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Factors that Influence the Prevalence of Type 2 Diabetes among Aboriginals in Canada

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Walden University

College of Health Sciences

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Olayinka E. Awoyemi

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2018

Abstract

Factors that Influence the Prevalence of Type 2 Diabetes among Aboriginals in Canada

by

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M.A. Katholieke Universiteit, Belgium, 2010

M.SC. Universiteit Hasselt, Belgium, 2008

H.N.D. The Polytechnic, Ibadan, Nigeria, 2000

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

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January 2019

Abstract

The focus of this study was on potential social determinants of health factors that influence the prevalence of type 2 diabetes in the general population of Canada, with emphasis on the disproportion in rates of the disease between Aboriginal and non-Aboriginal populations of Canada. This study also examined the risk factors that are peculiar to the general, Aboriginal, and non-Aboriginal population of Canada. A total number of 101,080 individuals who were 18 years and above provided data for this study. The data and information obtained from these participants were used to answer the major research questions regarding if there was any association between the social determinants of health and the prevalence of type 2 diabetes in the Aboriginal and non-Aboriginal populations of Canada. Multiple logistic regression technique was the main statistical method adopted for this study. Results showed that smoking was peculiar to the prevalence of the disease in the Aboriginal population. It was also revealed that, while the same risk factors could be responsible for both Aboriginals and non-Aboriginals, the odds of having this disease was higher among Aboriginals in Canada. The results also indicated that risk factors such as sleep apnea, scoliosis, migraine, asthma, and osteoporosis to be significantly associated with the prevalence of type 2 diabetes in Canada. While scoliosis reduces the odds of type 2 diabetes in the non-Aboriginal population, it increased the odds in the Aboriginal population. The adverse and disproportionate impact of these risks factors on Aboriginals in Canada means governments at all levels in Canada and other stakeholders need to pay attention to the problem of smoking, sedentary and unhealthy lifestyle, lack of quality education, and income opportunities.

Factors that Influence the Prevalence of Type 2 Diabetes among the Aboriginals in Canada

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Dedication

This research study is dedicated to every individual who has suffered any form or degree of racial discrimination. Victims of this wicked act should not surrender the pursuit of their goals or give up their dreams, but rather remain determined and focused. The only way to punish your abusers is to achieve success, which always makes them sad.

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Chapter 1: Introduction to the Study

Introduction

Diabetes is one of the major chronic diseases that are associated with metabolism. It is the consequence of the inability of the pancreas in the body to produce the required insulin or when the generated insulin in the body is not enough or adequate to meet the amount that is required on a daily basis (National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2014). Diabetes has two major types: type 1 and type 2. Type 1 diabetes results when the beta cells that produce insulin in the pancreas are destroyed, leading to insufficient insulin in the body system. Type 2 diabetes which is the most common of the two kinds is caused by the combination of many factors which include resistance to insulin, a situation that arises when there is ineffective and inefficient use of the generated insulin by liver cells, fat, and muscles of the body (NIDDK, 2014). Type 2 diabetes also results when the pancreas of the body can no longer able to generate the needed quantity of insulin to compensate for the impaired ability to use insulin (NIDDK, 2014). The common symptoms of diabetes are excessive rates of urination, intense thirsty feelings, unclear vision, intense demand for food despite excessive eating habits, extreme exhaustion, loss of weight despite consumption of food in excess (type 1 diabetes), long cuts and bruises healing duration, and hands and feet becoming tingling, painful, and numb (American Diabetes Association [ADA], 2014).

Background of Study

It is estimated that about 347 million individuals on earth are suffering from diabetes and the overall risk of dying is estimated to be at least two times the risk of individuals who are not diabetic; countries that are considered to be low and middle

income account for more than 80% of deaths associated with diabetes (World Health Organisation [WHO], 2016a). In 2010, the rate of diabetes diagnosis in the US was discovered to have increased concomitantly, where approximately 21 million adults who were 20 years old or older were confirmed to be diabetic (Selvin, Parrinello, Sacks, & Coresh, 2014). In Canada during the year 2015, the prevalence of this disease was estimated at 3.4 million, which represents approximately 9.3% of the Canadian population, while the prevalence during the same year when the focus was on prediabetes among Canadians who were 20 years old or above was estimated at 5.7 million, representing approximately 22.1% of the entire Canadian population (Canadian Diabetes Association [CDA], 2015).

Diabetes is a chronic disease that can be managed, but the consequence of not properly managing diabetes as needed could lead to various complications associated with this disease (CDA, 2014). Being diabetic has been linked to various levels of health severity and sometimes deaths. Adverse health outcomes such as blindness, circulatory problems, lower limb amputation and cardiovascular diseases (CVDs) are commonly-known complications associated with being diabetic (Clark, 2014). CVD has been reported to increase the rate of all causes of deaths by approximately three times and in relation to diabetes, it is estimated that one out of two diabetic deaths is due to CVDs (Phillips, 2014). Diabetes is also primarily responsible for causing approximately 60% of nontraumatic lower limb amputations; there are two to four times higher risk of stroke and two to four times higher death rates due to heart disease (Kent et al., 2013). The rise in the risk of developing heart disease and stroke is also linked to diabetes and 50% of diabetes deaths are associated with CVDs, mostly due to heart disease and stroke (WHO, 2014). In addition to being responsible

for the development of blindness, heart failure and stroke, kidney failure, and amputations, the number of deaths linked to diabetes is more than the deaths due to acquired immune deficiency syndrome (AIDS) and breast cancer combined, and it is estimated that a diabetic American dies every 3 minutes (Diabetes Research Institute Foundation [DRIF], 2014). The combination of diabetes with reduction in blood flow promotes neuropathy which is nerve damage in the feet, which increases the risk of developing foot ulcers, infections, and ultimately amputations; it can also results in blindness because of the prolonged buildup of impairment of the small blood vessels in the retina (WHO, 2014).

Obesity or overweight is a major prominent factor that is responsible for the development of type 2 diabetes (Harvard School of Public Health, 2014). It is the fifth major cause of death and 2.8 million adults are estimated to die every year as a result of this disease (WHO, 2013). Being obese or overweight has been linked to depression, cancer, low quality of life, lung function and respiration, reproduction, musculoskeletal disorder, impaired cognitive and memory function, and vascular diseases as well as other related health outcomes such as stroke, cardiovascular death, and coronary artery disease (Harvard School of Public Health, 2014). This reflects the potential danger that is inherent in being obese or overweight. Body mass index (BMI) is generally considered to be a measure that is reliable and valid for determining and classifying body fat. A BMI value that is less than 18.5 is considered underweight; 18.5 and 24.9 is considered normal; 25.0 and 29.9 is considered overweight; a BMI value that is 30 and above is considered obese (CDC, 2015).

The diabetes epidemic results from both environmental and genetic factors (Ley et al., 2011). Factors such as age, ethnicity, education, employment, access to

healthcare, socioeconomic status (SES), lifestyle, and genetic disposition are common social determinants of health which are considered to be putative risk factors for developing diabetes (Brooks, Darroch, & Giles, 2013; Ghosh & Gomes, 2011). Individuals who are above 40 years of age, and people who are above 25 years of age and of South Asian, Chinese, African-Caribbean, and Black African descent have the highest risk of developing type 2 diabetes (Clark, 2014). In addition to this, African Americans, Hispanic/Latino Americans, American Indians, and some Asian Americans and Pacific Islanders are considered to be at higher risk of this disease (CDC, 2014). In the general population of Canada, family history is associated with a small increase in the risk of type 1 diabetes development, while in relation to type 2 diabetes development, being overweight or obese, unhealthy food consumption, inadequate physical body engagement, older age, high blood pressure, impaired glucose tolerance (IGT), ethnicity, poor nutrition during pregnancy, history of gestational diabetes, and diabetic family history are risk factors associated with this type of diabetes (International Diabetes Federation, 2014). Factors such as high blood pressure, smoking, cholesterol, BMI, income, education, lifestyle, poverty, and access to quality healthcare are regarded as modifiable risk factors, because they are factors that can be altered if appropriate provisions are put in place, while factors such as gender, race, ethnicity, and age are regarded as nonmodifiable risk factors simply because these factors cannot be altered (The Regents of The University of California, 2015).

Problem Statement

There is a huge margin when comparing the health status of Aboriginal peoples to the overall population of Canada (Willows, Hanley, & Delormier, 2012).

The total number of diabetic people in Canada between 2009 and 2013 rose by 15.2%, where the rate among male Canadians rose by 13% and their female counterpart rose by 18%. This is based on the inference from Statistics Canada (2014b), where the overall number of diabetic Canadian, 12 years and older in the 2009 was 1,706,148 (6.0%), the number of male diabetic Canadians was 937,014 (6.6%), and female diabetic Canadians was 769,134 (5.3%); while in the 2013, the overall number of diabetic Canadians in the same age category was 1,964,874 (6.6%), the number of male diabetic Canadians was 1,058,059 (7.2%), and the number of female diabetic Canadians was 906,815 (6.0%). In 2009, at least one out of two Canadians diagnosed with diabetes belonged to the working age, which is between 25 and 64 (Public Health Agency of Canada [PHAC], 2011).

