyors. The surveyors backed down but the Métis knew measures would have to be taken to secure their rights. Within two weeks of this incident, the governor was prevented from entering and establishing Canadian authority in the region. Under the leadership of Louis Riel, the Métis established a provisional government. Some Canadians attempted to prevent the formation of the government and conflict ensued. Canadian prisoners were taken and one, Thomas Scott, was executed. Although this action caused great tension, representatives from the Métis government met with the Canadian government and negotiated the Manitoba Act of 1870 which created the province of Manitoba.

The creation of Manitoba was not to be a great a victory for the Métis. The Canadian government gained control over public lands but the Métis were given land grants, in the amount of 1.4 million acres, towards the "extinguishment of Indian title". However, the distribution system was so slow and mismanaged that few Métis benefited. Much of the land was taken by Canadian settlers. Because of persecution and prejudice by settlers from Ontario many Métis migrated to the South Saskatchewan Valley where they hoped to continue their traditional way of life. Others migrated north or into the United States. Some moved with Aboriginal kin, while others remained at Red River, worked on farms and were assimilated into the Euro-Canadian society .

The disappearance of the buffalo caused great difficulties for Indians and Métis. Many Métis began farming but as they did not have title to the land, they once again faced the threat of removal by settlers and the Canadian government. The Métis petitioned for recognition of their land rights but the government seemed disinterested. Riel, who had been in forced exile, was summoned to Saskatchewan and once again established a provisional government. The conditions, however, were completely different than they had been at Red River. The North-West was firmly under the control of Canada, whereas Red River had not been. Conflicts ensued and it was at Batoche in 1885 that government troops defeated the Métis in what became known as the North-West Rebellion. Riel was hanged for treason and the Métis were refused recognition as distinct people. Many Métis migrated further west or north. Some recognition of Aboriginal claim was granted in the issuance of "half-breed scrip", which was a certificate for land or money. Again, few Métis benefited as poverty forced them to sell the certificates or land acquired through the certificates (Métis National Council, 1992; McMillan, 1988; Miller, 1991; Lussier, 1978).

Many Métis lived impoverished lives well into the 20th century. The living conditions of the Métis were investigated in Alberta by the Ewing Commission in 1935. The mandate of the Commission was to

> "..enquire into the conditions of the Métis, with reference to health, education and welfare, and to make recommendations to rectify the situation" (Harrison, 1985:99).

It is obvious then that the conditions under which the Métis lived were less than adequate. The situation was not unique to Alberta, but was similar in all prairie provinces.

Contemporary Identity

Three factors were instrumental to the development of a distinct nationalist identity among 19th century western Canadian Métis. The first was the fierce rivalry between the Hudson's Bay and North West Companies. Second was the failure on the part of the Hudson's Bay Company to assert a monopoly over trade, and finally, the relative isolation of Red River during the first half of the 19th century allowed the Métis population to grow in size and strength. Along with the nationalist identity, a well-defined Métis culture evolved which was marked by distinct style of dress, foods, occupational roles, entertainments and land-holding systems.

As products of the fur trade, Métis identity was so completely tied to this way of life that they were not able to withstand the depletion and disappearance of the beaver and buffalo. Coupled with the political climate of the time which led to loss of their land base and economic opportunities, Métis identity and cohesion were seriously weakened. Despite recognition as distinct people in the Manitoba Act, Sir John A. Macdonald, after the North West Rebellion, claimed that there was no separate category of "half-breeds". He further stated:

> "That phrase (the extinguishment of the Indian title) was an incorrect one, because the half-breeds did not allow themselves to be Indians. If they are Indians they go with the tribe; if they are half-breeds, they are whites, and they stand in exactly the same relation to the Hudson Bay Company and Canada as if they were altogether white" (Sealey, 1980:108).

Sealey claims that the Métis became "non-people" through official government policy (1978:108). After 1885, some Métis moved to northern areas and joined Métis communities or established new ones. Some denied their identity and became assimilated into Euro-Canadian culture. Others were able to hold on to their lands and farmed or worked as farm labourers. Some who had joined Aboriginal kin were forced away after the establishment of the reserve system. Métis slums or "shanty-towns" grew on the peripheries of reserves and white communities or on strips of land on either side of public roads (road allowances). In 1930, the federal government transferred control of public lands to the provinces. While special arrangements were made for Indians, none were made for the Métis. As far as the federal government was concerned, Aboriginal claims were extinguished in the late 19th century through of the issuance of land grants and scrip. The Métis were now considered ordinary citizens (Métis National Council, 1992; Peterson & Brown, 1985; Sealey, 1980).

Well into the twentieth century Métis people were defined by poverty and hopelessness. The Ewing Commission used as their definition of Métis "anyone having Indian blood in their veins and living the normal life of a half-breed" (Métis National Council, 1992:11). Although the "normal life of a half-breed" was not clearly defined, the investigation was not meant to include "respectable Métis" -- "those who had settled down to farm life or were integrated into the society at large" (Harrison, 1985: 99).

Three factors form the basis for contemporary Métis ethnic identity: (1) mixed Aboriginal and Euro-Canadian ancestry, (2) an historical past centred around Red River, and (3) a feeling of being defrauded of land which was promised to them (Sealey, 1980). The aspirations of contemporary Métis, which involve reformulation of identity and recognition of rights as one of Canada's Aboriginal peoples, are directly related to these three factors and will be achieved politically.

In 1971 the Native Council of Canada was formed "to represent the interests of the Métis and Non-Status Indian people across Canada" (Peterson & Brown, 1985). However, the Métis did not feel that their interests were being properly represented and in 1983 withdrew from the Native Council and formed the Métis National Council (MNC). The goals of the MNC include: (1) constitutional recognition of the contribution of the Métis to Canadian history: (2) entrenchment in the constitution of the inherent Aboriginal right to self-government. The Métis are not seeking sovereignty but status as a "Nation within a Nation" -- this would include management of social, cultural, and economic affairs;

(3) control of membership and federal assistance in enumerating that membership; and (4) constitutional recognition of the inherent right of the Métis to a land and resource base (Métis National Council, 1992).

The goals and demands of the Métis are not unique to them but are similar to those voiced by status Indians in Canada and Aboriginal groups in other parts of the world. Many of these groups have experienced similar histories and are using reformulated ethnic identities based on their pasts as important political tools in their struggle for recognition and entitlements.

Theoretical Aspects of Ethnic Identity

Ethnic groups have been defined as social groups who possess particular cultural traits which distinguish them from other groups. In this way ethnic groups would be synonymous with cultural groups and would be defined and described using cultural trait inventories. However, differences in objective cultural traits are not the definitive feature of ethnicity because cultural traits (e.g., language, religion) can be shared among groups who consider themselves to be quite distinct. In anthropology, Fredrik Barth is credited with changing the focus of ethnic studies. According to Barth (1969), there is no perfect correlation between ethnic groups and cultural similarities and differences. Rather, the important concept in ethnic studies is the boundary that exists between groups. The focus of ethnic studies then is on the boundaries that define groups rather than what they enclose.

Seen from this perspective ethnicity is a dynamic process rather than a static entity. Ethnicity is dynamic because it is relational -- ethnic groups are defined in relation to what they are not, and this is achieved through contact with others. Thus, ethnicity is really a facet of a relationship rather than a property of a group. This is not to say that culture is irrelevant to ethnic studies. Cultural differences are important if they are considered relevant in interactions with others. In other words, ethnicity is defined from the perspective of group members and cultural traits are important if they make a difference in particular social contexts (Eriksen, 1992;1993).

According to Eriksen (1993), contemporary ethnic identity formation is a political process that has occurred as a result of modernization, especially in areas where particular ethnic groups are granted special rights. Abner Cohen sees similar political motivations and claims that in modern society ethnicity is being used as an "instrument for competition over scarce resources" (cited in Eriksen, 1993:45). Sawchuk agrees and claims that the Métis are an example of an ethnic group as "interest group". While studying contemporary Métis identity in the 1970's he concluded that

> "the manipulation of the concept of metis identity by the formally constituted Manitoba Metis Federation was primarily a political and economic strategy, as demonstrated by the organization's ability to obtain economic aid from the federal government specifically for metis communities" (Sawchuk, 1978:11).

Aboriginal North Americans, like many groups traditionally studied by anthropologists, have undergone rapid social and cultural changes, however, identity has not disappeared but has, in some cases, emerged in a new powerful form. Descriptions of a group's historical past are being used in the creation of contemporary ethnic identities. Ethnic groups, using historical accounts of their pasts, have objectified and reified culture and are using cultural symbols (e.g., clothing) to communicate that they "have a culture".

However, the new identities are qualitatively different from the ancestral cultures upon which they are based, even though they are being presented as old and traditional (Eriksen, 1993).

Contemporary Métis lack common cultural elements. Although Michif is classified as a Métis language, it was never a common language. Métis people spoke French, English, and Aboriginal languages. The most common language at the present time is probably English. Neither is there a predominant religion. Much of Métis folklore has been lost and art and clothing styles, (e.g., beadwork on buckskins) and foods such as bannock and pemmican, which originated with the Métis, have been attributed to other Aboriginal cultures such as the Cree, Ojibwa, Assiniboine, Eastern Sioux, and northern Athapascan peoples (Crawford, 1985; Brasser, 1985).

The determination that a group composed of mixed Euro-Canadian and Aboriginal ancestry should be classified as an Aboriginal group is thus based on ideas about race, tradition and political advantage. The desire for the Métis to be constitutionally recognized as an Aboriginal group is motivated by a desire for access to resources which would otherwise be unattainable.

Contemporary Métis appear to have decided that the boundary that best defines their group is their ancestry. Identification as Métis is controlled and defined by the Métis, as demonstrated by the fact that not all individuals of mixed Euro-Canadian and Aboriginal ancestry are classified as Métis. Further, identification as Métis is made in relation to other groups; Métis are careful not to be classified as either "white" or "Indian". That the Métis ethnic movement is politically motivated has been established. The success of the movement will rest upon the ability of the Métis to instill pride in an historical past. The creation of a contemporary identity will have to rest on an historical culture and achievements. A resurgence in interest in Métis language, art, crafts, lifestyles, and legal issues has begun and time will tell as to whether group cohesion can ever again be realized. However, having achieved constitutional recognition as Aboriginal people, the Métis may expect governmental support similar to that provided to Canada's other Aboriginal groups.

Implications for Health Research

The health status of the Métis as a distinct aboriginal group has not yet been investigated. Three factors have emerged from the analysis of contemporary Métis identity that will impact upon researching type 2 diabetes among the Métis: (1) the Métis are a hybrid population of Aboriginal ancestry, (2) contemporary Métis are a diverse group who display wide variation in lifestyles and ancestry, and (3) identification as Métis is achieved through self-ascription.

The Métis display great diversity in degree of Aboriginal ancestry and lifestyle, both of which are risk factors for type 2 diabetes. Membership as Métis is based on self-identification which contributes to the great diversity that is found with respect to lifestyles and ancestry. Thus, the genetic profile of some Métis populations within certain regions may closely resemble that of a Status Indian population, (e.g., those Métis populations who live adjacent to reserves), while other Métis groups may have little Aboriginal ancestry. Lifestyle is another important consideration. The Métis appear to share with other Canadian Aboriginal populations the fact that they are, on average, economically disadvantaged with respect to the general Canadian population. Poverty affects types of foods consumed, types of physical activities, and stressors which may all contribute to diabetes risk. The lifestyles of some Métis closely resemble that of the dominant Canadian society, whereas the lifestyles of others may more closely resemble that of reserve populations. The Métis population is also young, (74% aged 35 years or younger) which means that large numbers are at risk of developing diabetes. If this is the case, the potential impacts of diabetic complications such as end-stage renal disease and micro- and macro-vascular disease on personal and public welfare and the economics of health care delivery argue strongly in favor of population based research on the Métis.

CHAPTER THREE

MATERIALS

The source of data for this research was the Aboriginal Peoples Survey (APS). The specific data analyzed were found in the APS "Adults Microdata File", which represents a selected sample of the total Aboriginal Peoples Survey population data set. The methodology used by Statistics Canada for selection of the records included in the Adults Microdata File had direct implications on the analysis undertaken for this research. Therefore that process will be outlined in some detail in order to facilitate understanding of some of the methods used to complete this research.

Aboriginal Peoples Survey

Planning for the Aboriginal Peoples Survey began in 1988 when Statistics Canada initiated discussions with representatives from national and provincial Aboriginal organizations, all levels of government in Canada, and research and service organizations. Two draft questionnaires (one for adults and one for children under the age of 15 years) resulted from these consultations. The questionnaires were pilot tested in a Manitoba Métis community, an Inuit community in Labrador, and on a First Nations reserve in British Columbia. Focus testing was also completed among urban Aboriginal residents in Vancouver, British Columbia, Sault Ste. Marie, Ontario and Quebec City, Quebec. Comments from the pilot and focus testing were incorporated into the final draft versions of the questionnaires (Denis, Dufour, Lavigne & Morin, 1993).

The APS was conducted across Canada in 1991 as a post-censal survey, which is a survey that is completed following a general Census of Population. One of the advantages of a post-censal survey is that census data are used to define both the population of interest and the sample to be included in the database. In regard to the APS, the population of interest was the 1991 Census-defined Aboriginal population. Specifically, the Aboriginal population defined through the 1991 Census included those individuals who reported: (1) a single Aboriginal origin (i.e., North American Indian or Métis or Inuit); (2) multiple Aboriginal origins (i.e., any combination of North American Indian, Métis or Inuit); or (3) multiple ethnic origins (i.e., Aboriginal origin in combination with at least one other non-Aboriginal origin) and/or (4) being registered under the *Indian Act* of Canada (Denis, Dufour, Lavigne and Morin, 1993; Statistics Canada, 1995a). Therefore, the Aboriginal population as defined through the 1991 Census included individuals who reported at least one Aboriginal origin and/or registration under the *Indian Act*.

A sample of individuals who claimed Aboriginal ancestry in the 1991 census was drawn by Statistics Canada and used to derive the APS sample. Individuals from the 1991 census sample who claimed to ***identify*** with an Aboriginal group and/or were registered under the *Indian Act* were eligible for inclusion in the APS (Denis, Dufour, Lavigne and Morin, 1993; Statistics Canada, 1995a).

Sample Design

The sampling design which was used to construct the sample from which the APS population was drawn was multi-staged and complex. Two sampling plans based on the 1991 Census-defined Aboriginal population were devised which allowed an overall representative sample to be chosen for the APS. Each province in Canada was divided into two domains. The first domain was comprised of communities that had a high concentration of Aboriginal people and included Indian reserves, numerous Inuit and Métis communities, as well as a number of northern towns and villages with a large Aboriginal population. The second domain was comprised of the rest of the province which was divided into different sections, including previously determined census metropolitan areas (CMA's: e.g., Winnipeg), a grouping of all other metropolitan areas, a grouping of all other urban areas, and a grouping of all other rural areas. A representative sample was chosen from each section of Domains 1 and 2, following a complex multi-staged design (Denis, Dufour, Lavigne and Morin, 1993; Statistics Canada, 1995a).

A screening process was then applied to this sample to determine the actual APS population. Individuals were asked if they ***identified*** with an Aboriginal group and if they were registered under the *Indian Act*. If respondents met either or both of these criteria, the entire APS adults questionnaire was then administered (Denis, Dufour, Lavigne and Morin, 1993; Statistics Canada, 1995a).

Data Processing and Estimation

A major process undertaken by Statistics Canada which had significant implications for data analysis was the weighting of the records included in the APS Microdata File. In large population surveys, weights are applied to every record for a number of reasons. Probability weights are used to represent probability of being sampled. Weights are also used to indicate the number of individuals the record represents; these weights are referred to as population or expansion weights. Finally, weights are used to adjust for non-response and non-coverage (Delgado, Johnson, Roy and Trevino, 1990; Goel, 1993). The weight assigned to each record in the APS Microdata File incorporates all of these types of weights.

Off-Reserve

The assignment of a weight to each record included in the Microdata File was achieved via a multi-stage process. The assignment of the first weight was achieved through a three-step process: (1) initial weight resulting from the sample design, (2) adjustment for non-response, and (3) post-stratification of the sample. The initial weight was based on the probability of being selected for inclusion in the sample. The initial weight was then adjusted to account for non-response. The overall non-response rate for the off-reserve component of the survey was approximately 22%; initial weights assigned to non-respondents were redistributed by increasing the weights of the respondents (Overall, the non-contact rate [16%] was slightly more than twice the refusal rate[6%]). In the final stage of assigning a record weight, an attempt was made to adjust the weights of the APS respondents to the census totals for a number of characteristics so that the two data sources would be comparable. The characteristics used at this stage were province, domain, sex, age group, ethnic origin, and registration status (i.e., registration under the *Indian Act*) (Denis, Dufour, Lavigne and Morin, 1993).

On-Reserve

The weighting of the on-reserve portion of the survey followed the three steps outlined above. The difference between the on- and off-reserve components was that the characteristics used in the third stage of adjustment for the on-reserve component consisted only of age group and sex. The overall on-reserve non-response rate was 21%, with the non-contact rate (14%) twice the refusal rate (7%) (Denis, Dufour, Lavigne and Morin, 1993).

Microdata Files

The following description of the methodology used for creation of the Adult Microdata File is based on the report of Éric Langlet (1995). After the completion of the APS, three Microdata Files were produced: (1) adults, (2) children, and (3) household. Prior to release of these files, the weights that had been assigned according to the previously outlined process were again readjusted out of concerns for respondent confidentiality. The concern was especially great for Aboriginal communities where the sampling fraction was approximately 35%; in addition, reserves with a population of less than 85 individuals were completely enumerated. Thus, both situations had the potential of resulting in record weights which were near or equal to one. In order to overcome the potential for breeching respondent confidentiality, the entire APS data base was sub-sampled and select categories of variables were regrouped. This sub-sampling and regrouping resulted in the Adults Microdata File, which therefore is a sample of the entire APS database, which is in turn a sample of the 1991 Census of Population, which is a sample of the Canadian population.

Sub-sampling

A sampling fraction of approximately 10% for all geographic areas was considered sufficient to reduce the risk of disclosure to acceptable levels. The sub-sampling method used in the production of the Adults Microdata File is known as sampling proportional to size. (As the goal was to achieve record weights of approximately 10, one out of 10 individuals with an initial weight of one would be chosen, and one out of two individuals with a weight of five would be chosen, etc.). In this way all individuals with a weight of less than ten prior to sub-sampling would have a weight of approximately 10 after sub-sampling.

This strategy was also used for the off-reserve component, however, there were fewer records with weights of less than ten because the overall sampling fraction was approximately 6%. Individuals with a weight of greater than 10 were automatically included in the sub-sample.

A vital consideration in the sub-sampling process was preservation of the distribution of certain key variables (i.e., the distribution of certain variables in the Microdata File had to be the same as in the total APS database). The variables chosen to guide the sub-sampling process included: (1) type of Aboriginal community, (2) geographic level, and (3) type of Aboriginal identity.