Aboriginal peoples is the general collective identity used to describe peoples who originally came from North America and their descendants (Aboriginal Affairs and Northern Development Canada [AANDC], 2013b). Aboriginal peoples in Canada, which include First Nations, Inuit, and Metis, are considered to be a racial minority and collectively represent 3.3% of the overall Canadian population (Health Canada, 2012). Approximately 75% of First Nations people are registered with Indian status, and among this category of people, approximately 51% of them live off reserve, which implies 49% of them live on reserve (Statistics Canada, 2015a). Therefore, just like other vulnerable populations, they are also expected to experience high unemployment rates, lack of proper education, high death rates, low quality of life and bad health, poverty, preventable diseases, and lack of access to quality healthcare.

Type 2 diabetes is a key prevalent and detrimental outcomes of being obese in the Aboriginal population of Canada and has been described as an epidemic among the First Nations (Willows et al., 2012). The crude prevalent rates of diabetes among Aboriginals in Canada was between 2.7% and 19%, with some estimated prevalent rates as high as 30% when there was age standardization (PHAC, 2011). When compared to the overall Canadian population, the rate of diabetic individuals among the First Nations of Canada is reported to be about three to five times higher, and within the Inuit population in Canada, the increasing trend of this diabolic disorder disease goes on unabated (Health Canada, 2012). The increasing trend and disproportionate rate of diabetes in the Aboriginal population of Canada is similar to what is observed among American minority groups, including American Indians and Alaska Natives, where there is also the onset of this disease at younger age, thereby increasing their level of vulnerability to various complications that are associated with diabetes (Cho et al., 2014). Canadian Aboriginals are considered to be at the highest risk of developing diabetes and its associated complications (Canadian Diabetes Association [CDA], 2013). Canadian children of First Nations heritage were responsible for approximately 44% of all incidences of type 2 diabetes in Canada (Sellers et al., 2016).

Apart from the epidemic of type 2 diabetes in the Aboriginal population of Canada, there are also high prevalence rates of risks such as obesity and smoking which are associated with diabetes (Ley et al., 2011). In addition to the risks which are associated with developing type 2 diabetes in the overall population of Canada, Aboriginals in Canada have some risk factors which are peculiar to them, including environmental influence, genetic predisposition, biological influence, poor access to

quality healthcare services, and rapid changes in terms of sociocultural affairs (Ghosh & Gomes, 2011; PHAC, 2011). Aboriginal populations have experienced a rapid epidemiological transition that synergises with unique genetic susceptibility to diabetes (Ley et al., 2011).

In terms of personal lifestyle, the high correlation between rates of obesity and diabetes in the Aboriginal population of Canada is associated with high consumptions of energy drinks and sedentary lifestyles (Wahi et al., 2013). Apart from personal and sedentary lifestyles, dispossession of hereditary land, colonialism, discrimination, loss of traditional health systems, poor educational systems, lack of access to sound healthcare, lack of food security, and poor housing provision are social determinants of health that are specifically associated with Aboriginals in Canada (Brooks et al., 2013). In addition to social determinants of health, poverty, household overcrowding, single parent households, geographical isolation and lack of access to healthcare providers with knowledge of Aboriginal languages, cultural values, or Aboriginal history are determinants of health that distinctively differentiate the Aboriginal population from the non-Aboriginal population (Willows et al., 2012).

Purpose of the Study

The absence of credible evidence in relation to various health challenges that are confronting the vulnerable population is a fundamental barrier to attain equitable health outcomes. However, there has not been any empirical research study that specifically targets the impact of social determinants of health on the prevalence of type 2 diabetes among Aboriginals in Canada. This also includes the disparity in the rate of this disease between Aboriginal and non-Aboriginal Canadians. The population of the Aboriginal Peoples in Canada is growing at a faster rate and even

more quickly than the overall Canadian population. It is estimated that 47% of the Aboriginal population is under the age of 25, while the growth of their counterpart in the non-Aboriginal population is 31.7% (PHAC, 2011). Therefore, this chronic disease poses a great danger to Canada if this trend is not checked. It is estimated that by the year 2025, the prevalence of diabetes and prediabetes in the same age group of Canadians would be 5 million, which represents 12.1% of the entire nation, and 6.4 million, which represents 23.2% of the whole population, thereby implying an increase of 44% from 2015 to 2025 (CDA, 2015). This study focuses on examining the impact of social determinants of health and other relevant factors on the prevalence of type 2 diabetes and also investigates the disproportionate rates of this disease in the Aboriginal compared to the non-Aboriginal population in Canada.

Nature of the Study

The nature of this research study is retrospective and quantitative. Variables such as race and ethnicity, gender, age, employment status, BMI, residency location, level of education, marital status, and income which were collected by Statistics Canada on behalf of the PHAC were used as prognostic factors to test various hypotheses in this study. A quantitative research design is applicable during the course of examining a public health concern or issue when the researcher focuses on logic, numbers, constant static data, and detailed convergent reasoning instead of divergent reasoning to determine the potential association between an item (a predictor variable) and another (a response or outcome variable) in the target population (University of Southern California, 2014).

Research Questions and Hypotheses

The following are the research questions and associated hypotheses developed for this study:

RQ1: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the general population of Canada?

$H_0$1: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes in the general population of Canada.

H_a1: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes in the general population of Canada.

RQ2: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the Aboriginal population of Canada?

$H_0$2: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes among Aboriginals in Canada.

H_a2: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes among Aboriginals in Canada.

RQ3: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the non-Aboriginal population of Canada?

$H_0$3: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes among non-Aboriginals in Canada.

H_a3: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes among non-Aboriginals in Canada.

RQ4: Is there any significant difference regarding the prevalence of type 2 diabetes between Aboriginals and non-Aboriginals in Canada while considering the impact of both modifiable and nonmodifiable risk factors?

H_04: There is no significant difference regarding the prevalence of type 2 diabetes between Aboriginals and non-Aboriginals in Canada while considering the impact of both modifiable and nonmodifiable risk factors.

H_a4: There exists significant difference in terms of the prevalence of type 2 diabetes between Aboriginals and non-Aboriginals in Canada while considering the impact of both modifiable and non-modifiable risk factors.

The Conceptual Framework

The conceptual framework used for this research study is the social ecological model (SEM). It is a framework that was based partly on the concept of reciprocal determinism, which takes cognisance of the association among people, groups, and their immediate and extended social environment (Golden et al., 2015). A single factor cannot sufficiently explain or provide any understanding regarding why some people or groups are more vulnerable to health outcomes, while other individuals or groups are not (WHO, 2016b). Health outcomes are viewed as a complex interplay between individual, relationship, community, and societal factors (CDC, 2015; WHO, 2016b).

Personal or individual level is the first component of SEM, it relates to how lifestyle and increase in likelihood of experiencing a health outcome such as type 2 diabetes are influenced by personal history and biological factors (WHO, 2016b). Aboriginals in Canada have a much higher risk of diabetes than other Canadians because of their lifestyle, which includes inactivity and less consumption of healthy

food (CDA, 2016). This indicates the relevance of the personal component of SEM to examining the influence of social determinants of health in relation to the prevalence of type 2 diabetes in the Aboriginal population of Canada.

The second component is personal relationships, a person's family, friends, associates, social circle, peers, and partners can influence his or her behavior and contribute to his or her range of experiences (CDC, 2015). This implies that a healthy or normal lifestyle of an individual can be negatively altered through the influence of his or her family, friends, partners, and associates, making him or her engage in unhealthy lifestyles. These lifestyles could include smoking, inactivity, drug use, and consumption of high caloric food, thereby leading to higher risk of developing type 2 diabetes. Individuals whose social networks in terms of parents, friends, and peers are made up of overweight individuals or those who engage in unhealthy lifestyles are more likely to underestimate their own weight and develop inaccurate perceptions of what constitutes appropriate weight status and healthy activities (Salvy , Haye, Bowker, & Hermans, 2012). Family, friends, peers, and associates can influence an individual to engage in unhealthy activities that could lead to the development of type 2 diabetes.

Community, which is the third component of SEM, provides the avenue for social relationships to take place, thereby providing the opportunity for these relationships to have influence on individuals or groups living within the community (WHO, 2016b). Aboriginals in Canada mostly live on reserves, rural and remote locations, or neighborhoods where most dwellers have low socioeconomic status. In the province of Manitoba which has the highest population of Aboriginal people in Canada, high prevalence of diabetes mellitus occurred in the geographic areas with

the highest concentration of Aboriginals who have the poorest lifestyles and lowest levels of environmental quality (Willows et al., 2012). Therefore, they lack access to good healthcare facilities, healthy food, quality education, and employment opportunities. The increased risk of type 2 diabetes among Aboriginals in Canada, which is the consequence of negative health outcomes, is associated with poverty, social marginalization, and colonisation (Ghosh & Gomes, 2011).

The fourth component of SEM is the societal factor, which helps to establish an environment that encourages and tolerates various unhealthy behaviours and lifestyles that influence the risk of increase in health outcome (CDC, 2015). Societal factors include social policies that tolerate socioeconomic inequalities between people and social and cultural norms that help to promote unhealthy lifestyles (WHO, 2016b). In relation to Aboriginal people in Canada, societal factors could include government policies that aid uneven distribution of available resources among Canadians, while social and cultural norms could include lack of awareness of the consequences of engaging in sedentary and unhealthy lifestyles. The non-alignment of government policies as they relate to the social determinants of health and the inequities in health between Aboriginal and non-Aboriginal populations of Canada are linked to the disproportionate higher rates of type 2 diabetes between Aboriginal and non-Aboriginals in Canada (Brooks et al., 2013). These four components show that the application of SEM might be the best contextual approach for examining the influence of social determinants of health regarding the prevalence of diabetes among Aboriginal people in Canada.

Definition of Terms

Off-reserve: The term for Aboriginal people who are not residing on a reserve (Willows et al., 2012).

Reserve: A piece of land, the legal title to which is held by the Crown (Willows et al., 2012).

The Indian Act: Legislation that highlights certain federal government obligations and also regulates how Indian reserve lands, monies, and other resources are managed (Willows et al., 2012).

Vulnerable population: The disadvantaged subpopulation of a community requiring utmost care, specific additional considerations, and better protections as determined by research (Shivayogi, 2013).

Assumptions

It is assumed that the collection and selection of respondents by Statistics Canada for CCHS 2016 was performed in accordance with the dictates and ethics of carrying out research studies on humans. It is assumed that data and information provided by Statistics Canada in relation to the CCHS 2016 survey are accurate, reliable, and valid. This study is based on the assumption that the sample of participants is a true representative of the overall Canadian population.

Limitations

This study used a cross-sectional design based on the outcome of CCHS 2016. The generalization of findings depends on the level of accuracy of the sampling technique used in obtaining the sample size and the true representativeness of the sample. In addition, part of CCHS 2016 survey was self-reported data and information

of respondents. This could provide avenue for falsification of responses which would impair the validity of the outcome.

Scope and Delimitations

This study investigated the role of social determinants of health in the prevalence of type 2 diabetes and also examined the disproportionate rates of this disease when comparing the Aboriginal population to the non-Aboriginal population in Canada. This study only considered data and information about Aboriginal and non-Aboriginal populations from the CCHS survey of 2016. The 2016 survey reported physical measurements of 101,080 people, but the population of Canada in 2014 was 35,540,400 (Statistics Canada, 2014a). Since a selected sample of individuals across the country was interviewed instead of the entire population, this is considered as a delimitation to this study. Therefore, the true representativeness of this sample can only be ascertained by Statistics Canada.

Significance of the Study

The outcome of this research study is expected to add to the existing body of knowledge regarding type 2 diabetes as it relates to the Aboriginal population in Canada. There is a huge discrepancy between Aboriginal and non-Aboriginals in Canada in terms of accessibility to quality healthcare, education, employment, healthy food, and safe and secure environments. Therefore, the findings of this study could lead all levels of government and public health institutions to abolish policies that are unfavourable and discriminatory to Aboriginals in Canada. Also, various levels of government and institutions, including foreign agencies could develop appropriate interventions and policies which are directed toward poverty alleviation, provision of affordable healthy food and securing neighbourhoods and environment, settling up of

facilities that will promote physical exercises, and enhancing access to quality healthcare services in various reserves, communities and settlements inhabited by Aboriginals across Canada.

Through creation of awareness and enlightenment as a result of findings from this study, Aboriginals in various reserves communities and settlements across Canada would be able to see the benefits in engaging in healthy lifestyles. These include consuming less caloric food items, adequate physical engagement, and ensuring adequate sleep. Through this study, they would also see the dangers that are inherent in unhealthy behaviours such as smoking, drugs and tobacco, and excessive alcohol consumption.

Summary

This chapter provided general information about diabetes and its impact on the Aboriginal population of Canada. This information includes causes, effects, symptoms, and the influence of social determinants of health regarding the prevalence of diabetes in Canada, most especially among Aboriginals. It also looked at disproportionate rates of diabetes between Aboriginals and non-Aboriginals in Canada. Chapter 2 focuses on academic literature that are relevant to the problem of diabetes in general and the Aboriginal peoples of Canada in particular.

Chapter 2: Literature Review

Introduction

The literature review begins with an overview of diabetes. This includes types, symptoms, risk factors, causes, complications, and impact on society. This review looks at relationships that may exist when looking at the prevalence of type 2 diabetes through the lens of social determinants of health, and the impact of this relationship on Aboriginal Peoples in Canada. Social determinants of health vary, hence the reason why this review provides an extensive overview of the composition of determinants and their relationships. Through the application of the conceptual framework, the individual influence of each of the social determinants of health along with their collective effect on the population of Aboriginals in Canada is also explored. In addition, this review provides insight into the impact of these social determinants of health as they relate to the imbalance in terms of prevalence and incidence rates of type 2 diabetes between Aboriginal and non-Aboriginal Canadians. The concluding part of this review provides a summary of potential risk factors, their association with social determinants of health, and how their individual and collective consequences lead to the higher prevalence of type 2 diabetes in the Aboriginal population of Canada.

Methodology

The literature search was carried out by accessing various scholarly databases and libraries. Through the use of the Walden University Library, Google Scholar, CDA publications, and textbooks. Search terms were *Aboriginal health, diabetes, Aboriginal in Canada and diabetes, social determinants of health and type 2 diabetes in Canada, causes of type 2 diabetes in the Aboriginal population of Canada, and*

government policies and incident of type 2 diabetes among Aboriginals in Canada. In particular, Medical Literature Analysis and Retrieval System (MEDLINE) and Cumulative Index to Nursing & Allied Health Literature (CINAHL) databases through the Walden University Library provided most of the peer-reviewed articles for this aspect of the study. Major inclusion criteria for literature to be considered for this research included being peer-reviewed, a publication date not earlier than 5 years before the date of publication. Articles from Wikipedia, reports or articles from news and media organizations, and articles from private organizations were excluded.

The Aboriginals in Canada

Aboriginals can also be described as the original peoples who were living in North America before the arrival of the European settlers (Willows et al., 2012). Aboriginal people in Canada self-identify as Indigenous people with historical links who occupy a place prior to invasion and colonization, have strong associations and links to land and water and other related natural endowments, and have unique languages, cultures, religions, ceremonies, and beliefs (Senese & Wilson, 2013). Aboriginals in Canada are considered to be distinct peoples with unique spiritual beliefs, cultures, languages, and histories and the constitution of Canada recognizes three groups of Aboriginal Peoples in Canada, which are the First Nations or the Indians, Métis, and Inuit (AANDC, 2013b). It is estimated that more than 370 million Indigenous peoples are living in various countries on every continent (Senese & Wilson, 2013). In 2011, according to National Household Survey (NHS), more than 1.4 million people identified themselves as Aboriginal, representing 4.3% of the entire Canadian population (Statistics Canada, 2015b). At the time of the 2011 NHS, 56% of people who identified themselves as Aboriginals were living in urban areas, with a

rapid increase rate of 4.7% per year between 1996 and 2011, due to the combination of high birth rates and greater interest of people to be identified as Aboriginals (Wilk & Cooke, 2015). The birth rate in the Aboriginal population of Canada is 1.5 times higher than the entire Canadian population (Wahi et al., 2013). In 2011, the number of people who identified as First Nations individuals was 851,560, representing 60.8% of the entire Aboriginal population and 2.6% of the overall population of Canada; the number of those who identified themselves as Métis was 451,795, representing 32.3% of the entire Aboriginal population and 1.4% of the overall population of Canada; the number of individuals who identified themselves as Inuit was 59,445, representing 4.2% of the entire Aboriginal population and 0.2% of the overall Canadian population (Statistics Canada, 2015d). The majority of Aboriginals in Canada live in places where there are inadequate presence of modern and basic life amenities. Aboriginal settlements across Canada are in urban, rural, or remote places, which include lands mostly referred to as reserves: Inuit settlements are located in Nunavut, Northwest Territories, Northern Quebec (Nunavik) and Labrador; Métis settlements are located mainly in Alberta, British Columbia, Ontario, Manitoba and Saskatchewan; Urban settlements of Aboriginal people comprising the Métis, non-status Indians, Inuit, and First Nations are located in various cities or towns that are not part of reserves or traditional Aboriginal settlements (AANDC, 2013b). The population of Aboriginal Canadian is growing rapidly and even faster than the overall population of Canada, most especially in terms of younger Aboriginals, where approximately one in two Aboriginals is below 25 years of age, while about one in three non-Aboriginals belongs to the same age group (PHAC, 2011).