A small portion of the APS respondents were also included in another large survey conducted by Statistics Canada, the 1991 Health and Activity Limitation Survey (HALS). Individuals who participated in both the HALS and the APS were not included in the APS sub-sampling process because of the risk of disclosure should the two Microdata files be matched. Because respondents common to both surveys were well distributed geographically, their removal from the APS Microdata File sampling process is not believed to introduce a source of bias. The public use microdata file (PUMF), of the 1991 Census also contains some records common to the APS. As with the HALS, individuals common to the APS and the PUMF were not included in the APS sub-sampling process. Elimination of these individuals from the sub-sampling process resulted in adjustment of the weights of the remaining records.

The final stage in the application of a record weight was achieved through post-stratification, the purpose of which was to ensure that the totals on certain variables matched those achieved in the total APS database. The following variables were used in the post-stratification process: (1) type of Aboriginal community, (2) province, (3) CMA/non-CMA, (4) sex, and (5) age group. Through application of the above processes, a final weight was attached to every record in the Adult Microdata File.

In summary then, the first stage in weight assignment was to account for the probability of being included in the APS sample. This initial weight was then adjusted to account for non-response and to ensure that on certain variables the APS database was comparable to the 1991 Census of Population. The second stage of weight assignment occurred during preparation of the Microdata file and was completed to further ensure confidentiality of respondents, especially those from Aboriginal communities because of the large sampling fraction. This weight was adjusted to ensure that the totals on certain variables in the Microdata File corresponded to those in the entire APS database. These weighting processes resulted in record weights ranging from approximately 10 to 125.

Structure of the Survey

The 148-item APS questionnaire was divided into nine sections covering the following subject areas: identity; language and tradition; disability; health, lifestyle and social issues; mobility; schooling; work and related activities; expenditures and sources of income; and housing. The questionnaire was administered by trained interviewers during the period of October 1991 to January 1992.

Structure of the Data Set

The APS Adults Microdata File became available to researchers at the University of Manitoba through the "Data Liberation Initiative", a cooperative venture between

Statistics Canada, the Social Sciences Federation of Canada, the Canadian Association of Research Libraries, the Canadian Association of Public Data Users, other government departments and participating Canadian Universities. Access to the Microdata File was achieved through the UNIX system.

The Adults Microdata File contains 596 variables corresponding to the 148 questions in the APS survey. Records in the Microdata file represent individuals from all provinces and territories across Canada. Records for self-identified Métis and North American Indians from the provinces of Manitoba, Saskatchewan and Alberta were extracted from the larger Microdata file for this research. Analysis was completed by Aboriginal group and province and then by Aboriginal group for all provinces combined, which will hereafter be referred to as "Western Canada". The number of records (unweighted) by Aboriginal group and province are found in Table 3.1.

Table 3.1
APS Unweighted Sample Size by Aboriginal Group and Province

	Manitoba	Saskatchewan	Alberta	Total
Métis	1022	993	1047	3062
North American Indian	2919	2747	2217	7883
Total	3941	3740	3264	10945

Incomplete Enumeration

One of the concerns in using census data for research on Aboriginal Canadians is non-participation of Indian bands. According to Young, since 1981 increasing numbers of Indian bands have refused to cooperate with census activities resulting in incomplete enumerations (1994). In 1991, 78 Indian reserves and settlements were incompletely enumerated. However, the largest concentration of Indian reserves and numbers of people were concentrated in Ontario. Only 15 Indian reserves and settlements in Manitoba, Saskatchewan and Alberta were incompletely enumerated, the majority of which (11) were in Alberta. In addition, 19 Indian reserves and settlements were incompletely enumerated for the APS; four from Manitoba, eight from Saskatchewan and seven from Alberta. The effects on the creation of the APS sample for these provinces may therefore be minimal.

CHAPTER FOUR

METHODS

Variable Selection

Because of the large number of variables in the Microdata file, the first stage of analysis included inspection of the Microdata file and selection of APS variables. The literature on diabetes epidemiology was used as a guide in the variable selection process. Variables were selected within the following categories: risk factors, co-morbidity, health behaviours, health care utilization, and disease complications. Demographic variables were also selected. A total of 166 variables were selected at this stage of the analysis. Variables corresponding to the section on "housing" were not included in the Microdata file and thus were not available for this research.

The primary variable of interest in this research was diabetes status. APS participants were asked the following question to determine diabetes status:

> "*Have you been told by a health care professional that you have diabetes?*"

Participants were asked to respond either "yes" or "no"; the questionnaire did not include responses such as "I don't know" or "unsure". No distinction was made between type 1 and type 2 diabetes.

Data Preparation

Record Weights

As stated previously, every record in the APS Microdata file was assigned a weight representing a combination of selection probability and adjustments for post-stratification, non-coverage and non-response. The weight for every record was assigned through the variable "RECWGHT"(i.e., record weight). For the production of simple statistics (i.e., frequencies) it was necessary that the sampling weight (RECWGHT) be applied to all records in order for the derived estimates to be representative of the survey population (Statistics Canada, 1995a). A problem arose, however, when applying the RECWGHT variable while performing bivariate analyses (i.e., testing for associations between two variables). The difficulty encountered with using the RECWGHT variable was that once applied, the weighted sample sizes were so large that significance tests would be inaccurate (i.e., the chance of making a type 1 error was increased). For example, when performing a Chi-square test for an association between diabetes and sex among western Canadian Métis, the statistical package would operate under the assumption that approximately 57,000 individuals had been sampled when the number of records was actually about 2,900. On the other hand, if analysis was completed on the sample without the application of the weights, then the characteristics of some records would be over- or under-represented relative to other records. Thus, in order for relationships to be meaningfully explored, weights must be applied. A new weight, referred to as "relative weight" (RELWT), was calculated which reduced the size of the sample while preserving the proportional distributions of all variables. The relative weight was determined by dividing each record weight (RECWGHT) by the overall average weight. In this way each record weight was re-scaled so that its value was close to one, and the sum of the weights was equal to the number of records in the sample (i.e., the effective sample size is equal to the number of participants in the survey) (Goel, 1993; Statistics Canada, 1995a).

The use of more complex statistical analysis techniques, such as logistic regression, presented an additional problem. The sample design used for the APS was highly complex resulting in unequal probabilities of selection for respondents. Although most statistical software packages allow the application of a weighting variable, which provides an accurate estimate of the variable under study, the calculated variances are inaccurate. The variances produced by most software packages (including SAS) will be underestimates because participants were not selected by simple random sampling. The consequence of this is that confidence intervals will be too small and p-values may be too liberal resulting in increased chances for type 1 errors (Goel, 1993). Software packages that allow researchers to incorporate complex survey designs are available, however, knowledge of the stratification and clustering of the sample's design is necessary. The recommendation of Statistics Canada (1995a) is to re-scale the weighting variable in the manner described above for "relative weight"; while this weight will not take into account the stratification and clustering, it will account for the unequal probability of selection thereby making the calculated variances more conservative and therefore more reliable.

Table 4.1 contains a comparison of the sample size when using unweighted data, the APS weight (RECWGHT) and the corrected weight (RELWT) by province and Aboriginal group. Although the total sample size with the application of the relative weight is nearly identical to that when no weight is applied, the structure of the data set is different. The proportional relationships that are achieved by applying the variable RECWGHT, are maintained when the RELWT variable is applied, whereas they are not when unweighted data are used.

Table 4.1
Weighted and Unweighted Sample Sizes by Aboriginal Group and Province

		RECORD WEIGHT		
Province	Aboriginal Group	Unweighted	RECWGHT	RELWT
Western Canada	Métis	3062	58894	3063
	North American Indian	7883	110806	7881
	TOTAL	10945	169700	10944
Manitoba	Métis	1022	21176	1022
	North American Indian	2919	39683	2920
	TOTAL	3941	60859	3942
Saskatchewan	Métis	993	15407	993
	North American Indian	2747	33533	2746
	TOTAL	3740	48940	3739
Alberta	Métis	1047	22311	1047
	North American Indian	2217	37590	2218
	TOTAL	3264	59901	3265

Coding

The majority of the responses in the APS Microdata File are categorical, meaning that the responses reflect categories of information rather than continuous measurements. For example, the variable age was grouped into categories, rather than reporting the actual age of the respondent at the time of the survey. The categorical variables in the APS fall into four categories: (i) dichotomous, (ii) nominal, (iii) ordinal, and (iv) discrete counts.

Dichotomous variables are those that have two possible outcomes. These variables were re-coded as "1" for a positive response or presence of an "event" and "0" for a negative response or absence of an "event" (e.g., diagnosed diabetes, 1=yes, 0=no).

Nominal variables are those that have more than two response categories but no inherent ordering (e.g., sub-provincial category: Indian reserve/settlement=1, census metropolitan area (CMA) = 2, other urban = 3, other rural = 4). Nominal variables were not re-coded for chi-square analysis, but were re-coded as "dummy" or design variables for logistic regression analysis. Ordinal variables are those for which there is some inherent ordering for the responses. As with the nominal variables, "ordinal" multiple response variables were re-coded as design variables for logistic regression analysis. The final type of categorical variable found in the APS Microdata File was the discrete count variable, in which the responses are the actual numbers (e.g., number of children ever born: response categories ranged from zero to seven or more children). Because the responses may not follow a normal distribution, the mean count was not assessed. Discrete count variables were also re-coded as design variables for logistic regression analysis.

In a number of cases, multiple response variables were re-coded as dichotomous variables, as follows:

Health - Participants were asked to rate their personal health status in comparison with others their age. The five possible responses included: "excellent", "very good", "good", "fair", and "poor". Because the response levels were not ordered categories that could be considered equally spaced and because of the arbitrary nature of the response, the decision was made to create a dichotomous variable which explored the difference between those who rated their health as 'good' versus those that did not. Thus, the "excellent", "very good" and "good" categories were combined to reflect those who rated their health as 'good', and the "fair" and "poor" categories were combined to reflect those who rated their health as 'poor'. In this case, the "event" was considered to be 'poor' health, thus 'poor' was coded as '1' and 'good' was coded as '0'.

Income - The total annual income variable was originally assigned six levels that ranged from $0.00 to $40,000 and over. Because at least 50% of Métis and North American Indians reported an annual income of less than $10,000 per year, a new dichotomous variable was created, comparing individuals who reported an annual income of less than $10,000 to those who reported an annual income of $10,000 and more.

Current Smoking Status - Current smoking status was originally assigned three response levels: "daily", "occasionally", and "not at all". A dichotomous variable comparing "daily" to "not daily" was created for logistic regression analysis, with 'daily'= '1' and 'not daily' = '0'.

Highest Level of Schooling - The APS variable measuring highest grade completed was originally assigned 7 levels ranging from "less than grade 5" to "grade 13". A three level design variable was initially created for logistic analysis, but significant differences were identified between only two groups so a dichotomous variable comparing those who had completed 'less than grade 9' = '0', to those who had completed 'grade 9-13' = '1'.

Disability - The APS Microdata file did not contain any variables which could be directly related to the complications of diabetes (e.g., amputations, blindness). Instead a series of questions were asked that related to a mobility disability and to sight impairment. These variables were combined such that if an individual responded 'yes' to any of the four questions related to mobility problems (i.e., C8, C9, C11, C12), they would be coded as having a "mobility disability" (DISAB). Similarly, if an individual responded 'yes' to either of the two questions assessing problems with sight (i.e., C4, C5), they were coded as having a "sight impairment" (SIGHT).

Two variables were created that may be considered indicators of level of disability. A series of questions was asked pertaining to activity limitation and the need for assistance with activities of daily living because of a long-term physical condition or health problem. If individuals responded 'yes' to any of the three questions related to activity limitations (i.e., C20_I, C20_III, C20_IV), they were coded as having an activity limitation (i.e., LTDACT 1=yes, 0=no). If participants responded that they required help with activities of daily living (i.e., C29, C32), they were coded as requiring assistance (i.e., ASSIST 1= yes, 0= no).

Body Mass Index - Participants' height and weight was provided by self-reporting. A new variable, body mass index (BMI), a measure of generalized obesity, was calculated dividing weight (kilograms) by height (meters^2). Following Haffner et al (1997) and the WHO Inter-Health Programme (Berrios et al., 1997), individuals were defined as obese with a body mass index ≥ 30 kg/m^2, and non-obese with a BMI < 30 kg/m^2.

Aboriginal Ancestry

One of the variables which has been found to be significantly associated with diabetes in studies among some North American Aboriginal groups is that of Aboriginal ancestry; a positive relationship between level of Aboriginal heritage and prevalence of diabetes has been found on the population level. Questions specific to Aboriginal ancestry were not asked of APS participants. However, an ancestry variable was derived from the "age", "ability to speak an Aboriginal language", and "participation in traditional activities" variables.

An assumption was made in the creation of this variable that the cohort aged 50 years and older would have less genetic admixture than the cohort aged less than 50 years. It was also assumed that a positive correlation existed between Aboriginal ancestry and (1) ability to speak an Aboriginal language, and (2) participation in traditional activities. Therefore, individuals who were 50 years of age and older **and** reported the ability to speak an Aboriginal language **and** participated in traditional activities, were classified as having greater Aboriginal ancestry (ancestry = 1). Those who did not fit all of these criteria were considered to have less Aboriginal ancestry and were coded as '0'.

The implications of selecting these variables to create a measure of Aboriginal ancestry is addressed in the "Discussion" section.

A listing of the variables which were used in this research and their coding schemes is found in Appendix A. The Aboriginal Peoples Survey questions which correspond to the variables used in this research are found in Appendix B.

Univariate Analysis

The SAS procedure "FREQ" was used to derive frequency distributions. The weighting variable, RECWGHT, was applied to derive estimates of the numbers of individuals reporting a particular response. The weighting variable, RELWT, was used to estimate proportions and percentages. The measure of sampling error recommended for use by Statistics Canada (1995a) is the coefficient of variation. While approximate coefficients of variation, applicable to all variables, are provided in the APS Microdata File User's Guide (Statistics Canada, 1995a), more accurate estimates of the variance for the specific variables diabetes, high blood pressure and heart problems were obtained from Statistics Canada and used in this research (Éric Langlet, September 1998). As per Statistics Canada guidelines, estimates with a coefficient of variation of 33.3% and greater are not for release and therefore are not reported in this research.

Standardization

One of the primary objectives of this research was to compare self-reported diabetes prevalence among Canadian Métis to self-reported rates among Canadian North American Indians and the general Canadian population. One of the potential problems inherent in such comparisons is the possibility of confounding the effects of one variable (e.g., differences in age distributions) with another (e.g., diabetes rate). Standardization is a method used to control for the effects of differences in age structure (or other confounding variables) when comparing two or more populations (Last, 1988). The direct method was used for this research:

$$p = \frac{\sum N_i p_i}{\sum N_i}$$

where,
- p= directly standardized rate
- N_i= stratum-specific sizes in the standard population
- p_i= age-specific rates for variable of interest in the given population

(Armitage, 1971).

The 1991 Canadian population adjusted for net census under-coverage was used as the standard population (Statistics Canada, 1995b).

Decomposition

The difference in crude diabetes rates between two populations can be attributed to differences in diabetes rates and also to differences in age structure. Decomposition analysis, as outlined by Keyfitz and Flieger (1971), allows for determination of the relative contributions of rates and age structure.

The difference in crude rates, D.C.R., is obtained by subtracting the crude rate of the given population from the crude rate of the standard population:

$$D.C.R. = \frac{\sum ({}_sP_x)({}_sD_x)}{{}_sP} - \frac{\sum (P_x)(D_x)}{P}$$

where,
${}_sP_x$= standard population
${}_sD_x$= diabetes rate of standard population
P_x= given population
D_x= diabetes rate in given population

The rates component of the difference, R.C., is achieved by subtracting the standardized rate of the given population from the standardized rate of the standard population:

$$R.C. = \frac{\sum ({}_sP_x)({}_sD_x)}{{}_sP} - \frac{\sum ({}_sP_x)(D_x)}{{}_sP}$$

The age component of the difference, A.C., is given by subtracting the difference in crude rates from the difference in standard rates:

$$A.C. = R.C. - D.C.R.$$

The proportion of the crude rate that is attributable to the difference in age structure between the two populations is achieved by dividing the difference related to age structure, A.C., by the difference in standard rates, R.C.

Bivariate Analysis

Bivariate and multivariate analyses were guided by the recommendations of Hosmer and Lemeshow (1989) for logistic regression. The first step in preparation for logistic regression analysis is selection of the variables to be included in the model-building stage. The chi-square test of independence was used to test the significance of the relationships between the outcome (dependent) variable, diabetes, and the selected explanatory (independent) variables. Pearson chi-square statistics were used to determine significance. Fisher's exact test was performed when counts on more than 25% of cells were less than 5. Variables with a p-value of <0.25 were retained for multivariate analysis. Chi-square analysis was completed by ethnic group for each province and the combined data. Univariate logistic regression was also used to test the significance of explanatory variables against diabetes for the combined western Canada data. The significance of diabetes as an *explanatory variable* was tested against numerous outcome variables.

An important part of the analysis at this stage was inspection of the bivariate contingency tables for the presence of zero cell counts. The occurrence of a zero cell will yield an odds ratio of either zero or infinity, leading to unstable parameter estimates and standard errors in logistic regression analysis. Strategies to handle zero cells include collapsing the categories of the variable; elimination of the problem category; modelling the variable as though it was continuous, if it was ordinally scaled; creation of new variables; and adding a constant to each cell of the contingency table(Menard, 1995; Hosmer and Lemeshow, 1989). Strategies employed for this research included aggregation of categories, construction of new variables combining two or more variables measuring similar concepts, and elimination of variables.

Difficulties with zero cell counts were primarily evident during the within-province analyses. However, the difficulties were negligible once the provincial data were aggregated into the Western Canada data set. Some new variables which were created because of instability during analysis at the provincial level were retained for the analysis at the combined provincial level because of their conceptual efficiency. These composite variables, created as measures of mobility disability, sight impairment, activity limitations and assistance with activities of daily living, were discussed previously.

Multivariate Analysis

Multicollinearity

Multicollinearity occurs when explanatory variables are highly correlated with one another. The consequence of multicollinearity for regression analysis is that parameter estimates become unreliable because of large variances and standard errors (Lewis-Beck, 1980). Assessment of multicollinearity was completed in three stages. First, bivariate correlations among all explanatory variables selected for inclusion in multiple logistic regression analysis were examined using Spearman's rank correlation coefficient, r_s, as the test statistic. A value of 0.80 or greater was considered indicative of high collinearity.

While bivariate testing takes into account the relationship between two variables at a time, it is not able to assess the relationship between one explanatory variable and all other explanatory variables. Thus, the second method for assessing multicollinearity involves regressing each explanatory variable on all other explanatory variables(Lewis-Beck, 1980). The SAS procedure REG (regression) was used to calculate a linear regression model. A regression model is reliable in this situation (i.e, using categorical outcome variables) because the interest lies in the relationships among the explanatory variables, not the model estimates themselves. The tolerance statistic, $1-R^2_x$ (where R^2_x is the variance in each explanatory variable, x, explained by all of the other explanatory variables), was used to assess the degree of collinearity. A tolerance of <0.20 is indicative of high collinearity (Menard, 1995).

The third method for assessing multicollinearity involves inspection of the parameter estimates during logistic regression. Large changes in the unstandardized coefficients, standard errors, and significance levels may indicate a linear relationship between the most recently entered variable and those already in the equation (Hosmer and Lemeshow, 1989). In addition, unstandardized coefficient estimates of greater than 2.0 and standardized estimates greater than 1 may indicate a collinearity problem (Menard, 1995).

Multiple Logistic Regression

Multiple logistic regression is an analytic technique that allows the researcher to examine the relationship between a categorical outcome variable and multiple explanatory variables. Models developed using multiple logistic regression estimate the probability that an event will occur and express the probability in the form of an odds ratio, where the odds of an event is equal to the ratio of the probability of the event occurring (p) to the probability that it will not ($1-p$): $\left(\frac{p}{1-p}\right)$

The logistic model can be written as:

$$\ln\left[\frac{p}{1-p}\right] = b_o + b_1X_1 + \ldots + b_kX_k$$

where b_o = constant; b_1 to b_k = estimated coefficients; k = number of explanatory variables; X_1 to X_k = values of the k explanatory variables (Polit, 1996).

The logistic regression model predicts the log odds of disease, which can easily be converted to the more understandable probability of disease. The constant term, b_o, measures the log odds of disease when the explanatory variables take the zero or baseline value. The coefficient, b_1, represents the log odds ratio measuring the increase (or decrease) in odds of disease corresponding to a one unit increase in the value of the explanatory variable.

The odds of disease is obtained through exponentiation of the log odds:

$$\text{Odds Ratio (OR)} = \exp(b_1)$$

The probability of disease is obtained as follows:

$$\Pr = \frac{OR}{1 + OR}$$

Multiple logistic regression is an especially useful analytic technique for the study of chronic diseases because of its ability to examine the influence of many factors at once. In other words, the effect of one variable can be determined while controlling for the influence of all other variables in the model.

Multiple logistic regression models using diabetes as the outcome variable were created for Métis and North American Indians by province and for the combined western Canada data set. Models were also generated assessing the impact of diabetes (i.e., as an explanatory variable) on high blood pressure and heart problems. Models were created with the SAS procedure LOGISTIC using stepwise and backwards logistic regression for variable selection.

CHAPTER FIVE

RESULTS

Characteristics of Study Participants

Age-Sex Distribution

The weighted sample size for the three study provinces is 169,700. Participation rates were similar in all provinces and averaged approximately 75%, with on-reserve response rates slightly greater than off-reserve rates. The age and sex distributions were similar between the Métis and the North American Indians with approximately 85% of each population under the age of 50 years (Figures 5.1 and 5.2).

Figure 5.1
Age-Sex Distribution of Western Canadian Métis (%)

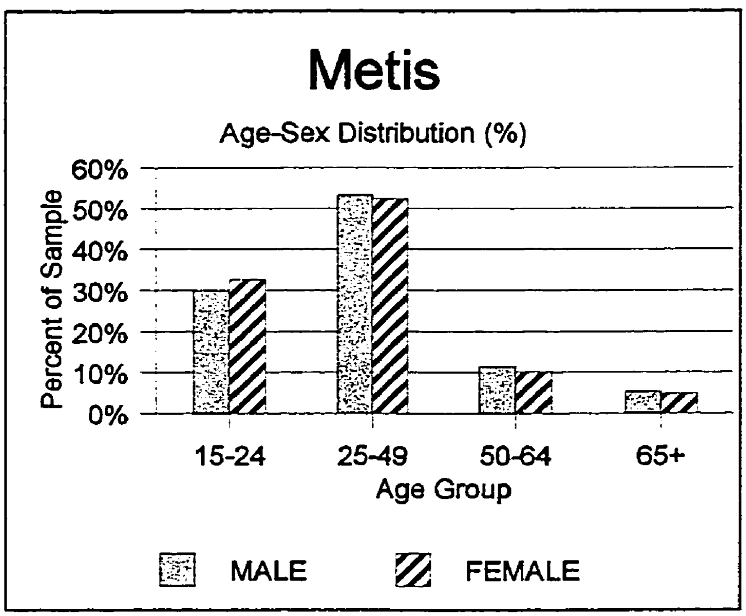
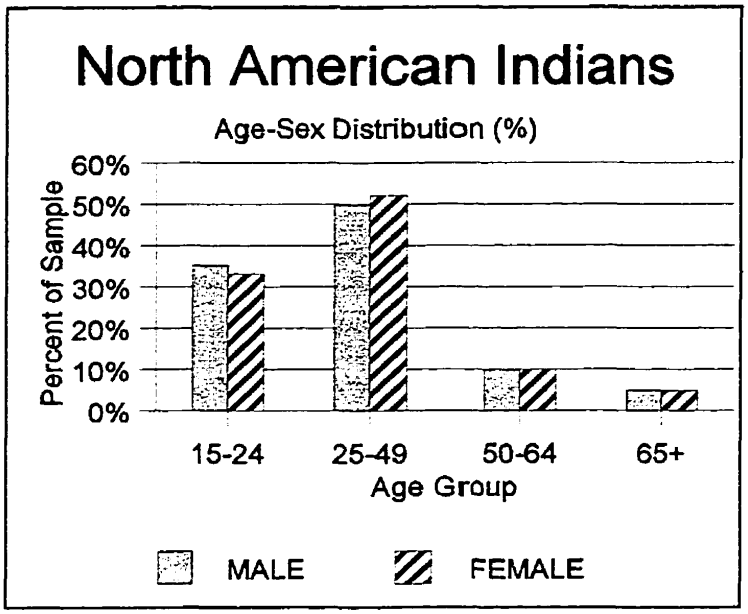


Figure 5.2
Age-Sex Distribution of Western Canadian North American Indians



Sociodemographic Characteristics

The sociodemographic characteristics of all study participants are found in Table 5.1. Because response rates to survey questions varied considerably, the percentages reported in Table 5.1 are not based on equal numbers of participants. One of the variables of interest which had the poorest response rate was "annual income". Among the Métis the non-response rate for this variable was 19%, while among the North American Indians the non-response rate was 25%. Among both groups non-response was equally distributed between males and females, but varied by age group, with the greatest non-response (i.e., 20-30%) among individuals in the 15-49 age groups. The non-response rates for the remaining variables included in Table 5.1 were less than 10%.

Table 5.1

Sociodemographic Characteristics of Study Participants (%)

Variable	Categories	Métis	North American Indian
Sex	Male	47%	46%
	Female	53%	54%
Age Group	15-24	31%	34%
	25-49	53%	51%
	50-64	11%	10%
	65^{-}	5%	5%
Education	< Grade 9	24%	33%
	≥ Grade 9	76%	67%
Annual Income	< $10,000	48%	58%
	≥ $10,000	52%	42%
Marital Status	Now Married	52%	52%
	Separated/Divorced	12%	10%
	Single	36%	38%
Employment Status	Employed	49%	34%
	Not Employed	14%	15%
	Not in Labor Force	37%	51%
Registered under *Indian Act*	Registered	12%	85%
	Not Registered	88%	15%
Speak Aboriginal Language •	Yes	22%	54%
	No	78%	46%

• Among the Métis who speak an Aboriginal language well enough to carry on a conversation, over 50% report speaking Cree, and 1% Michif.

Some interesting differences on socioeconomic variables were noted between the Métis and North American Indians. North American Indians reported speaking an Aboriginal language well enough to carry on a conversation more than twice as frequently as Métis participants. Métis participants were more likely than North American Indian respondents to earn more than $10,000 per year, and to have completed at least grade 9.

Distribution of Record Weights

The final weight attached to each record varied widely by province, identity (i.e., North American Indian vs Métis), sub-provincial category and age. Saskatchewan participants (Métis and North American Indian) had the smallest and most stable mean weights (i.e., lowest standard deviations), while Aboriginal groups in Alberta had the largest and most variable weights. In all provinces, mean record weights were greater among the Métis than among North American Indians. Sub-provincial variation was also observed, with the most stable weights assigned to North American Indian residents of Indian reserves ($\bar{x}$=10), and the largest and most variable weights assigned to residents of large metropolitan areas (Métis: $\bar{x}$=25; NAI: $\bar{x}$=23). In addition, weights were generally larger and more variable among participants in the 15-49 age groups. The mean record weight for Western Canadian Métis and North American Indians was 19 and 14, respectively.

Diabetes Prevalence

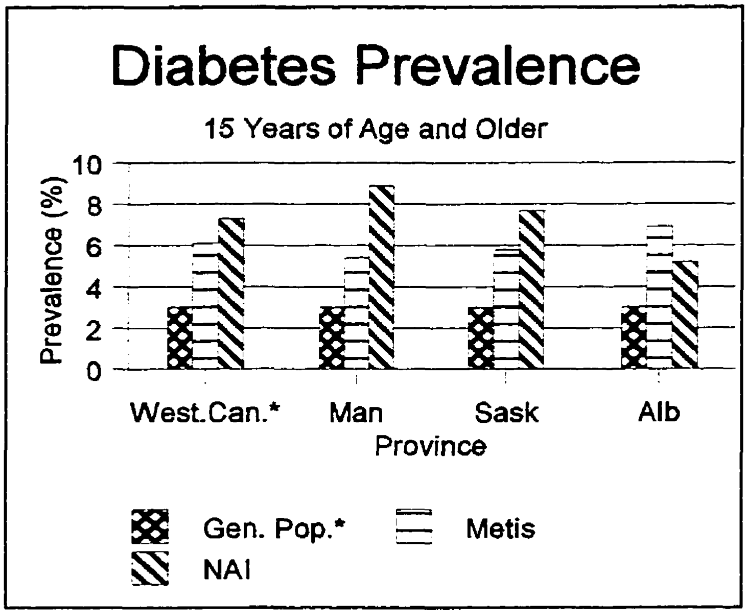
The crude prevalence of diabetes among the Métis, North American Indian and general Canadian populations is reported by province in Table 5.2 and Figure 5.3.

Table 5.2
Crude Diabetes Prevalence - Age 15^{+} (Prevalence expressed as percentage)

	POPULATION		
Province	**Métis**	**North American Indian**	**General Population***
Western Canada	6.1	7.3	3.0•
Manitoba	5.4	8.9	3.0
Saskatchewan	5.8	7.7	3.0
Alberta	6.9	5.2	3.0

* Source: 1991 General Social Survey (Statistics Canada, 1994).
• Prevalence applies to Manitoba, Saskatchewan and Alberta combined.

Figure 5.3
Diabetes Prevalence by Population and Province - 15 Years and Older



* Source: 1991 General Social Survey (Statistics Canada, 1994).
* Prevalence applies to Manitoba, Saskatchewan and Alberta combined.

The crude diabetes prevalence among Western Canadian Métis (6.1%) is slightly less than that reported by North American Indians (7.3%) [χ^2=3.803, p=0.051], and twice the rate of the western Canadian general population for the same geographic area. Interestingly, diabetes prevalence among Manitoba and Saskatchewan Métis is significantly less than the rates reported by their respective North American Indian populations [Man: χ^2=12.202, p=0.001; Sask:χ^2=5.313, p=0.021], while the opposite trend is witnessed in Alberta [χ^2=6.217, p=0.013]. That the association between diabetes and Aboriginal group for the pooled Western Canada data is different from the individual provincial data is an example of *Simpson's Paradox* (Agresti, 1996), and probably results from the fact that the association between the variables is of different directions and similar magnitude. The effect of this difference is noticed only in rate comparisons between the two Aboriginal groups but does not affect within-group analyses.

The non-response rate for the diabetes variable was generally low; 2.3% for the Métis and 1.9% for the North American Indians. Non-response was lowest among Saskatchewan Métis (1.3%) and North American Indians (1.2%), and highest among Alberta Métis (3.85%). Generally, non-response was greater among females than males except among Alberta Métis and Saskatchewan North American Indians. No discernible age-related trends were noted.

Geographic differences in diabetes prevalence were noted. Alberta Métis were approximately 1.5 times more likely to report having received a diagnosis of diabetes than were the Métis of Manitoba and Saskatchewan [OR=1.4, (95% Confidence Intervals: 1.1,1.9)]. Among North American Indians, Manitoba and Saskatchewan participants were approximately 1.5 times more likely to report having diabetes than Alberta North American Indians [Man: OR=1.73, (1.38,2.17); Sak: OR=1.49, (1.18,1.89)]. Sub-provincial geographic differences were noted among North American Indians but not among the Métis. While the prevalence of diabetes among rural dwelling Métis (7.1%) was greater than among urban dwelling Métis (5.7%), the difference was not statistically significant. North American Indians living on-reserve were 1.5 times more likely to report having received a diagnosis of diabetes than North American Indians living off-reserve [95% Confidence Intervals: 1.25,1.77].

Diabetes prevalence among Métis and North American Indian women is significantly greater than among men [Métis: χ^2=16.062, p=0.001; NAI: χ^2=24.992, p=0.001], while the rates are similar among the general Western Canadian population (Table 5.3).

Table 5.3
Crude Diabetes Prevalence by Population and Sex

	POPULATION		
Sex	**Western Canada***	**Métis**	**North American Indian**
Female	3.0	7.6	8.7
Male	3.0	4.3	5.6

*Source: 1991 General Social Survey (Statistics Canada, 1994). Western Canada comprised of Manitoba, Saskatchewan and Alberta.

The crude diabetes prevalence among both Aboriginal groups and the Canadian population increases significantly with age and is represented graphically in Figures 5.4 to 5.6.

Figure 5.4
Crude Diabetes Prevalence by Age and Sex - Western Canadian Métis

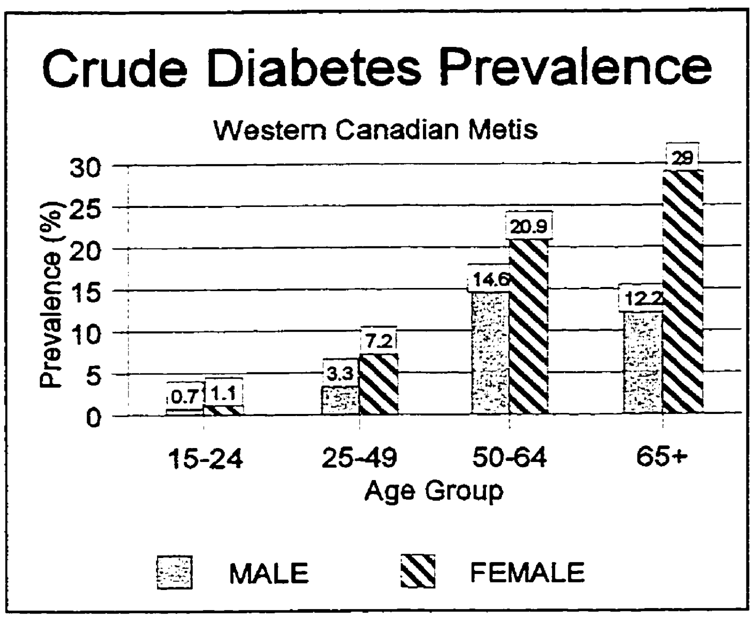


Figure 5.5
Crude Diabetes Prevalence by Age and Sex - Western Canadian North American Indians

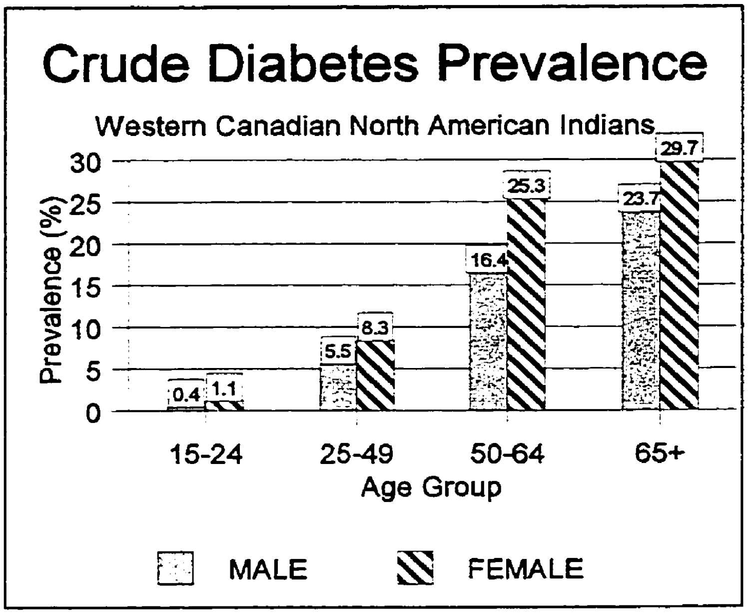
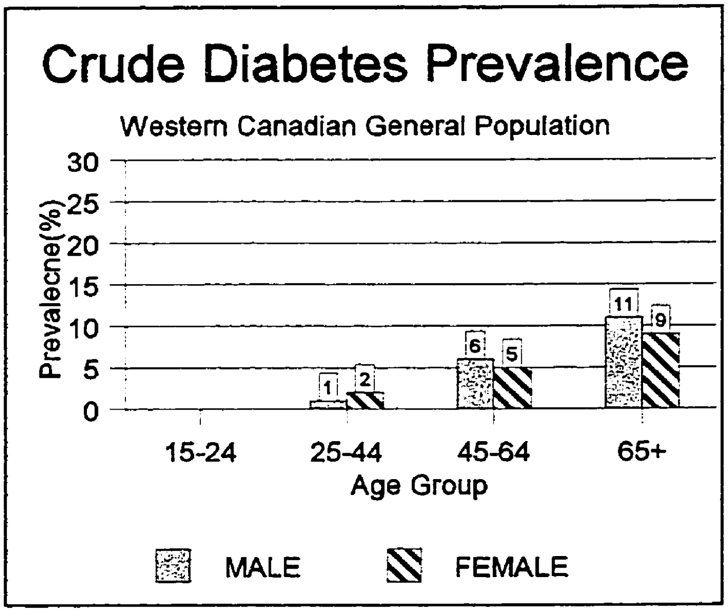


Figure 5.6
Crude Diabetes Prevalence by Age and Sex - Western Canada General Population



Source: 1991 General Social Survey. (Statistics Canada, 1994).
Data for the 15-24 years age group were suppressed by Statistics Canada.
Western Canada comprised of Manitoba, Saskatchewan and Alberta.

Standardized Diabetes Rates

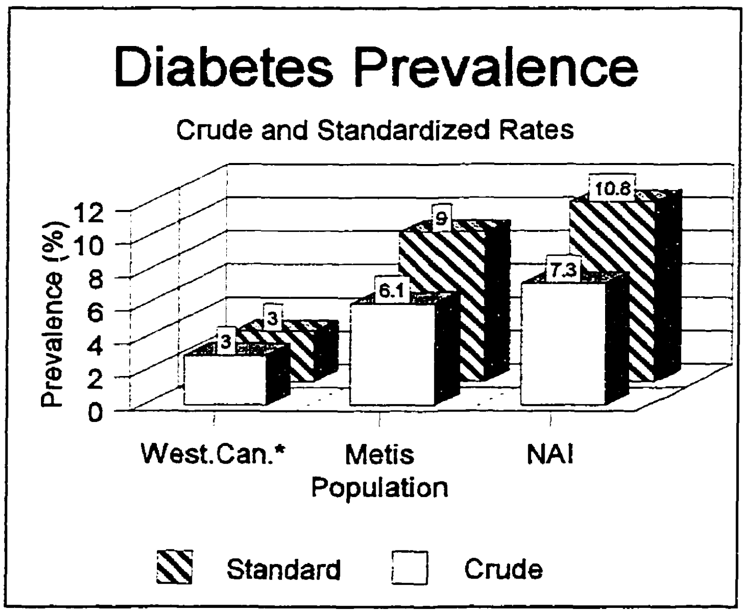
The directly standardized diabetes rate provides an estimate of what the crude diabetes rate among the study populations (i.e., Métis and North American Indians) would be if these populations had the same age structure as the standard population (i.e., Canadian population). As expected, the directly standardized diabetes rates among the Métis and North American Indians are greater than their respective crude rates. Table 5.4 and Figure 5.7 provide a comparison of crude and directly standardized diabetes rates.