Diabetes

Diabetes reduces quality of life and inflicts suffering on people. It is a metabolic disorder that is based on the manner the body utilizes digested food for energy (NIDDK, 2014). It is considered a chronic disease due to the fact that it cannot be cured but maintained, and can last throughout the life of the sufferer. It is a debilitating and sometimes fatal disease, in which the body system of the sufferer is either unable to generate the needed insulin or adequately use the generated insulin (CDA, 2016). Diabetes has two major kinds: type 1 and type 2. The number of diabetic people globally rose from 108 million in 1980 to 422 million in 2014, while the global prevalence among adults who are over the age of 18 rose from 4.7% to 8.5% during the same period (WHO, 2016a). In the United States, diabetes is the sixth ranked leading cause of death (Clark & Utz, 2014). In 2010, there were approximately 21 million confirmed cases of diabetes among US adults who were 20 and above (Selvin et al., 2014). In Canada, its prevalence has almost doubled since 2000 (Brown, Nevitte, Szeto, & Nandi, 2015). It was reported that 6.7% of Canadians aged 12 or older representing about 2 million people suffered from diabetes in 2014, which is not significantly different from the rate in 2013, but is substantially higher than the rates between 2001 and 2009 and 2011 (Statistics Canada, 2015c). The estimated prevalence of diabetes in Canada in 2015 was 3.4 million, which represents 9.3% of the Canadian population; the estimated prevalence of prediabetic individuals aged 20 years and older in 2015 was 5.7 million, which represents 22.1% (CDA, 2015). In developed nations such as Canada, individuals or people who are socioeconomically marginalized are inequitably affected by diabetes (Ghosh, 2012).

Type 1 Diabetes

Type 1 diabetes previously known as insulin-dependent, juvenile or childhood-onset (WHO, 2016a), develops in the body system as a result of insufficient supply of insulin due to the destruction of beta cells which are located in the pancreas (NIDDK, 2014). It is described as an autoimmune disease which has a strong link to genes and one of the most common chronic diseases among children (Sørensen et al., 2012; You & Henneberg, 2016). It is estimated that about 5 to 10 percent of individuals with diabetes are suffering from type 1diabetes, which could have started during childhood or adolescence, but can as well appear in adulthood (CDA, 2016). Type 1 diabetes is associated with 3 classic presenting symptoms which are polydypsia, polyphagia and polyuria, along with overt hyperglycemia which necessitate the need for urgent exogenous insulin replacement (Atkinson, 2012). As of 2014, type 1 diabetes represents between 5% and 10% of the total estimated 387 million people with diabetes globally (You & Henneberg, 2016). The incidence of type 1 diabetes in both non-Hispanic white and Hispanic youth in the US is similar to what is observed globally between 1990 and 2008, where the incidence was found to be increasing between 2.8% and 4.0% per year (Dabelea et al., 2014). Newhook, Penney, Fiander, and Dowden (2012) observed that in Canada between 1987 and 2010, the incidence of type 1 diabetes in the population of children aged 0 - 14 was 37.7 per 100,000 per year, and the incidence between 2007 and 2010 was 49.9 per 100,000 per year of the same Canadian population, which shows an increase of 1.03 per 100,000 per year over the 24 year period.

Type 2 Diabetes

Type 2 diabetes which is also known as non-insulin-dependent or adult-onset (WHO, 2016a), is the more common of the 2 types of diabetes. It is caused by the aggregation of different factors which include insulin resistance, a condition that arises when the generated insulin by the body system is unused effectively and efficiently (NIDDK, 2014). Ninety to 95% of all cases of diabetes are type 2 (Brown et al., 2015). Based on the increasing number of younger individuals aged between 20 and 40 years being diagnosed of type 2 diabetes, the perception that this disease mostly affects older individuals has to be revised and modified (Zoungas et al., 2014). An individual with type 2 diabetes may not show any sign, but the most common symptoms include fatigue, drowsiness, frequent and increased urination, extreme thirst, excessive hunger, blurred vision, inexplicable weight loss, genital and bladder infections, and irritability (Diabète Québec, 2014b).

Complications of Diabetes

Type 2 diabetes is ranked among the 10 leading causes of death among the wealthy countries, and in Canada, it is ranked the 7th leading cause of mortality, with about 2 out of 3 deaths linked to either heart disease or stroke (Brown, Nevitte, Szeto & Nandi, 2015). Complications from diabetes can be of different forms, with the common complications such as circulatory difficulties, cardiovascular diseases (CVDs), blindness, and amputation of lower limb (Clark, 2014). Various forms of musculoskeletal disorder such as dupuytren's contracture, flexor tenosynovitis, trigger finger, adhesive capsulitis and positive prayer sign which are of the upper extremities are some of the major complications associated with type 1 diabetes (Larkin et al., 2014). Vascular complications which include nephropathy, retinopathy and

hypertension which can impair the quality of life of individuals with type 1 diabetes and limit their life expectancy can as well result into kidney failure and blindness, cardiac disease, stroke and limb amputations (James et al., 2014). Deaths due to CVD are responsible for about half of all death of diabetic individuals and the constant difference in the rate of deaths is suspected to be the consequence of the inability to reduce the risk factor among individuals who are diabetic and also the inability to improve the risk factors among those who are pre-diabetic (Phillips, 2014). Besides complications such as CVD, blindness, cardiac disease and kidney failure, diabetes is considered to be the principal cause of 60% of non-traumatic lower limb amputations which include the conferment of 2 to 4 times higher risk of stroke and a 2 to 4 times higher mortality rate due to heart disease (Kent et al., 2013). The number of deaths resulting from diabetes is more than the total combination of deaths from both acquired immune deficiency syndrome (AIDS) and breast cancer; diabetes takes the life of an American in every 3 minutes (DRIF, 2014). In addition to these complications, which can as well be the outcome of not properly maintaining the disease, lack of proper treatment of diabetes can also result into erectile dysfunction or impotency (CDA, 2014). Apart from its negative impacts and complications, diabetes also has adverse effect on the economy. In 2010, diabetes-related spending cost the Canadian economy approximately $12 billion (Brown et al., 2015).

Risk Factors of Diabetes

Apart from its association with various cardiovascular diseases, cancer, reproduction, low quality of life, respiratory disease, memory and cognitive function, the prevalence of type 2 diabetes is considered to be mostly influenced by being obese or overweight (Harvard School of Public Health, 2014). Out of every 10 individuals

with type 2 diabetes 8 are overweight (Diabète Québec, 2014b). Obesity is the outcome of imbalance in energy that is obtained from a complex interaction among lifestyle, genetic composition, environment, and society (Cheng, 2012). It is also described at the individual level as the response of the body system to constant positive energy balance as a result of excess consumption of calorific foods or insufficient physical engagement, or both (Willows, Hanley & Delormier, 2012). An individual who has a BMI value that is less than 18.5 is regarded as being underweight; an individual who has a BMI value that ranges between 18.5 and 24.9 inclusively is regarded to be normal or of healthy weight; an individual who has a BMI value that ranges 25.0 and 29.9 inclusively is regarded as being overweight; while an individual who has a BMI value that is 30 and over is regarded as being obese (CDC, 2015). In addition to being overweight or obese, the risk of developing type 2 diabetes is also associated with gender, where men are more at risk than women; age, where the risk of developing the disease increases with age; large waist circumference; level of physical activity; eating habits; high blood pressure; heredity; previous abnormal blood sugar level; women who gave birth to a baby who weighs above 4.1kg; and ethnicity, where Aboriginals, Africans, Asians, and Latin-Americans are at higher risk (Diabète Québec, 2014b).

Aboriginals in Canada and Type 2 Diabetes

Diseases such as obesity, type 2 diabetes, hypertension, and heart disease have higher prevalence rates in the Aboriginal population of Canada (Willows et al., 2012). The prevalence and incidence rates of diabetes are multiple times higher among the Indigenous people across the world when compared to the overall population (Harris et al., 2013). Aboriginal population in Canada is diverse in terms of cultures, histories,

local governments, and other characteristics, but the groups within this diverse population share many commonalities in relation to diabetes which include prevalence that is substantially higher than the rate in the non-Aboriginal population; onset of the disease at younger age leading to higher prevalence of youthful-onset type 2 diabetes; and a serious burden of micro- and macro-vascular difficulties (Willows et al., 2012). Aboriginal Canadians are considered to be among the group of people at highest risk of diabetes and related complications (CDA, 2013). They are even considered to be experiencing an epidemic of type 2 diabetes (Dyck et al., 2015). The prevalence of diabetes among First Nations Aboriginals in Canada who reside on reserves is 17.2%; the prevalence among those who reside outside the reserve is 10.3%; the prevalence among the Métis is 7.3%; while the prevalence among non-Aboriginals is 5% (Rice et al., 2016). Previous research studies within the last two decades on diabetes in the Aboriginal population of Canada revealed that the crude prevalence of diabetes ranges from 2.7% to 19%, and as high as 30% when based on age standardization (Public Health Agency of Canada, 2011). Besides the imbalance in the rates of diabetes between the Aboriginals and non-aboriginals, there also exists disproportion in rates of diabetes-related deaths and complications, where the Aboriginals in Canada have higher rates than non-Aboriginals (Harris et al., 2013). Apart from being identified as a high risk population of CVD, an increasing risk of cancer has also been observed among First Nations in Canada (Wilk & Cooke, 2015). These disproportional rates of diabetes and other related obesity complications in the Aboriginal population of Canada when compared to non-Aboriginal population are suspected to be linked to various factors.

Effect of Type 2 Diabetes in Terms of Aboriginals' Age

The scourge of diabetes in the Aboriginal population of Canada does not exclude children and youths, even little or no regard is given to gender. In the general population of Canadian children, type 2 diabetes mellitus has a minimum annual incidence of 1.55 per 100000 children who are younger than 18 years of age (Sellers et al., 2016). Aboriginal children in Canada have higher rate of diabetes when compared to their non-Aboriginal counterparts in Canada, and therefore they are considered to be a high risk population (Wahi et al., 2013). Between 1980 and 2005 in Canada, the prevalence rates of diabetes among First Nations children were more than triple (Harris et al., 2013). Based on the national prospective surveillance study, it was discovered that between 2010 and 2012, 8 out of 10 individuals with type 2 diabetes and persistent albuminuria were children who self-declared to be descendants of First Nations people of Canada (Sellers et al., 2016). In addition to having higher rates of diabetes, the First Nations people have higher likelihood of developing diabetes if they are female, young adults, and during the stage of childhood and adolescence in comparison to non-Aboriginals in Canada (Dyck et al., 2015). Wahi et al., (2013) noted that apart from the fact that higher prevalence of obesity, type 2 diabetes, and CVD are recorded among Aboriginal adults in comparison to their non-Aboriginal counterparts in Canada. It is also noted that, the prevalence of type 2 diabetes is excessively higher among Aboriginal youths than non-Aboriginal youths in Canada (Wahi et al., 2013). In comparison to the general Canadian population, the age-standardized prevalence of type 2 diabetes is 3-5 times higher in the First Nations population of Canada and this disease along with other metabolic syndromes do not exclude First Nations children and youths (Willows, Hanley & Delormier, 2012).

Effect of Type 2 Diabetes in Terms of Aboriginals' Gender

In relation to gender disparity, Sellers et al. (2016) discovered in a study that focused on persistent albuminuria in Canadian children with type 2 diabetes that, approximately 2 of 3 children with confirmed cases were females. In terms of age standardized prevalence rates of type 2 diabetes with focus on productive years, more than 20% of women who are First Nations are diabetic in comparison to 16% of their male counterparts (Harris et al., 2013). Gestational diabetes mellitus is another form of this disease that disproportionately affects Aboriginal women in Canada. The rates of gestational diabetes mellitus in Canada are 2 to 3 times higher among Aboriginal women than non-Aboriginal women (Harris et al., 2013).

Social Determinants of Health

The state of health that relates to being healthy or otherwise is determined by the circumstances and environment in which people live and dwell (WHO, 2016a). The health and wellbeing of individuals or communities are largely influenced by social conditions which include the level of education, employment status, and the type of neighborhood (O'Brien et al., 2014) The place of abode, the condition of the environment, genetic composition, level of income and educational attainment, and relationships with friends and family to a large extent impacts the health of people (WHO, 2016b). These factors and conditions which can be categorised as income level and social status; social support networks; educational level; employment and working conditions; social environments; physical environments; individual health practices and coping skills; healthy child development; gender; and culture are referred to as the social determinants of health (Public Health Agency of Canada, 2016). Social determinants of health expose various degrees of health inequities

between and within communities due to the fact that they are influenced by distribution of money, power, and resources (Brooks, Darroch & Giles, 2013). The impacts of these factors on people or population which could either be positive or negative could result into various types of health outcomes including diseases and death. These determinants interact in a unique way to affect health disparities by inhibiting the ability of various communities or group of people to attain health equity (Garrett, Dube, Babb, & McAfee, 2014). Social determinants of health such as health behaviours, physical environments, employment and income, education, and food insecurity that directly affect individual or group of people physically, mentally, emotionally, and spiritual health are regarded as proximal; those that emanate as a result of health care systems; educational systems; community infrastructure, resources, and capacities; environmental stewardship; and cultural continuity are regarded as intermediate; while social determinants such as colonialism, racism and social exclusion, and self-determination which originate as the consequence of political economic, and social systems are regarded as distal (Brooks, Darroch & Giles, 2013).

Aboriginals in Canada and Social Determinants of Health

The population of Aboriginals in Canada is distinct in comparison to their non-Aboriginal population counterpart when focusing on social determinants of health (Willows et al., 2012). They are considered to be at higher risk of lifestyle-related chronic diseases which are the major causes of death among Canadians, contrary to consistent higher rates of death and illness which are due to infectious diseases (Wilk & Cooke, 2015). Specific determinants of health which include Aboriginal status, race, social exclusion, disability, food security, education, early life

style, gender, employment and working conditions, health services, housing, income and income distribution, social safety net, and unemployment and job security are associated with the Aboriginal population in Canada (Tait, Henry & Walker, 2013).

Aboriginal groups in Canada are different from one another, but they mostly suffer from poor health outcomes in comparison to non-Aboriginals due to health inequities that emanated from social determinants of health (Senese & Wilson, 2013). The alarming rates of health outcomes in the Aboriginal population of Canada cannot be attributed to a single determinant of health. Brooks, Darroch and Giles (2013) noted that determinants of health interact in a variety of levels and ways to influence the health, therefore, it is uncommon for a single determinant to influence the health of an individual or community. Delayed degenerative diseases are common among wealthy Canadians and other citizens of wealthy countries due to higher standards of living, while the risk of these diseases among Aboriginal Peoples are the consequences of high rates of low income, food insecurity, unemployment, and other determinants of social and economic discrimination (Wilk & Cooke, 2015). The higher rates of various negative health outcomes in the Aboriginal population of Canada are linked to factors such as behaviors including diet and physical exercise, genetic predisposition, and unfavorable political history and psychosocial factors which are the outcomes of generational colonization that ultimately destroyed the values, cultures and spiritual practices of the Aboriginals in Canada (Harris et al., 2013). This brings about the suspicion that the health variations between the populations of Aboriginals and non-Aboriginals in Canada are linked to social rather than biological determinants (Findlay & Janz, 2012). In Canada, colonization, health

care access, and educational systems are considered to be the main determinants that influence health outcomes such as type 2 diabetes (Brooks, Darroch & Giles, 2013).

Relationship between Social Determinants of Health and Type 2 Diabetes among Aboriginal Canadians

Aboriginal peoples in Canada can be considered as racial minority group. They can be regarded as vulnerable population and therefore, tend to share similar features of any vulnerable populations, which could include unemployment, lack proper education, ill-health, poverty, suffering from preventable diseases, lack of access to quality healthcare services, and discrimination. There is overwhelming gap in the health status of the Aboriginal Peoples of Canada when compared to non-Aboriginals (Willows, Hanley & Delormier, 2012). Beside the risks that are linked to the emergence of type 2 diabetes in the general population of Canada, there are specific risk factors of type 2 diabetes which include genetic predisposition, environmental impact, lack or inaccessibility to quality healthcare delivery, biological influence, and frequent alterations in relation to socio-cultural affairs that are associated with Aboriginals in Canada (Ghosh & Gomes, 2011; Public Health Agency of Canada, 2011). Some personal choices in terms of lifestyle can influence the development of type 2 diabetes and other obesity-related complications. Personal lifestyles, unhealthy diet and constrained potential for physical exercises are the main focus of attention when it comes to the difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada (Ghosh & Spitzer, 2014). In addition, the prevalence of type 2 diabetes among the Indigenous people of Canada is mostly associated with compromised diet and insufficient provisions to engage in physical activities (Ghosh & Spitzer, 2014). The likelihood of an individual to

experience adverse health outcome such as type 2 diabetes and personal behaviors are influenced by both biological and personal historical factors (WHO, 2016a). The prevalence of obesity in the Aboriginal population of Canada is the consequence of lack of physical engagement and/or consumption of too much caloric food, a claim that is supported by virtually all research studies (Willows, Hanley & Delormier, 2012). The likelihood of smoking and having Body Mass Index (BMI) value that can be categorized as obese or overweight is higher among Aboriginals than non-Aboriginals in Canada (Wilk & Cooke, 2015). Also, the choice of taking up western ways of living including high energy intake and inadequate physical exercise is highly correlated with the increased prevalence of obesity and diabetes in the Aboriginal population of Canada (Wahi et al., 2013). Studies conducted in various Aboriginal communities revealed that while quantifying the caloric and food intake, Aboriginal children tend to consume market food of poor quality (Willows, Hanley & Delormier, 2012).