Table 5.4
Crude and Directly Standardized Diabetes Prevalence by Population

	POPULATION		
Rate	Western Canada•	Métis	North American Indian
Crude	3.0	6.1	7.3
Standardized	3.0	9.0	10.8

•Source: 1991 General Social Survey (Statistics Canada, 1994)
Western Canada comprised of Manitoba, Saskatchewan and Alberta.

Figure 5.7
Crude and Standardized Diabetes Prevalence by Population



*Source: 1991 General Social Survey (Statistics Canada, 1994)
Western Canada comprised of Manitoba, Saskatchewan and Alberta.

Decomposition

The difference in crude diabetes rates between two populations can be attributed to difference in age distribution and true difference in diabetes prevalence. Through decomposition analysis the relative contributions of age composition and diabetes to the observed differences in their respective crude rates can be examined. Decomposition of rates was completed between Aboriginal groups, between sexes within Aboriginal groups and between sexes between Aboriginal groups (Table 5.5).

Table 5.5
Decomposition of Crude Diabetes Rates

Standard Population	Given Population	Difference in Crude Rates	Rate Component	Age Component	Proportion of Difference due to Age
NAI	Métis	10.71	12.2	1.49	0.122
Métis	NAI	-10.71	-13.06	-2.35	0.180
NAI-Female	NAI-Male	28.74	27.85	-0.89	0.032
NAI-Male	NAI-Female	-28.74	-27.47	1.27	0.046
Métis-Female	Métis-Male	34.65	37.05	2.40	0.065
Métis-Male	Métis-Female	-34.65	-39.17	-4.52	0.115
NAI-Male	Métis-Male	13.54	16.83	3.29	0.195
Métis-Male	NAI-Male	-13.54	-18.36	-4.82	0.262
NAI-Female	Métis-Female	7.63	8.24	0.61	0.074
Métis-Female	NAI-Female	-7.63	-8.34	-0.71	0.085

The standard and given populations are found in the first two columns of Table 5.5. Column three represents the difference in crude diabetes rates between the standard and given populations. Negative values resulted when the crude diabetes rate in the given population was greater than that in the standard population. The difference in crude rates related to age structure is found in column four, while the difference attributed to rates is in column five. The proportion of the difference in crude rates that is attributable to the difference in age structure between the standard and given populations is found in column six.

Two values are provided for each comparison switching standard and given populations (i.e, North American Indians as standard and Métis as the given population and vice versa). The proportion of the difference in crude rates between the two populations that is due to differences in age structure probably lies somewhere between the two given values. For example, the proportion of the difference in crude diabetes rates that is due to differences in age structure between North American Indians and the Métis probably lies between 12 % and 18%. The largest proportion of the difference in crude diabetes rates between the Métis and North American Indians that may be attributed to differences in age structure is found among males and accounts for approximately 19.5 to 26%. Thus, the majority of the difference in crude rates between North American Indians and the Métis can be attributed to differences in diabetes rates.

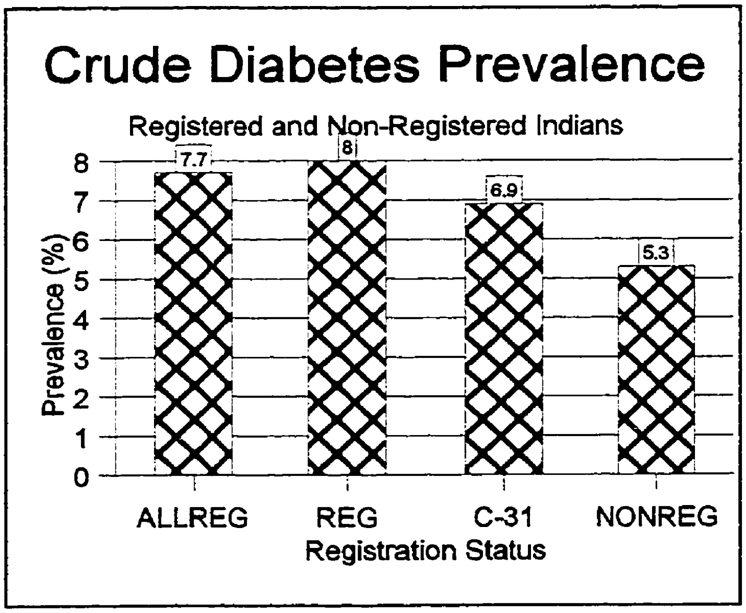
Bill C-31 Registrants

Bill C-31 registrants have the potential to greatly affect the health statistics on Aboriginal peoples. If Bill C-31 registrants are systematically different from the populations they are entering (i.e., registered Indian) or those from which they are exiting, then they have the ability to skew the statistics in one direction or another. For example, if Bill C-31 registrants have a higher (or lower) level of diabetes than non-registrants, then their exit from the non-status Indian population may decrease (or increase) the prevalence of diabetes in that group.

A total of 100,891 APS participants included in this research reported registration under the *Indian Act*. Of these, 23,420 (23%) were registered as status Indians under Bill C-31. Interestingly, seven percent (n=7,332) of registered Indians identify themselves as Métis and not as North American Indian. Forty-eight percent (n=3515) of the Métis who are registered under the *Indian Act* achieved status through Bill C-31. The following analysis is completed on aggregated registered Indians and Bill C-31 registrants and does not differentiate by identity (i.e., Métis versus North American Indian).

The crude prevalence of diabetes among registered Indians including Bill C-31 registrants (ALLREG), registered Indians minus Bill C-31 registrants (REG), Bill C-31 registrants (C-31), and non-registered Indians (NONREG) is presented in Figure 5.8.

Figure 5.8
Crude Diabetes Prevalence by Registration Status



Diabetes prevalence is significantly greater among registered than non-registered Indians [χ^2=21.876, p=0.001], and among Bill C-31 registrants alone compared to non-registered Indians [χ^2=4.967, $p<0.05$]. However, the prevalence of diabetes among registered Indians remains essentially the same with or without the inclusion of the Bill C-31 registrants.

Presumably, at one point, those who achieved status under Bill C-31 would have been classified as non-registered Indians, whether North American Indian or Métis. When the Bill C-31 registrants were removed from the registered Indian category and placed into the non-registered category, the resulting diabetes prevalence of 5.8% among the non-registered group was not significantly different from the "actual" non-registered diabetes prevalence of 5.3%. Thus, the Bill C-31 registrants had the effect of decreasing the prevalence of diabetes among registered Indians and increasing the prevalence among non-registered Indians, although the changes were not statistically significant at the 0.05 level.

Determinants of Diabetes

Bivariate Analysis

A listing of the variables identified as risk factors for diabetes which achieved a significance level of at least 0.25 on Chi-square testing for the combined Western Canadian data is found in Table 5.6. The risk of diabetes is represented by the odds ratio; each level of the variable is measured against a reference level, identified by the category with an odds ratio equal to one. The "p" values in Table 5.6 represent the level of statistical significance achieved on Chi-square testing. Variables which achieved statistical significance in provincial analysis but not in the combined data analysis are not included in these listings.

Table 5.6
Analysis of Risk Factors for Diabetes by Aboriginal Group

	POPULATION	
	Métis	North American Indian
Sex		
Female	1.0	1.0
Male	0.528****	0.635****
Age		
65^{-}	1.0	1.0
15-24	0.036****	0.023****
25-49	0.209****	0.196****
50-64	0.856	0.696**
Age Group		
15-49	1.0	1.0
50^{-}	6.343****	6.371****
Participate in Physical Activities		
No	1.0	1.0
Yes	0.377****	0.362****
Body Mass Index		
<30 kg/m^2	1.0	1.0
≥ 30 kg/m^2	5.163****	3.085****
Annual Income		
<$10,000	1.0	1.0
$\$10,000^{-}$	1.039	1.290**
Employment Status		
Not Employed	1.0	1.0
Employed	0.872	1.379*
Education		
<Grade 9	1.0	1.0
≥Grade 9	0.259****	0.303****
Speaks Aboriginal Language		
No	1.0	1.0
Yes	3.281****	3.431****
Aboriginal Ancestry		
Lesser Degree	1.0	1.0
Greater Degree	4.699****	4.724****

*$P \leq .25$; **$P \leq .05$; ***$P \leq .01$; ****$P \leq .001$ compared to reference group identified by odds ratio = 1.0.

The majority of the variables listed in Table 5.6 had a clearly significant association with diabetes status. The relationships between diabetes and risk factors were similar between the Métis and North American Indians, except that among the Métis, there were no significant relationships between diabetes and annual income and employment status. Among both Aboriginal groups the risk of diabetes increases with age and is greater among females than males. Those who are classified as obese (i.e., BMI $\geq 30 kg/m^2$) are at increased risk for diabetes compared to those who are not classified as obese (i.e., BMI $< 30 kg/m^2$). Risk of diabetes is less for those who reported participation in physical activities and who completed at least grade 9. Both Métis and North American Indian participants who reported ability to speak an Aboriginal language well enough to carry on a conversation are three times more likely to report having received a diagnosis of diabetes than those who report inability to speak an Aboriginal language. Annual income and employment status were significantly associated with presence of diabetes among North American Indian participants.

Multivariate Analyses

Because age may act as a confounder in the observed associations between diabetes with other variables, multivariate analyses were conducted to control for the possible effects of age on diabetes and other variables of interest. The percentage of individuals with diabetes by selected socioeconomic characteristics, health status measures and health behaviors is presented in Tables 5.7 and 5.8. The age group '15-24' is omitted from the tables because of the small numbers of individuals with diabetes and the resulting high coefficients of variation.

Table 5.7

Diabetes Prevalence by Age Group and Select Risk Factors - Métis

	DIABETES PREVALENCE		
	Age Group		
	25-49	50-64	65+
	%	%	%
Income			
<$10,000	5	23	21
≥$10,000	5	15	19
Not Reported•	7	17	-
Employment			
Not Employed	6	19	-
Employed	5	8	-
Education**			
<Grade 9	8	22	24
≥Grade 9	5	14	8
Speak Aboriginal Language**			
No	4	17	18
Yes	9	20	23
Participation in Physical Activity*			
No	8	20	23
Yes	4	18	15
Body Mass Index**			
<30kg/m²	4	10	21
≥30kg/m²	13	38	23

*P=0.005; **P=0.001 (Cochran-Mantel-Haenszel Statistic)

- Coefficient of Variation > 33⅓

• Diabetes prevalence reported for those who did not respond to the annual income question because of the large non-response rate for the variable.

Table 5.8
Diabetes Prevalence by Age Group and Select Risk Factors - North American Indians

	DIABETES PREVALENCE		
	Age Group		
	25-49	50-64	65^+
	%	%	%
Income			
<$10,000	7	24	24
≥$10,000	5	16	31
Not Reported•	7	21	17
Employment			
Not Employed	4	13	-
Employed	6	14	-
Education*			
<Grade 9	10	22	28
≥Grade 9	6	18	21
Speak Aboriginal Language*			
No	4	13	28
Yes	9	22	27
Participation in Physical Activity*			
No	8	22	28
Yes	6	15	23
Body Mass Index*			
$<30 kg/m^2$	5	19	25
$\geq 30 kg/m^2$	14	26	37

*P=0.001 (Cochran-Mantel-Haenszel Statistic)
- Coefficient of Variation > 33⅓
• Diabetes prevalence reported for those who did not respond to the annual income question because of the large non-response rate for the variable

Among the Métis and North American Indians, level of education, ability to speak an Aboriginal language, participation in physical activity and body mass index remained significantly associated with diabetes status after controlling for the effects of age. Diabetes prevalence was significantly greater among Métis and North American Indians who had completed less than grade 9, who reported an ability to speak an Aboriginal language well enough to carry on a conversation, whose body mass index was equal to or greater than 30 kg/m^2, and who did not participate in physical activities. However, once the effects of age were considered, annual income and employment status no longer remained associated with diabetes status among North American Indians.

Multicollinearity

All variables included in the analysis were assessed via bivariate correlation testing. The variable "AGEGRP" rather than "AGE" was used because the "AGE" variable consisted of four levels while "AGEGRP" was a dichotomous variable. Some variables were highly correlated (0.35-0.45), but this was not unexpected. For example, among the Métis, age was highly correlated with a number of variables including level of education (-0.418), and chronic conditions such as arthritis were highly correlated with other health status variables such as self-reported health status (0.373), and presence of a mobility disability (0.405).

Multiple regression models were created for the select sub-set of variables which were to be used in logistic regression analysis. These variables included age (separate analyses were conducted with AGEGRP), sex, diabetes, high blood pressure, heart disease, arthritis, emphysema, asthma, tuberculosis, physical activity, body mass index, education level (school), smoking status, annual income, sight impairment and mobility disability. When regression analyses were conducted using the design variable for Age, the first two levels of the variable, corresponding to the age groups '15-24' and '25-49', were highly correlated with the majority of the remaining variables and produced tolerance levels of <0.20. When the variable "AGEGRP" was used, no collinearity problems were noted (i.e., tolerance on all variables was greater than 0.20). As Menard (1995) indicates, the good news is that multicollinearity is easy to detect; the bad news is that there are few acceptable ways to deal with it. One proposed solution is to remove involved variables. In this analysis such a solution is unacceptable because of the importance of the age variable in predicting diabetes status. Another solution specific to this analysis would be to use the dichotomous age variable, rather than the design variable. While this solves the collinearity problem it does result in a loss of information. An additional solution proposed by Menard (1995) is to combine collinear variables into a single scale. This would not be possible in this analysis because of the effect of age on almost every variable. Menard (1995) concludes that the safest way to deal with collinearity problems is to focus on the collective effects of all variables in the model and interpret with caution the effects of individual predictors.

Multiple Logistic Regression Analysis

One of the primary objectives of this research was to determine the variables which were predictive of diabetes status among the two Aboriginal study groups. The variables that were significantly associated with diabetes among the Métis and North American Indians are presented in Tables 5.9 and 5.10.

The probability of diabetes among the Métis was tested with six explanatory variables: sex, age, physical activity, body mass index, level of education and income. The goal of modeling was to test the etiological relationship between diabetes and previously established risk factors for the disease. Four variables were significantly related to the presence of diabetes: sex, age, obesity, and level of education. The overall model was statistically significant (model χ^2=219.935, p=0.0001).

Table 5.9
Logistic Regression Analysis for Diabetes Among Western Canadian Métis

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-1.3329	0.1696	0.0001	-
Sex (Male)	-0.6871	0.1743	0.0001	0.503
Age 1(15-24)	-2.5347	0.3764	0.0001	0.079
Age 2(25-49)	-1.1028	0.1872	0.0001	0.332
BMI ($\geq$30kg/m^2)	1.1408	0.1749	0.0001	3.129
Education ($\geq$Grade 9)	-0.5954	0.1839	0.0012	0.551

-2 Log Likelihood 1075.686
Model Chi-Square (5df) 219.935 (p=0.0001)

N = 2729.17

Each of the variables that are significantly associated with diabetes status can be interpreted as having an effect on the presence of diabetes independent of all other variables in the model. For example, after controlling for the effects of age, body mass index and level of education, there remains a significant difference in diabetes prevalence between men and women. Specifically, the odds of diabetes among Métis males is approximately half (0.503) of that for women and this reduction in the odds of disease is not related to age, obesity, or level of education.

The variables in the above table can be placed into equation form, and used to predict the probability of diabetes for any combination of the explanatory variables. The equation is as follows:

$$\ln(^{p}/_{1-p}) = -1.3329 - 0.6871(\text{sex}) - 2.5347(\text{age1}) - 1.1028(\text{age2}) + 1.1408(\text{BMI}) - 0.5954(\text{school})$$

where, **sex =** 1 if 'male' 0 if 'female'; **age1 =** 1 if '15-24' 0 if not; **age2 =** 1 if '25-49' 0 if not;

BMI = 1 if 'obese' ($\geq$30kg/m^2) 0 if 'not obese' (<30kg/m^2); **School =** 1 if 'grade 9 and over' 0 if 'less than grade 9'.

Thus, the probability of diabetes for a Métis women, aged 55 years who is obese and has a high school diploma is:

$$\ln(^{p}/_{1-p}) = -1.3329 + 1.1408 - 0.5954$$
$$= -0.7875 \text{ (log odds)}$$

$$\text{Odds of disease} = (\exp) -0.7875$$
$$= 0.455$$

$$\text{Probability of disease} = {}^{0.455}/_{1.455} = 0.313$$

This suggests a prevalence of diabetes of 31.3% in Métis women with these characteristics.

The probability of diabetes among Métis males with the same characteristics is:

$$\ln(^{p}/_{1-p}) = -1.3329 - 0.6871 + 1.1408 - 0.5954$$
$$= -1.4746 \text{ (log odds)}$$

$$\text{Odds of disease} = (\exp) -1.4746$$
$$= 0.229$$

$$\text{Probability of disease} = {}^{0.229}/_{1.229} = 0.186$$

Suggesting a prevalence of diabetes of 18.6% among Métis males with these characteristics.

The values listed under Table 5.9 are criteria for assessing the fit of the model. The likelihood of the model, given by -2 Log Likelihood, measures the success and believability of the model. A good model will predict a high probability of disease for those who have the disease and a low probability of disease for those who do not have the disease. The overall likelihood is the product of these probabilities (Hassard, 1993). The model Chi-square tests the null hypothesis that all of the coefficients for the model (b^1 to b^k) are zero (i.e., that they have no effect on the outcome variable). When the Chi-square value is statistically significant ($p \leq 0.05$), then the null hypothesis is rejected and we conclude that the explanatory variables allow for better prediction of the outcome variable than if they were not included (Menard, 1995).

As previously noted, a possible problem of multicollinearity was discovered for the age variable and other variables in the model. According to Menard (1995), a final check on multicollinearity involves examining the unstandardized and standardized coefficient estimates. Any unstandardized and standardized estimates exceeding 2 and 1 respectively, may be indicative of a problem. The unstandardized estimate of the first category of the age design variable (age1), exceeds 2 but the unstandardized estimate of 0.644 does not exceed 1. Standardized estimates for the remaining variables did not exceed 1 (data not shown). Although the model estimates are to be interpreted as having effects independent of any other variables in the model, the intermingling of age with other variables cannot be completely ruled out. However, the p values for the other variables are very strong indicating a solid relationship with the outcome variable that could not be completely accounted for by the possible effects of age on the other explanatory variable.

Variables significantly associated with diabetes among North American Indians are found in Table 5.10. The probability of diabetes among North American Indians was tested with six explanatory variables: sex, age, physical activity, body mass index, level of education and income. Five variables were significantly related to the presence of diabetes: sex, age, physical activity, body mass index, and level of education. The overall model was statistically significant (model χ^2=602.182, p=0.0001).

Table 5.10
Logistic Regression Analysis for Diabetes Among Western Canadian North American Indians

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-0.8909	0.1283	0.0001	-
Sex (Male)	-0.4155	0.1000	0.0001	0.660
Age 1(15-24)	-3.3304	0.2759	0.0001	0.036
Age 2(25-49)	-1.2973	0.1507	0.0001	0.273
Age 3(50-64)	-0.3114	0.1509	0.0390	0.732
Physical Activity Participation (Yes)	-0.3155	0.1103	0.0042	0.729
BMI ($\geq 30 kg/m^2$)	0.7620	0.1053	0.0001	2.143
Education ($\geq$Grade 9)	-0.4120	0.1102	0.0002	0.662

-2 Log Likelihood 3097.803
Model Chi-Square (7df) 602.182 (p=0.0001)

N = 6914.09

The models developed for both Aboriginal groups are similar and incorporate those variables which have been found to be significantly associated with diabetes among other Aboriginal and non-Aboriginal groups. According to this model, North American Indian males have a decreased risk of diabetes compared to females; the risk of diabetes increases significantly with age, although the risk is fairly similar between those aged 50-64 years and 65 and over; individuals who participate in physical activity have a slightly less risk than those who do not participate; the risk of diabetes among the obese is twice as great than for the non-obese; and the probability of disease is less among those who have higher levels of education. All of these variables have significant independent effects on the probability of disease, and the risk of diabetes is increased or decreased depending on the characteristics of participants on these variables.

The unstandardized estimate for the first level of the age variable exceeds 2, but the unstandardized estimate of 0.865, approaches but does not exceed 1. The unstandardized estimates for the remaining explanatory variables are all less than 1 (data not shown). Like the Métis, the relationships between the outcome variable and the explanatory variables are very strong, but the possibility that age may still have an influence on the other variables cannot be completely ruled out.

The above models were constructed to examine the relationship between diabetes and variables which have been implicated in diabetes etiology. One important variable that was not available with the APS data is Aboriginal ancestry. A composite variable comprised of age, ability to speak an Aboriginal language and participation in traditional activities was created which was meant to approximate Aboriginal ancestry. Separate models incorporating this variable were developed and are provided in Tables 5.11 and 5.12.

Table 5.11
Logistic Regression Analysis of Diabetes Incorporating Aboriginal Ancestry Variable - Western Canadian Métis

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-1.9407	0.1685	0.0001	-
Sex (Male)	-0.6651	0.1738	0.0001	0.514
Aboriginal Ancestry (Greater Degree)	0.9090	0.2912	0.0018	2.482
Physical Activity Participation (Yes)	-0.5228	0.1729	0.0025	0.593
BMI ($\geq 30 kg/m^2$)	1.3951	0.1719	0.0001	4.035
Education (≥Grade 9)	-0.9679	0.1757	0.0001	0.380

-2 Log Likelihood 1123.714
Model Chi-Square (5df) 166.692 (p=0.0001)

N = 2709.01

The model was tested with six variables: sex, ancestry, physical activity, BMI., school and income. The overall model was significant (model χ^2=166.692, p=0.0001). The derived ancestry variable was significantly associated with diabetes controlling for the effects of sex, physical activity, obesity and level of education. Participants classified as having a greater degree of Aboriginal ancestry were almost 2.5 times more likely to report having received a diagnosis of diabetes than were those classified as having less Aboriginal ancestry.

A logistic regression model with diabetes as the outcome variable was created using six variables, including the ancestry variable, for North American Indians. All six variables were significantly associated with diabetes status (Table 5.12).

Table 5.12
Logistic Regression Analysis of Diabetes Incorporating Aboriginal Ancestry Variable - Western Canadian North American Indians

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-2.0019	0.1115	0.0001	-
Sex (Male)	-0.3947	0.1114	0.0004	0.679
Aboriginal Ancestry (Greater Degree)	0.8506	0.1369	0.0001	2.341
Physical Activity Participation (Yes)	-0.7570	0.1207	0.0001	0.469
BMI ($\geq$30kg/m^2)	0.8438	0.1179	0.0001	2.325
Education ($\geq$Grade 9)	-0.8536	0.1189	0.0001	0.426
Annual Income ($\geq$\$10,000)	0.4090	0.1085	0.0002	1.505

-2 Log Likelihood 2568.304
Model Chi-Square (6df) 326.938 (p=0.0001)

N = 5195.14

The overall model was statistically significant (model χ^2=326.938, p=0.0001). North American Indian participants classified as having a greater degree of Aboriginal ancestry are approximately twice as likely to report having diabetes than are those classified as having less Aboriginal ancestry.

Impact of Diabetes

The presence of diabetes places individuals at greater risk for cardiovascular disease and renal, neurologic and opthalmologic complications, all of which impact negatively on quality of life. APS participants were asked to evaluate their health status compared to others their age, and to indicate if their mobility, ability to perform activities of daily living (i.e., personal care), or activity levels had been impaired due to a "condition or health problem". The impact of diabetes on the lives of APS participants was explored through comparison of the frequency of these measures of negative health status between those with and without diabetes (Tables 5.13 and 5.14). The relationships between diabetes and health status measures were tested controlling for age and sex.

As expected, Métis and North American Indian participants with diabetes were more likely than those without diabetes to report their health status as poor. In addition, both Métis and North American Indian individuals with diabetes more frequently saw someone about their health in the past year than did those without diabetes. Métis participants with diabetes reported significantly more visits to community health representatives than those without diabetes. North American Indians with diabetes reported significantly more visits to medical doctors, community health representatives, traditional healers and eye doctors/ specialists than did those without diabetes.

At least three variables included in this analysis may be considered to represent the effects of illness complications on the lives of study participants and not surprisingly, individuals with diabetes were more likely to experience lifestyle limitations than were those without diabetes. Significantly greater numbers of Métis and North American Indian participants with diabetes reported activity limitations, the need for assistance with the activities of daily living, and difficulties with ambulation (mobility disability) than those without diabetes.

Table 5.13
Frequency of Health Status Indicators by Diabetes Status - Western Canadian Métis (%)

	DIABETES STATUS	
	With Diabetes	Without Diabetes
Health Status Indicator	%	%
Self-Reported Health Status* Poor	45	12
Mobility Disability*	41	11
Activity Limitations*	41	12
Require assistance with activities of daily living*	19	5
Saw someone about health in past 12 months*	94	76
Saw medical doctor about health in past 12 months	99	96
Saw community health representative about health in past 12 months*	16	7
Saw traditional healer about health in past 12 months	4	3
Saw eye doctor/specialist about health in past 12 months	47	38

* P=0.001 (Cochran-Mantel-Haenszel Statistic)

Table 5.14
Frequency of Health Status Indicators by Diabetes Status - Western Canadian North American Indians (%)

	DIABETES STATUS	
	With Diabetes	Without Diabetes
Health Status Indicator	%	%
Self-Reported Health Status***		
Poor	42	12
Mobility Disability***	37	11
Activity Limitations***	32	11
Require assistance with activities of daily living***	21	5
Saw someone about health in past 12 months***	92	71
Saw medical doctor about health in past 12 months**	98	93
Saw community health representative about health in past 12 months***	30	14
Saw traditional healer about health in past 12 months*	16	10
Saw eye doctor/specialist about health in past 12 months***	56	41

* P<0.05; **P<0.01; ***P=0.001 (Cochran-Mantel-Haenszel Statistics)

The composite variables derived to represent the need for assistance with the activities of daily living, activity limitations and mobility disability may be related to other chronic health conditions besides diabetes. Logistic regression models were run to determine if diabetes was still related to these variables after controlling for the effects of age and sex and three other chronic health conditions (arthritis, heart disease, and emphysema) which may also have debilitating effects on the lives of those affected. After controlling for the effects of the above variables, diabetes remained a significant predictor of all three variables. Métis and North Americans with diabetes were almost twice as likely to report the need for assistance in activities of daily living than those without diabetes [Métis: OR=1.7 (1.1, 2.7); NAI: OR=1.7 (1.3, 2.3)]. After controlling for the same variables, Métis participants with diabetes were almost twice as likely to report activity limitations than those without diabetes [OR=1.8 (1.2,2.6)], while North American Indians with diabetes were almost 1.5 times more likely to report activity limitations than those without diabetes [OR=1.4 (1.1,1.8)]. In addition, individuals with diabetes were more likely to report a mobility disability than those without diabetes [Métis: OR=1.5 (1.2,1.9); NAI: OR=1.7 (1.1,2.50]. Thus, even after the effects of other chronic health conditions and age are taken into account, individuals with diabetes were more likely than those without diabetes to report debilitating effects of disease.

In summary, individuals with diabetes were more likely to rate their own health as poor, to suffer negative debilitating effects of illness, and to seek health care more frequently than APS participants without diabetes.

Co-morbidity

Diabetes has been established as a major risk factor for cardiovascular disease. In addition individuals with diabetes are at risk for severe opthalmologic complications, including blindness. A comparison of the prevalence of high blood pressure, heart problems and sight impairment by diabetes status is presented in Tables 5.15 and 5.16. Métis and

North American Indian diabetics reported significantly higher rates of all three conditions than non-diabetics after controlling for the effects of age and sex.

Table 5.15
Prevalence of Chronic Health Conditions by Age, Sex and Diabetes Status - Western Canadian Métis

	AGE GROUP					
	25-49		50-64		65+	
	With Diabetes	Without Diabetes	With Diabetes	Without Diabetes	With Diabetes	Without Diabetes
	%	%	%	%	%	%
High Blood Pressure**						
Both Sexes	26	10	52	23	36	33
Females	24	11	39	27	31	47
Males	30	9	74	18	52	23
Heart Problems**						
Both Sexes	9	5	32	14	55	36
Females	7	5	23	14	68	40
Males	13	5	48	15	21	32
Sight Impairment*						
Both Sexes	12	5	17	11	42	33
Females	12	5	12	11	42	33
Males	14	4	25	11	42	34

*P=0.006; **P=0.001 (Cochran-Mantel-Haenszel Statistic)

After adjusting for sex and age, Métis with diabetes were almost three times more likely to report having high blood pressure and heart disease, and twice as likely to report a sight impairment than Métis participants without diabetes. North American Indians with diabetes were more likely to report diagnoses of high blood pressure and heart problems and indicate a sight impairment than were those without diabetes. After adjusting for age and sex, North American Indians with diabetes were four times more likely to report having high blood pressure, and twice as likely to report heart problems and sight impairment.

Table 5.16

Prevalence of Chronic Health Conditions by Age, Sex and Diabetes Status - Western Canadian North American Indians

	AGE GROUP					
	25-49		50-64		65+	
	With Diabetes	Without Diabetes	With Diabetes	Without Diabetes	With Diabetes	Without Diabetes
	%	%	%	%	%	%
High Blood Pressure*						
Both Sexes	35	11	50	24	65	34
Females	32	10	51	28	68	35
Males	41	11	48	19	61	34
Heart Problems*						
Both Sexes	14	4	23	14	38	28
Females	11	4	19	12	34	26
Males	19	4	31	17	44	30
Sight Impairment*						
Both Sexes	12	7	28	14	47	35
Females	13	8	28	14	39	36
Males	12	5	28	14	57	34

*P=0.001; (Cochran-Mantel-Haenszel Statistic)

According to National Population Health Survey (NPHS) data, the prevalence of hypertension, heart disease, cataracts and glaucoma is greater among the general Canadian population with diabetes than among Canadians without diabetes (James, Young, Mustard, and Blanchard, 1997). Although the age group comparisons for the APS and NPHS are not exactly similar, they are close enough to infer that the prevalence of self-reported heart disease and hypertension among Métis and North American Indian diabetics is generally greater than among the general Canadian population with diabetes (Table 5.17). Comparison of opthalmologic complications are not possible because questions regarding specific conditions were not asked in the APS as they were in the National Population Health Survey.

TABLE 5.17

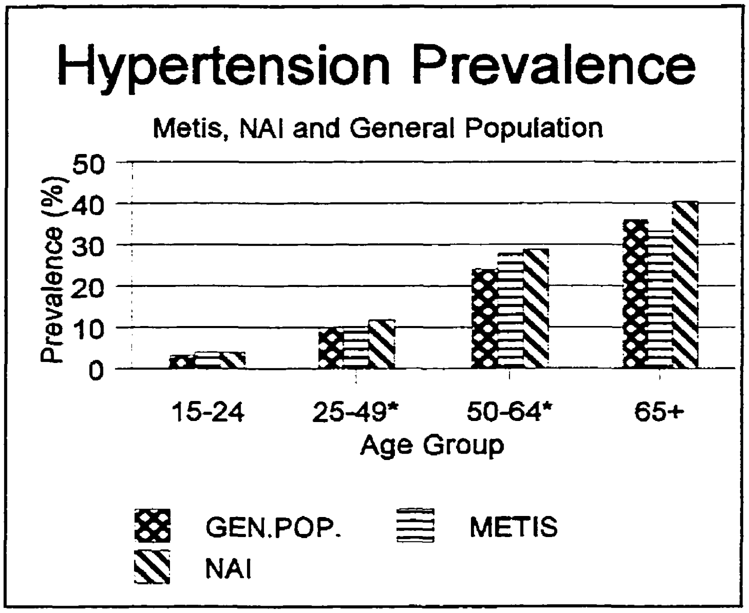
Prevalence of Chronic Health Conditions by Age, Sex and Diabetes Status - General Canadian Population

	AGE GROUP					
	25-44		45-64		65+	
	With Diabetes	Without Diabetes	With Diabetes	Without Diabetes	With Diabetes	Without Diabetes
	%	%	%	%	%	%
High Blood Pressure						
Both Sexes	15	3	36	14	41	27
Females	•	2	42	15	49	31
Males	•	3	31	13	31	22
Heart Disease						
Both Sexes	•	1	16	5	24	16
Females	•	1	•	4	23	14
Males	•	1	19	6	26	18

Source: Report on the 1994/95 National Population Health Survey, (James et al., 1997)
• Data suppressed at source

The overall prevalence of hypertension and heart disease among the Métis, North American Indians and Canadian population, not differentiating between those with and without diabetes, is provided in Figures 5.9 and 5.10.

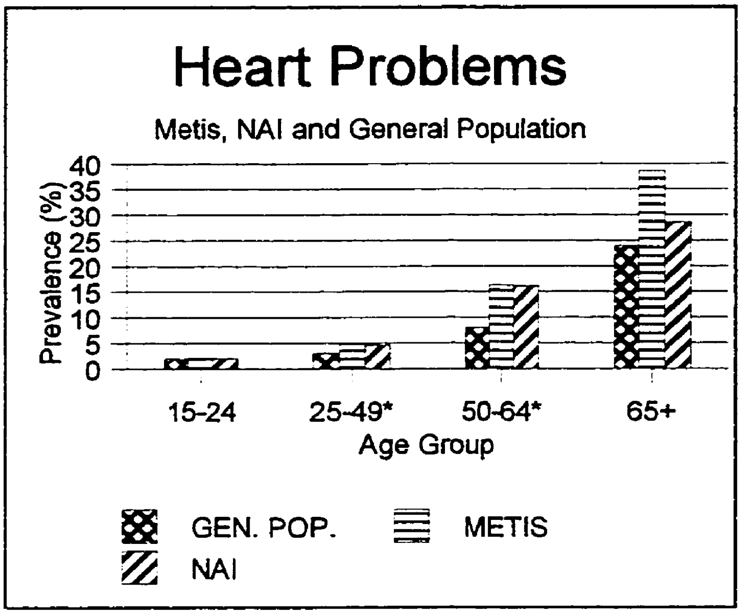
Figure 5.9
Crude Prevalence of Hypertension by Age Group and Population



Source of General Canadian Data: 1991 General Social Survey (Statistics Canada, 1994).
* Age Groups for General Population: 25-44; 46-64.

The prevalence of self-reported hypertension is similar among the three populations. The prevalence of self-reported "heart problems" is greater among the Métis and North American Indians than among the general Canadian population. Thus, Métis and North American Indians of western Canada exhibit significant morbidity when considering self-reported levels of diabetes, hypertension and heart problems.

Figure 5.10
Crude Prevalence of Heart Problems by Age Group and Population



Source of General Canadian Data: 1991 General
Social Survey (Statistics Canada, 1994).
* Age Groups for General Population: 25-44; 46-64.

In addition to cardiovascular and opthalmologic associations, Métis participants with diabetes were more likely to report having received a diagnosis of arthritis or rheumatism, emphysema or shortness of breath, and tuberculosis than those without diabetes. The excess risk experienced by those with diabetes for other chronic health conditions, after controlling for the effects of age and sex, is provided in Table 5.18.

Table 5.18
Risk of Select Chronic Disease among Diabetics by Aboriginal Group

	Risk of Chronic Condition among Diabetics Compared to non-Diabetics	
Chronic Health Condition	Métis	North American Indian
Arthritis/ Rheumatism	OR=2.9 (2.1,3.9)**	OR=2.1 (1.7,2.5)**
Emphysema/ Shortness of Breath	OR=2.9 (2.0,4.3)**	OR=2.1 (1.6,2.7)**
Tuberculosis•	OR=2.0 (1.2,3.4)*	OR=1.5 (1.1,2.2)*

OR=Mantel-Haenszel Odds Ratio (95% Confidence Intervals)
* P<0.05; **P<0.001 (Cochran-Mantel-Haenszel Statistics)
• Tuberculosis included in this table even though it not technically a "chronic illness".

High Blood Pressure

Because diabetes was determined to be strongly associated with hypertension among the Métis and North American Indians when controlling for age and sex, logistic regression modelling was performed to examine those variables which were significantly associated with hypertension among these two groups, and to see if diabetes remained a significant predictor of hypertension once other variables besides age and sex were considered. The logistic models for hypertension are presented in Tables 5.19 and 5.20. The probability of high blood pressure was tested with seven variables: sex, age, diabetes, physical activity, body mass index, level of education and annual income. Four variables were significantly associated with the presence of high blood pressure among the Métis. The model was statistically significant (model χ^2=244.476, p=0.0001).

Table 5.19
Logistic Regression Analysis for High Blood Pressure - Western Canadian Métis

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-2.4417	0.1129	0.0001	-
Age Group (50+)	1.3779	0.1593	0.0001	3.966
Diabetes (Yes)	0.9921	0.1820	0.0001	2.697
Physical Activity participation (Yes)	-0.4073	0.1260	0.0012	0.665
Body Mass Index (≥30kg/m²)	1.1672	0.1725	0.0001	3.213
Age Group*BMI Interaction	-0.7563	0.2817	0.0073	0.469

-2 Log Likelihood 1887.740
Model Chi-Square (5df) 244.476 (p=0.0001)

N = 2964.57

Diabetes remained significantly associated with high blood pressure after controlling for the effects of age, physical activity, and obesity; the risk of high blood pressure among the Métis is almost three times as great for those with diabetes than those without (OR= 2.697).