At community level, factors which include built environment, accessibility and affordability of healthy food, easy access and cheap tobacco have the likelihood of influencing the development of unhealthy lifestyles (Wahi et al., 2013). Apart from the alteration to lifestyle, the obvious inequities in social determinants of health such as poverty, poor housing condition, inadequate educational attainment, lack of access to quality food, and unemployment are substantial contributors to the widespread of diabetes in various Aboriginal communities in Canada (Dyck et al., 2015). The higher rates and imbalance in both prevalence and incidence of type 2 diabetes within the Aboriginal population in comparison to the non-Aboriginals in Canada are associated with different levels of complex factors and they are as well influenced by the

alterations in the ways Aboriginal Peoples live (Ghosh & Gomes, 2011). Most Aboriginals in Canada live on reserves, remote or neighborhoods in urban areas that are populated by low-income individuals or those at the lower end of the social status ladder. This condition can as well contribute to the prevalence of adverse health outcomes including type 2 diabetes in the Aboriginal population. For instance, in Winnipeg, a city in the province of Manitoba in Canada, research investigation discovered a high prevalence of diabetes mellitus in the geographic areas that have the least socioeconomic status, the poorest lifestyles and the least level of environmental quality (Willows, Hanley & Delormier, 2012). In a study conducted by Wahi et al. (2013) on a reserve named Six Nations Reserve in the province of Ontario in Canada, there exists extensive socioeconomic problems with high rates of unemployment, low income, and lack of basic education, leading to obesity, tobacco use, diabetes and CVD among the dwellers of this reserve. Modifiable risk factors which include obesity, physical activities, diet, socioeconomic status (SES), and stress are outcomes of intermediate risk factors such as the impacts of colonization, poverty, sociopolitical system, and accessibility of quality healthcare system (Ghosh & Gomes, 2011). Through colonization process which included taking over ownership of land and environmental dispossession, the ties between Aboriginal Peoples and their land is destroyed (Senese & Wilson, 2013). Colonialism in relation to health inequities against the Aboriginal population of Canada plays a fundamental important role (Senese & Wilson, 2013).

Colonization

Colonization of the Aboriginal population of Canada resulted in inequities in the social determinants of health and it is part of the major risk factors that led to the

decreased rates of physical exercise; it brought about stress; dietary acculturation and an unhealthy diet; food insecurity; obesity and metabolic syndrome; and high rates of diabetes during pregnancy for the development of type 2 diabetes in this Canadian population (Harris et al., 2013). Colonization by the Europeans as well as dispossession of traditional land, and assimilation policies such as the Indian act and residential schools, which are historical factors have a huge impact in determining the health status of Aboriginals in Canada (Willows, Hanley & Delormier, 2012). Residential school system and large-scale fostering and adoption of Aboriginal children to non-Aboriginal homes were parts of the colonial policies of the federal government of Canada. (Tait, Henry & Walker, 2013). Colonization can be regarded as a form of racism and discrimination, which is usually less aggressive when compared to slavery and genocide which are violent; it considers imbalance in power as neutral and natural process (Loppie, Reading & Leeuw, 2014). Through colonization, avenues and chances that could enhance the enablement of Aboriginals in Canada to live healthy and be economically independent were largely limited (Willows, Hanley & Delormier, 2012). The Indian act which is a product of colonization defined Aboriginal identities in relation to constructed racial division due to the fact that the convenience of the Canadian state is more important than the political and cultural groupings which are the actual basis of characterizing the Aboriginals in Canada (Senese & Wilson, 2013). The outcome of colonization in terms of adverse health consequences is not peculiar to Canada. The higher rates of these health outcomes including type 2 diabetes can be observed in other countries where indigenous populations have been subjected to adverse treatment such as colonization (Harris et al., 2013). Regardless of the nature of oppressions, they have

adverse effect on the well-being of the racialized group (Loppie, Reading & Leeuw, 2014).

Housing

Another major determinant of health that could be associated with the prevalence of type 2 diabetes among the Aboriginal Peoples of Canada is their housing condition. It is difficult for Aboriginal Peoples of Canada to have access to quality, safe and affordable housing, a situation which is largely influenced by constant and ongoing discrimination in terms of employment and housing, as well as the outcomes of inter-generational trauma and historical colonization experience (Gaetz, Gulliver & Richter, 2014). Aboriginals who are Inuit are 10 times more likely to be crowded in their homes, and are 4 times more likely to dwells in homes that require major repairs when compared to non-Aboriginals (Statistics Canada, 2016). As observed in countries such as the United State of America and New Zealand, there are documented health problems among Aboriginals in Canada that can directly or indirectly be associated with poor housing which can lead to short and long term health outcomes (Andersen et al., 2016). The prevalence of diabetes among the First Nations people on reserves in Canada is 3 to 5 times higher than Non-Aboriginals in Canada (Health Canada, 2013). Aboriginals in Canada are more likely to reside in low-income neighborhoods which thereby expose them to unhealthy food sources when compared to those who reside in higher-income neighborhood (Willows, Hanley & Delormier, 2012). Their communities across Canada lack the needed access to quality health services, which is more challenging for individuals who live on reserves and rural areas (Brooks, Darroch & Giles, 2013); and the insufficiency of housing opportunities for them both on and off reserve has been a constant issue,

leading to high rate of homelessness (Gaetz, Gulliver & Richter, 2014). One of the major factors that contribute to the housing problem of Aboriginals who reside on reserves across Canada is the diminishing interest of the federal government of Canada to invest adequately on Aboriginal housing which results into poor housing condition, mold problem, overcrowding and poor ventilation (Loppie, Reading & Leeuw, 2014). Location and accessibility of the needed health care services can also contribute to the higher prevalence of type 2 diabetes among the Indigenous people of Canada. Type 2 diabetes can be treated and managed effectively if it is diagnosed early, but with the difficulties in accessing the needed health services, early detection can be impossible, leading to delayed diagnosis that can make treatment more challenging (Brooks, Darroch & Giles, 2013). Willows, Hanley and Delormier (2012) discovered that in Edmonton, a city that is located in the province of Alberta in Canada, Aboriginals who reside in this city were more likely to be found in low-income neighborhoods. In addition to problem of housing, Aboriginal Peoples of Canada in spite of making up about 4.3% of the entire population of Canada, represent about 16% of individuals who are homeless in Toronto, 30% in Ottawa, 46% in Saskatoon, over 60% in Winnipeg and over 70% in Regina (Gaetz, Gulliver & Richter, 2014).

Education

Lack of quality and sound education as part of social determinants of health also implies that education can influence the chance of Aboriginal Peoples in Canada to experience higher prevalence of type 2 diabetes. Education has direct impact on the health status of First Nations people due to the positive correlation between higher levels of educational attainment and health status, based on the perspective that the

more an individual is educated the more such individual can make healthy lifestyle choices (Brooks, Darroch & Giles, 2013). The levels of educational attainment and training of Aboriginal people in Canada are lower when compared to their non-Aboriginal counterparts (Patrick, 2014). The health disparities in relation to type 2 diabetes and other related diseases between the First Nations and their non-First Nations counterparts in Canada are strongly linked to the low levels of educational accomplishment in the population of First Nations across Canada (Brooks, Darroch & Giles, 2013). The main reason why Aboriginal Peoples of Canada are behind their non-Aboriginals counterparts in relation to education has been linked to the historical assimilative policies associated with education (Giles, Cleator, McGuire-Adams & Darroch, 2014). This also includes the inability of the federal government of Canada to provide adequate funding for the needed educational programs for Aboriginals in Canada, a situation that has significant adverse effect on their educational opportunities (Loppie, Reading & Leeuw, 2014). In comparison to all other provincial schools across Canada, First Nations schools have no funding for sports and other recreational programs, which implies lack of accessibility to sport, exercise, and recreation opportunities that contribute to physical engagement required to reduce adverse health outcomes such as obesity and type 2 diabetes (Brooks, Darroch & Giles, 2013). Apart from providing the Aboriginals in Canada with the needed enlightenment in relation to the benefits that are embedded in choosing healthy behaviors and the dangers inherent in sedentary lifestyles, having good education would also aid their chances of securing meaningful employment. In 2011, the overall employment rates of Aboriginals in Canada aged 25 to 64 was 62.5% in comparison to 75.8% of non-Aboriginals in Canada; the employment rates of Aboriginals in

Canada in the same age group with no certificate, diploma or degree was 41.9%; those with high school diploma or equivalent was 64%; and those with postsecondary certificate, diploma or degree was 74.2%; while the employment rates of non-Aboriginals in the same age group with no certificate, diploma or degree was 57.1%; those with high school diploma or equivalent was 71.7%; and those with postsecondary certificate, diploma or degree was 80.7% (Statistics Canada, 2015e). In relation to overall gender affiliation, the monotonic increase in the prevalence of diabetes among women is associated with decrease in income and low educational attainment, while among men, the prevalence is concentrated among those with lower educational level and income (Brown et al., 2015).