The model contains an interaction term between age group and body mass index. An interaction occurs when the association between the risk factor (obesity) and the outcome variable (high blood pressure) differs, or depends on the level of a covariate (age). If there was no interaction present then the relationship between obesity and high blood pressure would be the same at all levels of the age variable. However, if there is an interaction between two variables then one can modify the effect of the other so that the relationship is not the same at all levels of the covariate (Hosmer and Lemeshow, 1989). Thus, the relationship between obesity and high blood pressure is different depending on the level of the age variable. In this particular case, obesity is a significant predictor of high blood pressure at all ages, however, the relationship between obesity and high blood pressure is stronger at younger ages (i.e., 15-49) than in older ages (i.e., 50-65+). This does not mean that the risk for high blood pressure is greater among those aged 15-49 years than among those aged 50 years and over; this is clearly not the case. The risk of high blood pressure among those aged 50 years and over is about four times the risk of those aged 15-49. The fact that greater numbers of individuals in the 50 and over age group report having received a diagnosis of high blood pressure suggests that the diagnosis is related to more than obesity in that age group.

The strength of the relationship between two variables in categorical data analysis is given by the odds ratio. One test for the homogeneity of odds ratio is the Breslow-Day statistic, which tests the null hypothesis of homogeneity in a set of tables (Stokes, Davis and Koch, 1995). The Breslow-Day statistic testing the relationship between body mass index and high blood pressure controlling for age is 6.409 with 1 df ($p=0.011$), which is clearly significant. Thus the null hypothesis of homogeneity is rejected.

The probability of high blood pressure among North American Indians was tested with seven variables: sex, age, diabetes, physical activity participation, body mass index, level of education, and annual income. Five variables were determined to be significantly associated with high blood pressure: age, diabetes, physical activity, obesity and annual income. The model was statistically significant (model $\chi^2=658.218$, $p=0.0001$). Diabetes remained significantly associated with high blood pressure after controlling for the effects of age, physical activity, obesity and annual income; the risk of high blood pressure among North American Indians with diabetes is almost five times as great than for those without diabetes (OR= 4.655).

Table 5.20
Logistic Regression Analysis for High Blood Pressure - Western Canadian North American Indians

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-2.8002	0.0991	0.0001	-
Age Group (50^{+})	1.8050	0.1418	0.0001	6.080
Diabetes (Yes)	1.5379	0.1425	0.0001	4.655
Physical Activity participation (Yes)	-0.3369	0.0947	0.0004	0.714
Body Mass Index ($\geq 30kg/m^2$)	1.0541	0.1272	0.0001	2.869
Annual Income ($\geq$\$10,000)	0.5703	0.1087	0.0001	1.769
Age Group*BMI Interaction	-0.6558	0.2058	0.0014	0.519
Age Group*Annual Income Interaction	-0.7097	0.1803	0.0001	0.492

-2 Log Likelihood	3679.325
Model Chi-Square (8df)	658.218 (p=0.0001)

N = 5696.25

Interaction terms were found between age and body mass index and age and income. Among North American Indians, the risk of high blood pressure among the obese was greater than among the non-obese at all ages, however, the relationship between obesity and age was twice as strong among those aged 15-49 than those in the $50\text{-}65^{+}$ age groups (Breslow-Day=21.298, 1 df, p=0.001). Income was significantly associated with high blood pressure among the 15-49 age group but not among the older age groups (Breslow Day=21.988, 1 df, p=0.001).

Heart Problems

Because diabetes was determined to be strongly associated with heart problems among the Métis and North American Indians when controlling for age and sex, logistic regression modelling was performed to examine those variables which were significantly associated with heart problems among these two groups, and to see if diabetes remained a significant predictor of self-reported heart problems once other variables besides age and sex were considered. The logistic models for heart problems are presented in Tables 5.21 and 5.22.

Table 5.21
Logistic Regression Analysis for Heart Problems - Western Canadian Métis

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-2.7894	0.2457	0.0001	-
Age Group (50+)	1.8082	0.2441	0.0001	6.100
Diabetes (Yes)	0.7483	0.2358	0.0015	2.113
High Blood Pressure (Yes)	1.9944	0.2704	0.0001	7.348
Physical Activity Participation (Yes)	-0.4340	0.1907	0.0229	0.648
Education (≥Grade 9)	-0.4883	0.2006	0.0149	0.614
Annual Income (≥$10,000)	-0.5127	0.1771	0.0038	0.599
Age * Hypertension Interaction	-1.2740	0.3659	0.0005	0.280

-2 Log Likelihood 935.068
Model Chi-Square (7 df) 259.152 (p=0.0001)

N = 2183.56

A logistic regression model for heart problems was run with nine variables: age, sex, diabetes, high blood pressure, physical activity, body mass index, smoking status, level of education, and annual income. Six variables, including diabetes, were significantly associated with heart disease. The overall model was statistically significant (model χ^2=259.152, p=0.0001). Diabetes remained significantly associated with heart problems, after controlling for the effects of age, high blood pressure, physical activity, level of education and income; the risk of heart problems among Métis with diabetes is twice that of those without diabetes.

An interaction term between age and high blood pressure was developed. The risk of heart disease among Métis with high blood pressure is great at all ages, however, the relationship between high blood pressure and age is stronger among those aged 15-49 than among those aged 65 years and over (Breslow-Day = 8.777, 1 df, p=0.003).

Table 5.22
Logistic Regression Analysis for Heart Problems - Western Canadian North American Indians

Variable	Coefficient	Standard Error	P Value	Odds Ratio
Intercept	-3.6492	0.0818	0.0001	-
Age Group (50⁺)	1.8073	0.1356	0.0001	6.094
Diabetes (Yes)	0.9973	0.1992	0.0001	2.711
High Blood Pressure (Yes)	1.7020	0.1476	0.0001	5.485
Age * Diabetes Interaction	-0.7043	0.2624	0.0073	0.494
Age *Hypertension Interaction	-0.6303	0.2137	0.0032	0.532

-2 Log Likelihood	3051.262
Model Chi-Square (5 df)	574.618 (p=0.0001)

N = 7702.06

A logistic regression model for heart disease among North American Indians was run with the same nine variables indicated for the analysis among the Métis. Three, including diabetes, were significantly associated with heart disease. The overall model was statistically significant (model χ^2=574.618, p=0.0001). Diabetes remained significantly associated with heart disease, after controlling for the effects of age and high blood pressure; the risk of heart problems among North American Indians with diabetes is almost three times the risk among those without diabetes.

Interaction terms between age and high blood pressure and age and diabetes were developed. The relationship between diabetes and heart problems and high blood pressure and heart problems was stronger among the 15-49 age group than among the 50-65 years and over group.

Summary

The prevalence of diabetes among the Métis is significantly greater than among the general Canadian population and approaches the level among North American Indians. The pattern of diabetes among the Métis in terms of risk factors, negative impact on quality of life and co-morbidity is similar to that for the North American Indian population. Risk factors for diabetes include sociodemographic factors such as age, sex, level of education, and ability to speak an Aboriginal language in addition to health status/behaviours such as obesity and level of physical activity. Although the impact of diabetes cannot be directly measured with the variables included in the APS, the effects of the disease can be inferred from the positive associations with those variables measuring the negative impact of chronic disease upon the lives of the study participants. In addition, the impact of diabetes upon cardiovascular disease was confirmed to exist among the Métis. The high prevalence of diabetes among the Métis as well as the strong associations between diabetes and hypertension and heart problems suggests significant morbidity in this population.

CHAPTER SIX

DISCUSSION AND CONCLUSIONS

The broad goals of this research were: (1) to estimate the self-reported prevalence of diabetes, risk factors and complications among the Métis and North American Indians of western Canada; (2) to test hypotheses related to diabetes etiology among the selected Aboriginal study groups; and (3) to evaluate the usefulness of the Aboriginal Peoples Survey for research upon the health of Aboriginal Canadians. Each of these objectives will be addressed.

Epidemiology of Diabetes Mellitus

Diabetes Prevalence

The crude prevalence of diabetes among western Canadian Métis (6.1%) is slightly less than the self-reported prevalence among North American Indians (7.3%), and twice the rate of the general Canadian population for the same geographic area (3.0%). Because the age-distribution of the Métis and North American Indian populations are significantly different from the general Canadian population, standardized prevalence estimates were derived. The directly standardized diabetes prevalence of 9.0% among the Métis is three times the diabetes rate among the general population. Although standardized rates are fictitious, fair population comparisons are now possible because the confounding effects of different age distributions in the populations of interest have been removed. The extent of self-reported diabetes among the Métis represents significant morbidity in this population; morbidity that up until this point had not been evaluated. In addition, the young age structure of the population indicates that the full extent of the situation will not be realized for years to come.

That the prevalence of diabetes among the Métis approaches the level reported by North American Indians is significant, knowing what we do about the hereditary nature and the severe complications of the condition. Through decomposition analysis it was determined that differences in age structure were not a significant factor in comparison of crude rates between the Métis and North American Indians. Thus, the comparisons between the two groups are more meaningful because we can be assured that they are based primarily on true differences in rates of diabetes.

Interesting inter-provincial differences in diabetes prevalence were found between Aboriginal groups. Diabetes prevalence among Manitoba and Saskatchewan Métis was significantly less than their respective North American Indian populations. However, in Alberta the rate of self-reported diabetes among the Métis was significantly greater than that reported by North American Indians.

What factors may account for this difference? One factor may be related to incomplete enumeration in the 1991 census. Recall that the sample for the APS was drawn from the 1991 general Census of Population. In Alberta, eleven Indian reserves and settlements were incompletely enumerated for the 1991 census, while the numbers in Manitoba and Saskatchewan were three and one, respectively. Some of these communities were incompletely enumerated for the 1986 census as well. The 1981 population estimate for the eleven reserve communities in Alberta that were incompletely enumerated in 1991 was 5523. Assuming that the population estimates for these communities remained stable from 1981 through 1991, this represents a significant portion of the Indian population who would not have been included in the APS sample. In addition, seven Alberta communities representing approximately 3000 individuals did not participate in the APS. The lack of participation in Alberta reserves and settlements was greater than in Manitoba and Saskatchewan. Among North American Indians, it was determined in this research that those living on-reserve were significantly more likely to report having diabetes than those residing off-reserve. Thus, if residents of reserve communities demonstrate a greater prevalence of diabetes than their off-reserve counterparts, then greater lack of participation among reserve residents in Alberta may have driven the North American Indian diabetes prevalence estimate downward. An additional indicator of participation is the value of the record weights. The mean record weight for Alberta North American Indians of 16.95, is significantly greater than mean weights for Manitoba (13.59) and Saskatchewan (12.21) North American Indians. Among Alberta reserve residents the mean record weight is slightly greater than Saskatchewan and Manitoba reserve residents and also exhibits a greater range.

Another factor which should be considered is that the direction of the reported difference in diabetes prevalence between Alberta Métis and North American Indians may, in fact, reflect a true difference in prevalence between the groups. The rate of self-reported diabetes among Alberta Métis was significantly greater than Métis from Manitoba and Saskatchewan [χ^2=5.4, $p<0.05$]. Thus, it may be possible that the Métis of Alberta are systematically different from the Métis in other portions of western Canada. This difference may be related to historical developments. By the late 1800's the Métis way of life was being severely threatened and many Métis at Red River migrated North, to Saskatchewan or to the northern United States. After their final defeat at Batoche in 1885, many migrated farther west or north. Some Métis communities survived in the prairies but in Alberta a number of Métis settlements were established on public lands provided by the province. Eight of the original twelve settlements remain today (Royal Commission on Aboriginal Peoples, 1996). It is entirely possible that the Alberta communities are more culturally intact than communities in other areas and this translates into a greater sense of cohesiveness and cultural identity than in other areas. It is also possible that the differences between the Alberta Métis and the Métis of the other prairie provinces are related to factors which increase the risk for diabetes, whether these be related to lifestyle, Aboriginal ancestry, or some combination of the two. In summary, it is possible that the greater reported prevalence of diabetes among Alberta Métis relative to Alberta North American Indians and Manitoba and Saskatchewan Métis is related to both under-enumeration of Alberta reserves and differences between the Métis of Alberta and the those residing in the remainder of western Canada.

The self-reported diabetes prevalence among APS participants is greater than the few estimates previously reported in the literature for North American Indians of Manitoba, Saskatchewan and Alberta. Comparisons between diabetes prevalence estimates must be interpreted with caution for at least three reasons: (1) The few studies that have been conducted on the prevalence of diabetes among Aboriginal peoples of Manitoba, Saskatchewan and Alberta pertain primarily to the registered Indian population living on reserves. The North American Indian APS estimates reported in this paper refer to non-registered, off-reserve groups in addition to registered Indian, reserve residents. This is not a major difficulty because APS estimates can be derived for the registered, on-reserve groups; (2) Case ascertainment methods and diagnostic criteria differ between studies. Estimates may be based on self-report, (as was the case for the APS), registers of previously diagnosed cases which identify documented diagnosed cases, and screening which identifies new cases. In addition, diagnostic criteria may differ which can affect the derived estimates. The most accurate estimates of diabetes prevalence are achieved via screening with oral glucose tolerance tests. Both chart reviews and self-reporting may result in underestimates because only known cases of diabetes are included while undiagnosed cases are excluded. Verification of diagnoses and diagnostic criteria can sometimes be achieved with studies based on registers of previously diagnosed cases but cannot with self-reported data from large population studies. (3) Scope of the studies may be different. The APS includes self-identified Aboriginal Canadians who claim to identify with their Aboriginal heritage. The sub-provincial categories of census metropolitan area, other urban areas, other rural areas and Indian reserves are the most specific within-province breakdowns that can be achieved. Sub-provincial distinctions cannot be made on geography (i.e., north vs south; proximity to urban centres; degree of isolation, etc.) or cultural group (i.e., Cree, Ojibwa, Sioux) therefore differences that may exist between such groups become blurred. Notwithstanding these difficulties, it remains instructive to compare studies in order to search for general trends and consistencies between comparable works.

The studies which will be used for comparison with the APS estimates are based on registers of previously diagnosed cases, thus the case ascertainment methods are not too divergent. Diagnostic criteria are not available with the APS data. The scope of the studies with which the APS estimates will be compared vary from those which included all reserves within a province to those which included a small number of select reserves.

Using Medical Services Branch (MSB) data, Young and associates (1990) estimated diabetes prevalence among Canada's registered Indian and Inuit populations. Estimates were based on previously diagnosed cases at year end 1987. In earlier work Young and colleagues (1985) estimated diabetes prevalence among registered Indians of northwestern Ontario and northeastern Manitoba. Estimates were based on previous diagnosis as of 1983. Comparison will be made with the estimates that included the Manitoba registered Indians. Pioro and colleagues (1996) used data from a diabetes survey conducted by the Saskatchewan Region of MSB on numbers of diagnosed cases of diabetes among all Saskatchewan reserves. Data were collected in 1990. Comparisons of crude diabetes estimates for the APS and the studies by Young and Pioro are presented in Table 6.1.

Table 6.1
Crude Diabetes Prevalence among APS On-Reserve Indians and Western Canadian Registered Indian Populations

	STUDY GROUP			
Province	**APS∘**	**Young et al (1985)·**	**Young et al (1990)·**	**Pioro et al (1996)•**
Manitoba	10.9	3.2, 3.5*	2.8	-
Saskatchewan	8.6	-	1.7	6.2
Alberta	7.0	-	2.2	-

* Manitoba communities · All ages
∘ 15 years and over • 20 years and over

The self-reported diabetes prevalence among reserve dwelling North American Indian APS participants was significantly greater than the estimates reported by Young and associates (1990) and (1985), but more comparable to the estimate provided by Pioro and colleagues (1996) for the Saskatchewan region. What factors may account for these differences? Timing of data collection raises two issues. First, the studies by Young et al (1985, 1990) were completed from five to eight years prior to the APS. The difference in prevalence may reflect a true increase in diabetes among Aboriginal peoples. Second, an increasing awareness of the problem of diabetes among Canada's Aboriginal peoples developed during the 1980's which led to increased surveillance for diabetes among health care practitioners. Even without an attendant increase in diabetes incidence, increased surveillance for diabetes would increase point prevalence estimates, because fewer undiagnosed cases would remain in the population. The magnitude of the problem of diabetes among Canadian Aboriginal people only began to be investigated in the 1980s, thus the estimates from the early to mid 1980's were probably recorded prior to the time that health care practitioners began screening for diabetes among their Aboriginal patients on a routine basis. Thus, changes in patterns of detection alone can result in an apparent increase in the occurrence of a disease (Feinstein, 1988). The estimate for the Saskatchewan reserves from 1990 is similar to the APS estimate from 1991.

Another factor which may influence prevalence estimates concerns the age of the study participants included in the estimates. APS estimates are based on individuals 15 years of age and above, the Saskatchewan estimate (Pioro et al., 1996) was based on individuals aged 20 years and older, while the studies by Young and associates (1985, 1990) were based on all ages. This is especially significant for diseases which are more prevalent in the older age categories in combination with populations that are heavily represented by younger age groups. If the younger age groups contribute very few cases to the numerator but constitute a significant proportion of the denominator, the prevalence estimate will be lower than if the younger age categories had been removed. For example, among Saskatchewan reserve residents, the under 20 years group contributed only 21 cases of diabetes but constituted over half of the reserve population, thereby decreasing the reported diabetes prevalence by half (i.e., the all age groups prevalence is $\frac{1146}{38028}=3.0\%$, compared to the prevalence reported for the 20 years and over group, $\frac{1125}{18236}=6.2\%$) (Pioro et al., 1996).

More interesting comparisons may be made among age-specific prevalence estimates, which are available for the APS data, Young and colleagues (1985) and Pioro and associates (1996) (Table 6.2). When different methodologies and the time factor are taken into consideration, the diabetes prevalence estimates derived from the APS data do not seem unreasonable.

Table 6.2
Age-Specific Crude Diabetes Prevalence among APS On-Reserve Indians and Western Canadian Registered Indian Populations

	STUDY GROUP					
	APS		Young et al. (1985)		Pioro et al (1996)	
Province	Age Groups	Prevalence %	Age Groups	Prevalence %	Age Groups	Prevalence %
Manitoba	15-24	1.9*	15-24	0.4	N/A	N/A
	25-49	11.0	25-44	5.3		
	50-64	27.6	45-64	12.6		
	65+	27.2	65+	9.6		
Saskatchewan	15-24	•	N/A	N/A	20-29	1
	25-49	7.4			30-39	3
	50-64	25.9			40-49	10
	65+	25.0			50-59	18
					60-69	23
					70+	17

* Figure to be used with caution. Coefficient of variation between 16.7% and 33.3%.
• Figure suppressed. Coefficient of variation greater than 33.3%.

An additional comparison can be made with more recent diabetes prevalence estimates among Canadian Aboriginal people from outside of the three study provinces. Fox and colleagues (1994) estimated diabetes prevalence among residents of the Sioux Lookout Zone (SLZ) based on a computerized registry of diagnosed cases. The report is based on data collected in 1992. The overall crude prevalence rate, including individuals less than 15 years of age was 4%, compared with a crude prevalence of 9% for APS reserve residents of western Canada aged 15 years and over. Age-specific comparisons are again interesting. Diabetes prevalence among SLZ males and females aged 15-24 was 0.7%, compared to the APS estimate of 1%. The diabetes estimates for SLZ males and females aged 55-64 were 12% and 24%, respectively, while the rates for APS males and females aged 50-64 were

19% and 31%, respectively. Harris and associates (1997) completed a community-wide prevalence survey using oral glucose tolerance testing in a remote community in Ontario from July 1993 to March 1995. The overall crude diabetes prevalence among residents aged 10 years and older was 17%, compared with a prevalence of 9% for on-reserve APS participants aged 15 years of age and older. Interestingly, the diabetes prevalence in this community as of 1992 was estimated at 7% (Gittelsohn et al., 1996). Thus, the APS diabetes estimates derived from the APS data set seem plausible when compared to estimates from other Canadian Aboriginal groups.