Household Income and Family Structure

Household income is another social determinant of health that is likely to contribute to the prevalence of type 2 diabetes among the Aboriginals in Canada. The general perspective about education is that good education improves the wellbeing, opens door to employment and enhances the chance to engage in economic opportunities, but unfortunately the low educational attainment and the relatively younger age of Aboriginal people in Canada are not enough to provide adequate reason why they are poorer (AANDC, 2013b). The household income can influence the food security of a family. Aboriginal households with children and headed by single parents, mostly women, who reside outside reserves and non-remote areas in Canada experience higher level of food insecurity than their counterparts who are non-Aboriginal families (Willows, Hanley & Delormier, 2012). There is a huge disparity in terms of earnings and income between Aboriginals and non-Aboriginals in Canada, and the gap is even more when comparing registered Aboriginals to non-

Aboriginals (AANDC, 2013a). Based on the Low Income Measure (LIM) scale, at least 50% of children belonging to status First Nations in Canada are poor; the situation in the province of Manitoba is far worse with 62% children of status First Nations considered poor (MacKinnon, 2013). It was observed that the incidence rates of diabetes are higher among individuals who are lower income, and the prevalence of this disease is higher among individuals who belong to the lower section of socio-economic status (SES) ladder; based on 2005 Canadian Community Health Survey, the prevalence of type 2 diabetes was more than 4 times greater among lowest income group than those in the highest income group (Brown, Nevitte, Szeto & Nandi, 2015). In terms of family structure, Aboriginal children are more likely to be catered for by a single parent, a grandparent or any other family members (Willows, Hanley & Delormier, 2012). When considering gender and income, low income is more likely to be higher among Aboriginal women in Canada; they are as well more likely to be unemployed and if employed, they are more likely to belong to the lower level positions (Patrick, 2014). Low level of household income among the Aboriginals in Canada can be linked to higher rate of unemployment among this group of Canadians. Patrick (2014) noted that the unemployment rates of Aboriginals in Canada are higher and their incomes are lower in comparison to non-Aboriginal in Canada. The problem of food security that is prominent in the Aboriginal population of Canada can be attributed to low household income and high unemployment rate. With reference to 2004 Canadian Community Health Survey, approximately 1 out of 3 Aboriginal households were found to lack food security in comparison to approximately 1 out of 10 non-Aboriginal households; approximately 1 out of 7 Aboriginal households experienced severe food insecurity which implies hunger when compared to

approximately 1 out of 33 households of non-Aboriginal households (Willows, Hanley & Delormier, 2012).

Forceful Assimilation and Child Fostering

Through the fostering policy of the federal government of Canada, Aboriginal children were taken away from their homes based on the considerations that: Aboriginal parents were "inferior" and "lacking in morals" when compared to their European counterparts; Aboriginal cultures and lifestyles were unsuitable for their children's social and moral upbringing; and based on the perspective that Aboriginal parents were "poor" and Indigenous (Tait, Henry & Walker, 2013). These unfavorable and discriminatory policies of the federal government of Canada toward the Aboriginal Peoples of Canada are likely to have influence on the development of various health outcomes including type 2 diabetes. The enactment of the 1876 Indian Act, a major government policy that has historical health consequence on the health of the Aboriginals in Canada allowed the federal government of Canada to be in charge of the educational system of the Aboriginals in Canada, thereby enabling the federal government to setup, operate, and administer Aboriginal schools (Brooks, Darroch & Giles, 2013). The Indian Act is described as a legislation that defines certain federal government responsibilities and coordinates the affairs of Indian reserve lands, Indian finances, and other resources (Willows, Hanley & Delormier, 2012). Through the designation of Aboriginals in Canada with "Indigenous statuses" and imposition of unfavorable government policies, legislations and actions, the federal government of Canada continuously promotes health and social disparities to the detriment of Aboriginal Canadians (Tait, Henry & Walker, 2013). In relation to Aboriginal health, the higher rates of type 2 diabetes among the Indigenous people in comparison to non-

Indigenous in Canada are associated with the lack of conformity of policies of the federal government of Canada in relation to the determinants of health and the inequities in health when comparing Aboriginals to non-Aboriginals in Canada (Brooks, Darroch & Giles, 2013). According to the Indian Act, the federal government of Canada is responsible for taking care of Aboriginal education, but instead, the policies of the government and their associated actions/inactions continuously have negative consequences on the health and wellbeing of Aboriginals in Canada (Tait, Henry & Walker, 2013). The consequence of government policies in terms of chronically underfunding First Nations education has a strong influence on the low levels of educational accomplishment that is observed among Aboriginals in Canada, which in turn has a strong influence in promoting high vulnerability of Aboriginals in Canada to various adverse health outcomes such as type 2 diabetes (Brooks, Darroch & Giles, 2013). Apart from the Indian Act, the child fostering policy of the federal government of Canada also has a negative impact on the wellbeing of Aboriginals in Canada, including their health. There are many narratives that document over at least two generations of abuse and neglect that are linked to fostering policy resulting into varying degrees of poor health and adverse social outcomes (Tait, Henry & Walker, 2013).

Summary

This literature preview provides detailed information about the Aboriginals in Canada and their origin. This review also espouses all the adverse health problems confronting the Aboriginals in Canada and the role of the government. Observations from literatures show that the higher prevalence of type 2 diabetes among the Aboriginals in Canada is closely associated with social factors than biological factors.

There were several inferences that relate the adverse health effects in the Aboriginal population of Canada to unfavorable government policies such as residential school system, colonization, the Indian Act, child fostering and underfunding of Aboriginal education. Apart from death and other chronic complications that are associated with type 2 diabetes, this literature also reflects on the incidence of cancer due to the influence of negative social determinants of health on the Aboriginals in Canada. This research study will provide valid and reliable information about the impact, magnitude and influence of social determinants of health in relation to the prevalence of type 2 diabetes in the Aboriginal population of Canada.

Chapter 3 of this study discusses the research design, data and data sources, the sampling techniques, variables and variable selection methods, and the statistical approaches considered for the data analysis in this study. It helps to provide background understanding relating to the choice of an approach over the other. It also discusses the assumptions that support the chosen statistical approaches.

Chapter 3: Research Method

Introduction

This section describes the choice of research design and method for this study. It further describes the source of data, types of data, sample size, and potential variables. This section presents a description of the statistical method. This description includes exploratory data analysis to obtain information about the dataset and enhance the understanding of the available data. This is achieved through the use of charts, tables, and graphs. The data description is followed by the process of selecting variables that are relevant to this research through their relationship with the response variable. At the end of the variable selection process, the data analysis approach that was appropriate for this research study is described. A summary concludes this chapter.

Research Design

The research design is an important aspect of any study. A research design involves the layout and step-by-step process to execute a research plan based on decisions that are inferred from broad assumptions regarding detailed methods used for data collection and analysis (Creswell, 2009). This research is a retrospective quantitative study. This is based on the fact that it made use of already collected data and information through the CCHS by Statistics Canada. It is a quantitative study because the data and information was numeric, logical, and objective.

Data and Data Sources

The research analysis was based on between Aboriginal and non-Aboriginal populations in Canada in relation to the disproportionate rates of type 2 diabetes. In order to achieve this goal, this study made use of the 2016 CCHS

conducted by Statistics Canada, in collaboration with Health Canada, the Public Health Agency of Canada, and the Canadian Institute for Health Information (CIHI), with the purpose of providing population-level information on health determinants, health status, and health system use (Government of Canada, 2017). The outcome of this survey became public in 2017. CCHS uses the area frame designed for the Canadian Labour Force Survey (LFS) as a sampling frame, which is a multistage stratified cluster design in which the dwelling is the final sampling unit (Statistics Canada, 2018). Therefore, CCHS 2016 was considered a sample of the entire population of Canada. It is highly impossible, impractical, or extremely cost-consuming to collate and collect the needed data and information from everybody who is affected by the research problem.

Sampling

Sampling is about selecting a fraction of a population, which is a true representative of a whole population (Suresh et al., 2011). The use of sampling techniques in the process of data gathering ensured that CCHS 2016, which involved a subset of Canadian population, was truly representative of the entire Canadian population. In terms of sample size, there were a total number of 101,080 Canadians who are 18 years and above. A cross-sectional study involves the presence of any association between diseases or any other health outcomes and other prognostic factors of interest in a well-defined population at a given time (Aschengrau & Seage, 2014). To this end, the use of CCHS 2016 ensured the proper investigation of any potential association between the prevalence of type 2 diabetes and various social determinants of health factors. CCHS 2016 focuses on examining associations between exposure and prevalence of diseases such as type 2 diabetes in a given

population such as the Aboriginal population in Canada at a single point in time (Aschengrau & Seage, 2014).