In summary, the APS estimates of diabetes prevalence for reserve residents were greater than previously documented estimates for the same regions. The differences may be due to an actual increase in disease prevalence in combination with increased surveillance for the disease and computational methods used for estimation. The APS estimates derived for this research seem to be congruent with more recent diabetes estimates when different methods are taken into account.

What are the implications for the Métis? The diabetes estimates for North American Indians derived from the APS data are comparable to estimates obtained from more recent work on Canadian Aboriginal peoples (Fox et al., 1994; Pioro et al, 1996; Harris et al., 1997). It has been demonstrated in this research that the Métis are exposed to similar risk factors for diabetes as the North American Indian population, be they genetic, behavioural or socioeconomic. Therefore it seems reasonable to have some confidence in one of the major findings of this research, specifically that the level of diabetes among the Métis approaches that of the North American Indian population.

Distribution of Diabetes

Among North American Indians the prevalence of diabetes was greater among residents of Indian reserves than among off-reserve residents. This finding may be related in part to the distribution of risk factors for diabetes between on-reserve and off-reserve residents. A significantly greater proportion of North American Indians over the age of 50 years reside on-reserve than off-reserve. After controlling for the effects of sex and age, on-reserve Indians are more likely to be obese than their off-reserve counterparts, less likely to have completed at least grade 9 and less likely to report participation in physical activities. Although the prevalence of diabetes among rural Métis was greater than urban Métis, the difference was not statistically significant. However, a significantly greater proportion of rural Métis were over the age of 50 years than urban Métis. After controlling for the effects of sex and age, a greater proportion of rural residents were obese. Although no differences between rural and urban Métis were found on physical activity participation, rural Métis were less likely to have completed grade 9 or greater than urban residents.

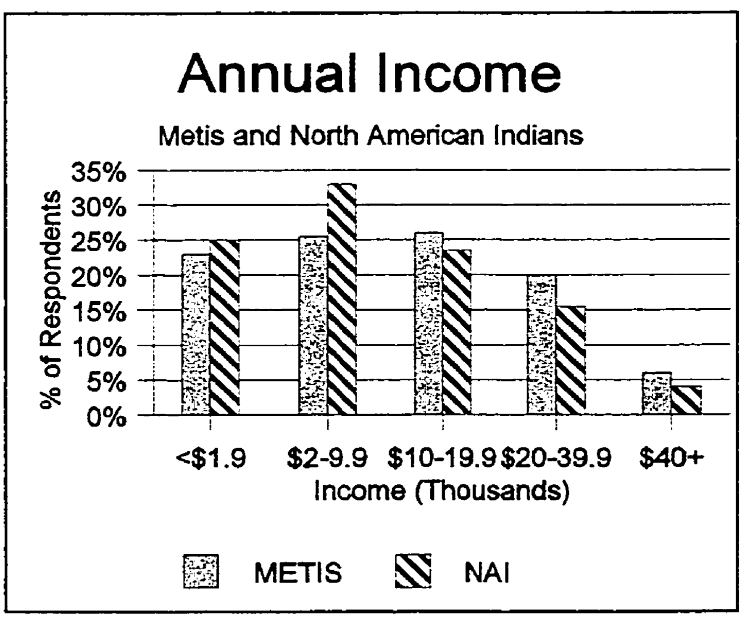
The prevalence of diabetes increased significantly with age and was greater among Métis and North American Indian women than among men. Diabetes prevalence generally increases with age in all populations (Barceló, 1996). The significantly greater prevalence of diabetes among Aboriginal women has been documented in numerous studies among other North American Aboriginal groups (Young, 1994). Greater rates of obesity in women have been cited as a reason for the higher diabetes prevalence in numerous studies (Pioro et al., 1996; Dyck et al., 1995; Harris et al., 1997). However, among APS participants neither Métis nor North American Indian women exhibited significantly greater rates of obesity than men. Another possible explanation for the differences between males and females in frequency of diabetes diagnosis is different patterns of health care utilization (Barceló, 1996). Métis women were three times more likely to report having seen someone about their health in the past 12 months than Métis males [OR=3.0 (2.5,3.60]; specifically, Métis women reported having seen a physician and a community health representative (CHR) approximately 1.5 times more frequently than Métis men [medical doctor: OR=1.6 (1.1,2.5); CHR: OR=1.5 (1.1,2.10]. Similar patterns were observed for North American Indians, where women reported seeing someone about their health almost 2.5 times more frequently than men [OR=2.4 (2.2,2.7)]. Although no significant differences in visits to community health representatives were noted, women reported visiting medical doctors more frequently than men [OR=2.9, (2.3, 3.7)]. Interestingly, no significant differences between the sexes were found in overall diabetes prevalence estimates for the general Canadian population from the 1991 General Social Survey (Statistics Canada, 1994) or the 1994/95 National Population Health Survey (James et al., 1997).

The relationship between socioeconomic status and poor health has been well documented even though measurement of socioeconomic status varies widely between studies (Frank, 1995; Frohlich and Mustard, 1996; Guralnik and Leveille, 1997). Measures of socioeconomic status often include income, education level, occupation level and sometimes include characteristics of residence and total wealth. While the majority of work has been concentrated on the relationship between adult socioeconomic status and adult health, interesting work is emerging on the relationship between childhood living conditions and socioeconomic inequalities in adult health (Rahkonen et al., 1997; Van de Mheen et al., 1997). Guralnik and Leveille (1997) argue that adequate evaluation of an individual's socioeconomic position should include more than determination of their income and education levels. While their concerns are noted, these were the two major measures available for this research because of the lack of data regarding housing conditions in the APS microdata file and the high percentage of respondents who indicated that they were not in the labor force.

Among the general Canadian population, diabetes is associated with low income (James et al., 1997). Among the general American population, diabetes is associated with lower income and education levels and higher unemployment levels after controlling for the effects of age (Cowie and Eberhardt, 1995). Three variables were used in this research to evaluate the relationship between socioeconomic status and diabetes among the Métis and North American Indians of western Canada: annual income, education level, and employment status. After controlling for the effects of sex and age, only level of education remained statistically associated with diabetes status among both Aboriginal groups. Annual income was determined to be a significant predictor of diabetes status among North American Indians in logistic regression analysis that incorporated the Aboriginal Ancestry variable. Interestingly, the risk of diabetes was greater among participants who reported an annual income of $10,000 or more. However, the effect of age on annual income may not have been as strong in this model as in the model which did not incorporate Aboriginal ancestry, because the age variable in this model was combined with two other variables (i.e., ability to speak an Aboriginal language and participation in traditional activities). Because annual income was not significantly associated with diabetes when the age variable was included as an independent variable, its significance in this model must be interpreted with caution.

Although statistical significance was achieved on only the education variable, it may be incorrect to conclude that diabetes among the Métis and North American Indians is not associated with lower socioeconomic status, because the distribution of the annual income variable is very narrow. In other words, only a small proportion of participants reported an annual income level which would allow for the type of differences in lifestyle that may impact upon diabetes and disease prevalence. For example, 50% of the Métis and 60% of North American Indians reported an annual income of less than $10,000 per year. Only 6% of the Métis and 4% of North American Indians reported an annual income of greater than $40,000 per year (Figure 6.1).

Figure 6.1
Annual Income by Aboriginal Group



Hypothesis Testing

Aboriginal Ancestry

One of the variables which has been demonstrated in population studies to have a significant association with diabetes is degree of Aboriginal ancestry. Because there were no data available on Aboriginal ancestry in the APS data set a composite variable was constructed using the variables: age, ability to speak an Aboriginal language and participation in traditional activities. Métis participants who were classified as having a greater degree of Aboriginal ancestry were almost 2.5 times more likely to report having received a diagnosis of diabetes than those who were designated as having less Aboriginal ancestry after controlling for the effects of sex, physical activity participation, obesity and level of education. North American Indian participants classified as having a greater degree of Aboriginal ancestry reported having diabetes twice as frequently as those designated as having less Aboriginal ancestry controlling for the effects of sex, physical activity participation, obesity, level of education and annual income.

Using the APS data set, there is no way of evaluating construct validity (i.e., is the variable measuring the intended concept). Because age is so strongly associated with diabetes, it is possible that the composite ancestry variable is measuring nothing more than the effects of age on the outcome variable. Logistic models were therefore developed to test the independent effects of the variables which had been combined to create the ancestry variable. Logistic models were run with the following eight variables: sex, age group, ability to speak an Aboriginal language, participation in traditional Aboriginal activities, physical activity participation, body mass index, level of education and income. Among the Métis, the variables which were significantly associated with the outcome variable, diabetes, included sex, age group, ability to speak an Aboriginal language, BMI and level of education; participation in traditional Aboriginal activities was not statistically significant. Métis participants who report the ability to speak an Aboriginal language were almost twice as likely to report having diabetes than those who are not able to speak an Aboriginal language after controlling for the effects of all other variables [OR=1.9 (1.3,2.7)]. Among North American Indians, sex, age group, ability to speak an Aboriginal language, physical activity, BMI, and level of education were significantly associated with diabetes status; participation in traditional Aboriginal activities and annual income were not. The risk of diabetes among North American Indians who are able to speak an Aboriginal language is twice that of those who are not able to speak an Aboriginal language [OR=1.9 (1.5,2.5)] after controlling for the effects of the other variables. Thus, it appears that age is not completely responsible for the significant association between the composite ancestry variable and diabetes. Insofar as ability to be fluent in an Aboriginal language is an indication of Aboriginal ancestry, the composite variable probably has some value, notwithstanding the lack of influence of the variable measuring participation in traditional Aboriginal activities.

A reduced variable measuring Aboriginal ancestry was created, composed only of the age group and ability to speak an Aboriginal language variables. Logistic models were run with the same variables as noted above. The ancestry variable remained statistically associated with the outcome variable, diabetes, for both the Métis and North American Indians. These results are suggestive of a relationship between Aboriginal ancestry and diabetes. However, as the ancestry variable is a crude and simplistic measure of Aboriginal ancestry, no firm conclusions can be drawn regarding the impact of Aboriginal ancestry on diabetes prevalence using the APS data set.

Associated Morbidity

The vascular conditions that accompany diabetes are severe and life threatening and include retinopathy, cardiovascular disease and stroke, hypertension, peripheral vascular disease and nephropathy (Barceló, 1996). With the exception of hypertension, questions pertaining to these specific conditions were not included in the APS questionnaire.

The conditions for which estimates could be obtained include high blood pressure, heart problems and sight impairment. Using logistic regression modelling it was determined that diabetes remained significantly associated with hypertension and heart problems after the effects of the other risk factors were taken into account. Among the Métis, factors which were significantly associated with hypertension included age, diabetes status, participation in physical activity and BMI. An interaction was discovered between age and body mass index. Individuals with diabetes were almost three times more likely to report having received a diagnosis of hypertension than those without diabetes, independent of the effects of the other variables. Variables significantly associated with heart problems included age, diabetes status, hypertension, participation in physical activity, level of education and income. An interaction between age and hypertension was discovered. Controlling for the effects of all other variables, Métis participants with diabetes reported heart problems twice as frequently as those without diabetes. In addition, Métis participants with diabetes were twice as likely to report a sight impairment than those without diabetes. Similar results were obtained for the North American Indian population.

In addition to cardiovascular and opthalmologic associations, Métis and North American Indian participants with diabetes were more likely to report having arthritis, emphysema, and tuberculosis than those without diabetes after controlling for the effects of age and sex. Thus, the extent of morbidity among the Métis and North American Indians of western Canada with diabetes is considerable.

Effects of Bill C-31 Registrants on Diabetes Prevalence

Diabetes prevalence was determined to be significantly greater among registered than non-registered Indians and among Bill C-31 registrants alone compared to non-registered Indians. However, the prevalence of diabetes among registered Indians remained essentially the same with or without the inclusion of the Bill C-31 registrants. In addition, when the Bill C-31 registrants were "removed" from the registered Indian category and placed into the non-registered category, the resulting diabetes prevalence among the non-registered Indians increased but not significantly.

That the Bill C-31 registrants did not significantly alter diabetes prevalence among registered or non-registered Indians may be related to the small numbers of Bill C-31 registrants relative to the total numbers of registered and non-registered Indians rather than the characteristics of the registrants themselves. No significant differences were found between Bill C-31 registrants and other registered Indians on diabetes prevalence, age distribution, body mass index or participation in physical activities. However, Bill C-31 registrants and "other" registered Indians were significantly different from the non-registered group. Bill C-31 registrants were more likely than non-registered Indians: (1) to be obese [OR=1.2 (1.1,1.4)], (2) to have a greater degree of Aboriginal ancestry (as determined with the composite ancestry variable) [OR=1.8, (1.4,2.1)], and (3) less likely than non-registered Indians to participate in physical activities [OR=0.83, (0.73, 0.93)]. Thus Bill C-31 registrants are significantly different from non-registered Indians on diabetes status and risk factors for diabetes, but because of their small numbers the impact is not statistically significant.

Strength of the Multiple Logistic Regression Models

One of the most important objectives of this research was to determine the variables that were predictive of diabetes status among the two Aboriginal study groups. The variables that were significantly associated with diabetes status among the Métis included age, sex, body mass index, and level of education. These same four variables along with participation in physical activities were associated with diabetes among the North American Indian population. Notwithstanding different methodologies and variable measurement, similar results have been found in previous work among Aboriginal North Americans (Young 1994; Barceló, 1996).

One of the significant findings of this research was that the design variable for age was highly correlated with most of the variables included in logistic regression analyses. Most of the proposed solutions to minimize the effect of multicollinearity were deemed unacceptable for this research. However, according to Menard (1995) the safest way to deal with collinearity problems is to focus on the collective effects of all variables in the model and interpret the effects of individual predictors with caution. Although the strength of logistic regression analysis is its ability to isolate the effects of variables independent of all other variables in the model, the possibility that age may be intermingled with the other variables included in the models cannot be completely ruled out. However, the strength of all of the variables included in the diabetes models for both the Métis and the North American Indians, as measured by the significance level, is impressive indicating a convincing relationship between the individual explanatory variable and the outcome variable. Similarly strong relationships are noted between the explanatory variables associated with high blood pressure and heart problems.

Evaluation of the Aboriginal Peoples Survey

The Aboriginal Peoples Survey is subject to some important limitations which have implications for the quality of the derived results. The limitations will be addressed under the broad headings of survey structure, sampling structure, ascertainment issues, validity of APS variables and missing data. The impact of self-reported data on accumulation of knowledge and general confidence in the Aboriginal Peoples Survey will also be addressed.

Survey Structure

The Aboriginal Peoples Survey is an example of a cross-sectional study, for which data on risk factors and disease status are measured at the same time. As with all cross-sectional studies, etiological inferences cannot be drawn because the temporal sequence of events cannot be established in the way they could be with a prospective study. Therefore, the logistic regression models that have been developed for this research must be regarded as suggestive of relationships between designated risk factors and outcome variables rather than conclusive proof of causation. For example, diabetes prevalence was determined to be greater among those who reported lack of participation in physical activities than among those who reported participation in physical activities. However, it cannot be stated with certainty that lack of physical activity preceded the development of diabetes. The possibility that lower participation rates in physical activities followed the development of diabetes cannot be ruled out. In other words, levels of participation in physical activities may have been equally distributed throughout the population but because of the development of diabetes level of participation decreased among those afflicted.

While conclusions about etiology cannot be drawn, hypotheses regarding diabetes etiology were tested. Significantly, relationships that had been noted among other North American Aboriginal groups were confirmed to exist among the Métis. This is an important finding because of the lack of previous research among the Métis.

Sampling Structure

The method of sampling for the APS was highly complex and resulted in the assignment of a weight to each record in the data set. The final weight attached to each record corresponded to the number of individuals that particular record represented. The value of the record weights ranged from 10 to 125, thus one record was intended to represent from 10 to 125 Aboriginal individuals. The mean record weights for western Canadian Métis and North American Indians were 19 and 14, respectively.

Complex probability sampling involving stratification and cluster sampling, resulting in the assignment of record weights, is the only way that a survey of the magnitude of the APS could be conducted. Unfortunately, it is difficult to assess the impact of the weights on the derived results. Comparison of weighted versus non-weighted data would not prove useful because the non-weighted data are not accurate reflections of the intended sample (i.e., weights are necessary so that on certain variables, the APS data are congruent with the larger census sample). While it may be reasonable to assume that one person could represent 19 others with respect to the less than 10 sociodemographic variables (i.e., age, sex, province, sub-provincial category, etc.), that were used in the weighting process, it seems more questionable to assume that one person could accurately represent 19 others with respect to all of the 596 variables of the APS.

In comparison with previous studies on the prevalence of diabetes among Aboriginal North Americans, the derived diabetes estimates presented in this research seem reasonable. In addition, some of the variables that were used to test hypotheses regarding diabetes etiology were sociodemographic ones that were included in the weighting process itself. Therefore, if the major findings of this research are interpreted cautiously, and general trends versus specific results are emphasized, the impact of the weights may be assumed to be minimal. For example, the specific odds ratio associated with an explanatory variable is not as important as the general trend of the relationship. So, that obesity is positively related to diabetes is more important than the exact magnitude of the relationship. Because there has been no previous research on the Métis this type of baseline information is vital.

Ascertainment Issues

It is generally agreed that prevalence estimates based on self-reporting result in underestimation because only known cases are captured, while undiagnosed cases remain hidden. This underestimation may be quite significant; some have estimated that for every case of reported diabetes, there are one to two undiagnosed cases (Zimmet, 1982; Harris, 1987). The diabetes estimates reported in this research may also be underestimates. For example, the overall diabetes prevalence among the Ojibwa-Cree of Sandy Lake, Ontario, based on screening with oral glucose tolerance tests, was determined to be 17%, which is approximately double the APS diabetes prevalence for Manitoba reserve residents of 9% (a large proportion of Manitoba's Aboriginal population is Ojibwa and Cree, thus Manitoba may be an appropriate comparison population).

Zimmet's (1982) estimate of the underestimation involved with self-reported data were made primarily in relation to South Pacific Island populations, while Harris's (1987) comments were made in relation to the United States Health and Nutrition Examination Survey. Some of the issues which may have influenced the underestimation about which these authors discuss may not be as potent in the context of Canadian Aboriginal research. First, awareness of the problem of diabetes among Canada's Aboriginal peoples has increased over the last decade which has probably influenced surveillance patterns such that health care practitioners are more likely to screen for diabetes among their Aboriginal patients than they were in the past. A second factor which may influence rate of diagnosis is accessibility to health care. Canadian citizens are not faced with the same type of financial disincentives to seek out health care as are citizens of the United States and may therefore take advantage of health care services more regularly than American citizens. Individuals who reside in the less isolated reserve communities have good access to health care in the form of nursing stations. It is in these communities that awareness of the problem of diabetes is greatest and screening for the disease has increased over the last decade at least. In contrast, urban Aboriginal peoples are more anonymous and may not seek out health care any more regularly than any other Canadian citizen, even though there are no financial disincentives. Although increased surveillance for diabetes and access to health care may lessen the degree of underestimation inherent with self-reported data among

Canadian Aboriginal peoples, it is not likely that these factors would eliminate the problem to any great extent. Therefore, it is likely that the APS estimates, as with previous large population surveys, are underestimates of the true extent of the problem among the Métis.

Variable Validity

Validity is the degree to which a measurement measures what it is intended to measure (Last, 1988). The strength of the results and the conclusions of any research are obviously dependent on the validity of the variables under study. Some of the variables used in this research may not have captured the intended concepts as accurately as is necessary for confidence in the measures. These variables will be addressed in turn below.

Ethnic Identification

Ethnic identity is a highly complex and emotionally charged issue that involves both cultural and genetic properties. Two issues are important in the assignment of ethnicity: self-identification and acceptance by a larger group. The reasons APS participants self-identified as Métis are not known to users of the APS. It is therefore not apparent to users of the APS data sets, whether individuals who self-identified as Métis would be accepted as Métis by the Métis nation. The consequence of not having a clear understanding of the reasons individuals self-identify as Métis for this research was that influence of Aboriginal ancestry (i.e., the genetic link) could not be legitimately investigated. Future research on the Métis should delve more deeply into Métis identity and its meaning bearing in mind that ethnic identification is not something that can be ascribed by outsiders like researchers to fit particular research frameworks.

Diabetes

APS participants were asked if they had been told by a health care professional that they had diabetes. No distinctions were made between type 1 and type 2 diabetes, therefore all reported cases were considered to be type 2 and were included in all aspects of the analysis. As noted previously, this may not have had too great an impact on the results because diabetes among Aboriginal peoples is almost exclusively the type 2 variety, even among younger individuals.

Heart Problems

Although strong associations between diabetes and heart problems were revealed, the validity of the heart problems variable may be disputable which may weaken the strength of the relationships. APS participants were asked if they had been told by a health care professional that they had "heart problems". Participants may have interpreted the term "heart problems" as broadly or narrowly as they chose, and there is no indication in the APS questionnaire or any accompanying literature of the types of conditions or problems that would qualify. Therefore, the estimates of heart problems may include conditions which may not necessarily be associated with diabetes.

Sight Impairment

A composite variable measuring sight impairment was constructed because the APS data set did not include variables associated with diabetes opthalmologic complications. Just as for the "heart problems" variable, the "sight impairment" variable probably includes conditions which are not associated with diabetes because the APS questions regarding sight difficulties were very general; participants were asked (1) if they had difficulty seeing the print on a page even while wearing corrective lenses (if applicable), and (2) if they had difficulty seeing the face of someone across the room even while wearing corrective lenses (if applicable). Individuals were classified as having a sight impairment if they answered affirmatively to either of these questions.

The strength of the relationship between diabetes and both heart problems and sight impairment, as measured by the significance level of the diabetes variable, was impressive. Therefore, it is probably not unwise to have some measure of confidence in the validity of the heart problems and sight impairment variables.

Participation in Physical Activity

APS informants were asked if they participated in any sports, games, dance or recreation which involved physical activity. Available responses were "yes" and "no". The question allowed broad interpretation on the part of informants and may have encompassed individuals who attended community dances monthly to those who participate in strenuous physical activity on a regular basis. Future research should incorporate type, frequency and intensity of physical activities and should also include physical activity that is associated with work, employment and subsistence activities in addition to activities associated with recreation and sport.

Missing Data

A survey on such a grand scope as the APS cannot necessarily include everything of importance to one specific aspect of study. Such is the case in relation to diabetes epidemiology. Important information that was not collected includes parental history of diabetes, degree of Aboriginal ancestry, cultural group affiliation, age at first diabetes diagnosis, type of treatment, if any (i.e., injectable insulin, oral medications), and more specific categories of diabetes complications including kidney disease, amputations and retinopathy.

Another area which was not covered well was diet and nutrition. While it is acknowledged that the relationship between diet and onset of chronic disease is especially complex and could not be untangled with a cross-sectional survey anyway, the questions of diet and nutrition included in the APS were limited. Participants were asked how often in a week did they eat meat, fish or poultry, and how much of the meat, fish or poultry was obtained through hunting and fishing by themselves, members of their family or friends. The only other nutrition question asked if participants had experienced the problem of not having enough food to eat during the past year. Neither the question about frequency eating meat, fish or poultry nor the one about not having enough food to eat during the past year were significantly associated with diabetes status.

Impact of Self-Reported Data

Cross-sectional surveys which rely on self-reported data are useful in establishing the existence of a problem. This type of methodology is economical and results can usually be obtained in a timely fashion. The APS was an extremely useful tool for research upon the Métis because the impact of diabetes upon the lives of the Métis had previously not been identified. However, once problems have been identified the usefulness of self-reported data is limited because they don't further our understanding of causality or risk in a meaningful manner. Diabetes has been established as a problem among North American Indians. Further cross-sectional studies such as the APS, no matter what the magnitude, will offer little but confirmation of existing knowledge. The APS represents a significant contribution for both the Métis and North American Indian groups because for the first time a truly national perspective can be attained. The picture that emerges from the APS is one of significant morbidity among Canada's Aboriginal peoples and thus should provide strong rationale for primary community-based research, the ultimate goal of which is development of intervention strategies aimed at risk reduction and delay of onset of diabetes complications.

Confidence in the Aboriginal Peoples Survey

Although imperfect, the validity of the results regarding the impact of diabetes among the Métis can be inferred from comparisons of the derived results for the North American Indian group with previous research on the registered Indian population of Canada. The derived estimates of diabetes among the North American Indians of western Canada are not implausible given the different study methodologies of the comparison research. The patterning of the disease was similar to what has been established among other North American Aboriginal groups. Thus, it does not seem unreasonable to have some degree of confidence in the accuracy of the estimates obtained from the APS, given the limitations of cross-sectional self-reported data.

While the reported diabetes prevalence probably represents underestimation of the true extent of the problem among the Métis, the strength of the relationships between diabetes and the investigated risk factors, associated conditions and complications were profound which fosters confidence in the general patterns that have been established. Thus, it is safe to have confidence in the major findings of this research, specifically that: (1) the prevalence of diabetes is greater among the Métis than among the general Canadian population; (2) the prevalence of diabetes among the Métis approaches the rates reported for North American Indians; (3) the pattern of disease among the Métis is similar to that reported for other North American Aboriginal and Aboriginal-hybrid populations; and (4) the Métis are experiencing significant morbidity related to diabetes.

Recommendations

Some broad recommendations for the future direction of research upon diabetes among the Métis are offered below:

1. Primary research in established Métis communities is required to determine accurate estimates of diabetes prevalence, risk factors, associated conditions and complications.

   Rationale

   As a result of this research a sense of the magnitude of the impact of diabetes among the Métis of western Canada has emerged. A strong measure of confidence in the general direction of the results of this research is justified. The extent of morbidity among the Métis has been determined to be profound which means that there must be no further delays at determining the true extent of the problem and at initiating interventions aimed at risk reduction and delay of onset of complications.

2. Future research on diabetes among the Métis must include community participation in the planning, design and implementation of interventions.

   Rationale

   Community participation in future research on diabetes among the Métis is vital for at least two reasons. The first concerns the issue of Métis identity. Identification as

Métis is subject to at least two important criteria: (1) self-identification and (2) acceptance by the Métis nation. Therefore, inclusion as Métis is a community decision, whether that community be local or national. Researchers must work closely with communities to determine the parameters of the research.

The second reason for community involvement is related to intervention strategies. The literature is replete with discussions of non-compliance with treatment regimens among individuals with diabetes. One of the factors contributing to the labelling of individuals and groups as non-compliant has been the lack of culturally specific diabetes education and intervention programs. Medical anthropologists investigating the meanings and experiences of diabetes among Aboriginal peoples have discovered that diabetes is placed within a broad cultural, political and historical context that is often not addressed in standard intervention programs. Successful intervention programs may rest upon culturally relevant and community-specific strategies. Only through community involvement will these types of strategies be created.

3. Future research on the epidemiology of diabetes among the Métis must include data on degree of Aboriginal ancestry.

Rationale

Aboriginal ancestry has been identified as a major risk factor for diabetes in population studies and may be a contributing factor to the excess prevalence of diabetes in the Métis in comparison with the general Canadian population. Notwithstanding the difficulties inherent in "untangling" interactions between risk factors, a greater understanding of the relative influence of ancestry can only be achieved when data are available.

CONCLUSIONS

Notwithstanding the limitations of the Aboriginal Peoples Survey, it is safe to conclude that the patterning of diabetes among the Métis and North American Indian populations of western Canada is similar to that established among other North American Aboriginal populations. The self-reported prevalence of diabetes among the Métis approaches that of the North American Indian population and is significantly greater than the self-reported rates among the general Canadian population. Diabetes among the Métis and North American Indians is related to sociodemographic factors such as age, sex, level of education and ability to speak an Aboriginal language, and health status/behaviors such as obesity and level of physical activity. The negative impact of diabetes upon the lives of those afflicted was demonstrated in this research. In addition, the strong association between diabetes and cardiovascular disease was confirmed to exist among the Métis and North American Indians of western Canada. The high prevalence of diabetes, hypertension and heart disease, the association of diabetes with other chronic health conditions, and the negative impact of chronic disease upon the lives of the study participants suggest profound morbidity in these populations.

The results of this research represent the first detailed analysis of diabetes among the Métis of western Canada and thus represent a significant contribution to the knowledge about diabetes among Aboriginal populations. The APS data set has been useful in establishing diabetes as a problem among the Métis and in providing evidence of the patterning of diabetes in the population. However, as useful as secondary data sources such as the APS are in establishing the magnitude of a problem, primary research within Métis communities must be conducted to verify the general trends uncovered in this research and to establish a more accurate picture of the epidemiology of diabetes among the Métis.

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APPENDIX A

APPENDIX A

Variables Used in Analysis and their Coding Schemes

Variable	Descriptor	Coding
SEX	Sex	1=Male; 0=Female
AGE	Age Group	1=15-24 years 2=25-49 years 3=50-64 years 4=65^{-} years
AGE 1 AGE 2 AGE 3	Design Variable for AGE	AGE1=15-24 AGE2=25-49 AGE3=50-64 Reference = 65+
AGEGRP	Age Group	1=50-65^{-}; 0=15-49
SUBPROV	Sub-provincial category	1=Indian reserve/settlement 2=Census metropolitan area 3=Other urban 4=Other rural
RES 1 RES 2 RES 3	Design Variable for SUBPROV	RES1=CMA RES2=Other Urban RES3=Other Rural Reference=Indian reserve
REGIND	Registered under *Indian Act*	1=Yes; 0=No
BILLC31A	Since June 1985, applied to be registered Indian	1= Yes 0= No
BILLC31R	Registered as status Indian under Bill C-31	1=Yes 0= No
B1	Speak Aboriginal language	1=Yes; 0= No
B11	Participate in traditional Aboriginal activities	1= Yes 0= No
C4	Difficulty seeing print on page	1= Yes 0= No
C5	Difficult to see face of someone across room	1= Yes 0= No

APPENDIX A (Continued)

Variables Used in Analysis and their Coding Schemes

Variable	Descriptor	Coding
C8	Difficulty walking 350 meters without a rest	1= Yes 0= No
C9	Difficulty walking up and down a flight of stairs	1= Yes 0= No
C11	Difficulty moving from one room to another	1= Yes 0= No
C12	Difficulty standing for more than 20 minutes	1= Yes 0= No
C20_I	Limited in kind/amount of activity at home	1= Yes 0= No
C20_III	Limited in kind/amount of activity at work	1= Yes 0= No
C20_IV	Limited in other leisure activities	1= Yes 0= No
C25	Require use of specialized aid/ equipment/system	1= Yes 0= No
C29	Need help with everyday housework	1= Yes 0= No
C32	Need help with personal care/ wash/dress/feed	1= Yes 0= No
C34	Use Specialized feature to enter, leave, move in home	1= Yes 0= No
C35	Difficulty leaving home to take short trips	1= Yes 0= No
D2_1	Diabetes - diagnosed by health care practitioner (hcp)	1= Yes 0= No
D2_2	High blood pressure	1= Yes; 0= No
D2_3	Arthritis/rheumatism	1= Yes; 0= No
D2_4	Heart Problems	1= Yes; 0= No
D2_5	Bronchitis	1= Yes; 0= No

APPENDIX A (Continued)

Variables Used in Analysis and their Coding Schemes

Variable	Descriptor	Coding
D2_6	Emphysema/shortness of breath	1= Yes 0= No
D2-7	Asthma	1= Yes; 0= No
D2_8	Tuberculosis	1= Yes; 0= No
D5	Saw anyone about health in past 12 months Medical Doctor Community Health Representative Traditional Healer Eye Specialist/Eye Doctor	1= Yes; 0= No 1= Yes; 0= No 1= Yes; 0= No 1= Yes; 0= No 1= Yes; 0= No
D9	Ever drank alcohol	1= Yes; 0= No
D10	Currently smoke cigarettes	1= Yes; 0= No
D18	Participate in sports, games, dance or recreation	1= Yes 0= No
HEALTH	Health as compared to others	1= Poor; 0= Good
DISAB	Mobility disability	1= Yes; 0= No
SIGHT	Sight impairment	1= Yes; 0= No
LTDACT	Limited in kind/amount of activity at home, work or in leisure activities	1= Yes 0= No
ASSIST	Need help with everday housework or personal care	1= Yes 0= No
INCOME	Total annual income	1= $10,000 and over 0= Less than $10,000
SCHOOL	Highest grade completed	1= Grade 9 and over 0= Less than grade 9
BMI	Body mass index	1= Obese; 0= Non-Obese
ANCESTRY	Aboriginal Ancestry	1=Greater; 0=Less

APPENDIX B

APPENDIX B

APS Questions Used in Analysis

Variable	APS Question
IDENT	With which Aboriginal group do you identify? North American Indian Inuit Métis Another Aboriginal Group
REGIND	Are you a registered Indian, as defined by the Indian Act of Canada? Yes No
BILLC31A	Have you applied to the Department of Indian Affairs and Northern Development since June 1985, to be registered as a status Indian under Bill C-31? Yes No
BILLC31R	Have you been registered as a status Indian under Bill C-31? Yes No
B1	Do you speak an Aboriginal language well enough to carry on a conversation? Yes No, I can't speak it, but I can understand it No, I can't speak it, nor understand it
B11	Do you participate in any traditional Aboriginal activities?* Yes No

* Traditional Aboriginal activities were defined in an introductory statement as: participation in the traditional Aboriginal ways of doing things such as hunting, fishing, trapping, storytelling, traditional dancing, fiddle playing, jigging, arts and crafts, pow-wows, etc.

APPENDIX B (Continued)

APS Questions Used in Analysis

Variable	APS Question
C4	Do you have any difficulty seeing the print on this page even with glasses or contact lenses if you usually wear them? Yes, have difficulty No difficulty
C5	Do you have any difficulty clearly seeing the face of someone across a room (that is, from 4 metres or 12 feet), even with glasses or contact lenses if you usually wear them? Yes, have difficulty No difficulty
C8	Do you have any difficulty walking 350 metres/400 yards without resting (about a quarter of a kilometre)? Yes, have difficulty No difficulty
C9	Do you have any difficulty walking up and down a flight of stairs, that is - about 12 steps? Yes, have difficulty No difficulty
C11	Do you have difficulty moving from one room to another? Yes, have difficulty No difficulty
C12	Do you have any difficulty standing for more than 20 minutes? Yes, have difficulty No difficulty
C20	Are you limited in the kind or amount of activity you can do because of a long-term physical condition or health problem, that is, one that has lasted or is expected to last 6 months or more... C20_I at home? Yes, I am limited No

APPENDIX B (Continued)

APS Questions Used in Analysis

Variable	APS Question		
	C20_III	at work?	
			Yes, I am limited
			No
			Not applicable, don't work
	C20_IV	in other activities such as travel, sport or leisure?	
			Yes, I am limited
			No

C25 — Does your condition or health problem require you to use a specialized aid, specialized equipment or system?
- Yes
- No

C29 — Because of your condition or health problem, do you need any help with your every day housework?
- Yes
- No

C32 — Because of your condition or health problem, do you need any help with your personal care, such as washing, grooming dressing and feeding yourself?
- Yes
- No

C34 — Because of your condition or health problem, do you use any specialized features to enter, leave or move about your home, such as an access ramp, a street level entrance, etc.?
- Yes
- No

C35 — Because of your condition or health problem, do you have difficulty leaving your residence to take short trips, that is trips to work, shopping or any other local trips under 80 km or 50 miles?
- Yes
- No

APPENDIX B (Continued)

APS Questions Used in Analysis

Variable	APS Question		
D1	In comparison with others your age, how would you describe your health. Is it...		
		Excellent?	
		Very Good?	
		Good?	
		Fair?	
		Poor?	
D2	Have you been told by a health care professional that you have...		
	D2_1	diabetes?	
			Yes
			No
	D2_2	high blood pressure?	
			Yes
			No
	D2_3	arthritis or rheumatism?	
			Yes
			No
	D2_4	heart problems?	
			Yes
			No
	D2_5	bronchitis?	
			Yes
			No
	D2_6	emphysema or shortness of breath?	
			Yes
			No
	D2_7	asthma?	
			Yes
			No
	D2_8	tuberculosis, that is, T.B?	
			Yes
			No

APPENDIX B (Continued)

APS Questions Used in Analysis

Variable	**APS Question**
D5	During the past twelve months, did you see anyone about your health? Yes No

D5a Who did you see? Was it...

A medical doctor?
Yes
No
A nurse?
Yes
No
A community health representative (CHR)?
Yes
No
An alcohol worker?
Yes
No
A traditional healer?
Yes
No
A dentist or dental health worker?
Yes
No
An eye specialist or eye doctor?
Yes
No
A midwife?
Yes
No
A druggist or pharmacist?
Yes
No
Someone else?
Yes
No

APPENDIX B (Continued)

APS Questions Used in Analysis

Variable	APS Question
D9	Have you ever taken a drink of alcohol - that is beer, wine, liquor or home brew? Yes No
D10	Do you now smoke cigarettes? Daily? Occasionally? Not at all?
D18	Do you participate in any sports, games, dance or recreation which involve physical activity? Yes No
IINCOME	Total Income derived from 1991 Census of Population $0 Less than $1,999 $2,000-$9,999 $10,000-$19,999 $20,000-$29,999 $30,000-$39,999 $40,000 and over Not stated
EMPLOYMENT STATUS	Labor force activity variable derived from 1991 Census of Population Employed Unemployed Not in Labor Force Not Stated

APPENDIX B (Continued)

APS Questions Used in Analysis

Variable	**APS Question**
EDUCATION	
	Highest grade of elementary/secondary school derived from 1991 Census of Population
	Less than Grade 5
	Grade 5-8
	Grade 9
	Grade 10
	Grade 11
	Grade 12
	Grade 13
	Not Stated