Statistical Sample Size Required

An important requirement of any study is the use of a sample that is truly representative of the entire population. This will ensure the reliability, validity, applicability, and generalization of the results to a larger population with the same characteristics and attributes. In order for this to be achieved, the sample size was derived based on the expectation that the study would achieve a 95% power, 5% significant level, and effect size of 0.50. Therefore, through the use of G*power software, a Z-test was considered as the test family to be used. In terms of the appropriate statistical test to be adopted in order to determine the required sample size, logistic regression was considered. Based on the null hypothesis that the prevalence of diabetes is not associated with certain social determinants of health factors, a two-tailed test was considered. By assuming a constant proportion, the null hypothesis was assumed to be 50% and by assuming the probability of diabetes in the population of Aboriginals in Canada in terms of the alternative hypothesis was 70%, the odds ratio considered was therefore 2.3333. (odds ratio = [0.7/0.3]/[0.5/0.5] = 2.3333). Also, by assuming a constant proportion in relation to the null hypothesis, 0.5 was selected as Pr(Y=1). The probability of rejecting a correct null hypothesis, also known as alpha was 0.05. The probability of rejecting a false null hypothesis, also known as power was 0.95. It is assumed that the independent variable of interest X is binomially distributed and the R square between X and the other independent variable is 0.5.

G*Power software determined a needed sample size of 623. Based on the Government of Canada (2017), 101,080 respondents were above 18 in the CCHS of 2016. To this end, by comparing the calculated required sample size to the actual sample obtained via CCHS 2016, 101,080 participants, which is the number obtained through CCHS 2016, was appropriate to attain 95% power, alpha of 5%, and effect size of 0.50. Therefore, a sample size of 101,080 persons was used for this research study.

Variables

Appropriate measuring tools must be used to measure variables in order to guarantee a high degree of isomorphism, or the extent of fit between measuring tools and the variable being measured, which is an indicator of how accurate the measuring tool is (Frankfort-Nachmias & Nachmias, 2008). In this study, the dependent or response variable was derived based on respondents being diabetic or not, which resulted in a dichotomous variable measured on binomial scale. This response variable can be considered a nominal variable, because a yes or no response cannot be ordered. The predictors or independent variables used in this study included age, gender, educational attainment, Aboriginal status, marital status, location, BMI, income, and other relevant variables in the dataset used for this study. Gender, marital status, location, family history, and Aboriginal status were all nominal variables since they cannot be ordered. Gender in this is study was measured as male or female. Aboriginal status was measured as Aboriginal or non-Aboriginal. Marital status was measured as unmarried, married, divorced, widow, or widower. Family history was measured as having history of diabetes in the family or not. Location was measured as either on-reserve or off-reserve. Educational level for this study was measured using

an ordinal scale; levels of educational achievements can be arranged from the lowest level, which is no education, to the highest level, doctorate degree. In this study, having no education was ranked as 1, elementary education as 2, high school education as 3, college diploma education as 4, university degree education as 5, master's degree as 6, and doctoral education as 7. Both age and BMI were measured on interval scales because they do not contain absolute zero.

Data Analysis

This study considered the use of appropriate statistical approaches that guaranteed the validity and reliability of the findings and outcomes. These approaches ranged from variable selection to model building. They also include the use of descriptive and inferential statistical methods. The right statistical approaches were determined based on the scales of the available variables, response variable in particular. This choice was also based on the match with the research questions and formulated hypotheses.

Variable Selection

Variable selection can be tasking when there are many potential predictors. In order to determine any potential relationship between the response variable, which in this present study is being diabetic or not, and the available potential independent variables, various statistical tests were carried out. Some of which included the application of chi-square, trend test and simple logistic regression analysis. Also, potential complications such as multicollinearity and confounding and impact of missing data were properly investigated and addressed. This ensured the validity and reliability of this study,

All available independent variables were individually tested through the use of univariate analysis technique to determine their association to the response variable. In order to avoid loss of information, every independent variable was tested against the response variable at 10% significant level. The more the number of predictors in the model, the more difficult the selection process becomes due to rapid increase in potential effects and interactions (Agresti, 2002). Chi-square test, trend test and simple logistic regression were all used for the process of selecting relevant variables for this research study. At the completion of the univariate analysis exercise, all the significant variables at 10% significant level were subjected to different statistical model selection techniques. The model selection procedure generated predictor variables that have significant effects in influencing the prevalence of type 2 diabetes. A saturated model that is made up of all the selected variables at 10% significant level was developed. The Mallow's C_p criterion was used to determine variables with small C_p value and the C_p value is close to p, the number of parameter. In order to prevent any potential problems of multicollinearity, Variance Inflation Factor (VIF) was used to identify variables which are to be retained in the final model. Any variable that has VIF value which is above 10 was excluded from the model based on Kutner et al., (2005) recommendation.

Descriptive Statistics

Descriptive statistical analysis of this research study was conducted in the form of exploratory data analysis (EDA). This analysis was performed in order to have some insight information about what was embedded in the data that was used for this research study. For the categorical variables in this study, bar charts and graphs were used to gain the initial information about the data, while for the continuous

variables, measures of central tendency and dispersion, along with box-plots and histograms were used for the same purpose of obtaining some preliminary information.

Analytical Statistics

The most suitable and appropriate statistical technique to pursue the research goals of this research study is the application of multiple logistic regression. This was based on the fact that the response variable was binomial. Also, there were more than one independent variable involved in this research study. These independent variables were measured on different scales such as nominal, binomial, ordinal, interval and ratio. Through the adoption of multiple logistic regression technique for this research study, all these variables with different scales were able to be investigated in order to determine their association with the response variable. The use of this technique through the application of univariate analysis also made provision for examining the individual relationship between the response variable and each of the predictors. Prior to the adoption and interpretation of the findings and outcomes, violation of assumptions of multiple logistic regression such as assumption of independent errors, assumption of incomplete information, assumption of multicollinearity, assumption of complete separation and assumption of linearity were all tested and verified.

Since this study uses a cross-sectional design, measures such as absolute risk, which is the risk of developing type 2 diabetes in the year 2015 in Canada, and relative risk, which is the ratio of the risk of type 2 diabetes in the population of Aboriginal in Canada to the risk of type 2 diabetes in the population of non-Aboriginal in Canada were also determined. These two measures provided the

prevalence of type 2 diabetes in the entire population of Canada and in the Aboriginal and non-Aboriginal populations of Canada in 2015/2016.

Multiple Logistic Regression

Logistic regression is applicable when the response variable is binomial or dichotomous and the explanatory or independent variable is of any scale and also met certain sets of assumptions. It becomes multiple logistic regression when the number of independent or explanatory variable is more than one. Multiple logistic regression can be written as follows:

$$\hat{p} = \frac{exp(b_0 + b_1x_1 + b_2x_2 + \ ... + b_px_{p)}}{1 + exp(b_0 + b_1x_1 + b_2x_2 + \ ... + b_px_{p)}}$$

where $\hat{p}$ is the expected probability that type 2 diabetes is present; $x_1$through x_p are distinct determinants of health and other prognostic factors; b_0 through b_p are the regression coefficients (Sullivan, 2012). It can as well be written differently as:

$$\ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = b_0 + b_1x_1 + b_2x_2 + \ ... + b_px_p$$

Ethical Concerns

Every study is expected to be carried out in compliance with the ethics and dictates of The Belmont Report of 1979. Respect for persons, beneficence and justice are the 3 main ethical principles on which the regulations for the protection of human subjects are based (Crosby, DiClemente, & Salazar, 2013). The data used for this research study was a secondary data gathered by Statistics Canada on behalf of Public Health Agency of Canada. Therefore, it is assumed that the process of gathering this data through the use of Canadian Community Health Survey was carried out in accordance to the Belmont principles. To this end, there is no potential avenue by which the use of this data could violate any ethical concerns.

Summary

This study is a retrospective quantitative study. It made use of data and information that were gathered through Canadian Community Health Survey, a cross-sectional survey conducted by Statistics Canada in the year 2016. This survey produced a sample that was representative of the entire Canadian population. Therefore, it was suitable for the purpose of this research study, which was to investigate the relationship between type 2 diabetes and social determinants of health across Canada with emphasis on the Aboriginal peoples.

The task of data analysis commenced with the process of variable selection which included data cleaning and preparation. This process was followed by exploratory data analysis and was concluded with the application of multiple logistic regression technique. This technique was the appropriate and relevant statistical approach to address the research goals and objectives of this study, because it allowed the use of dichotomous response variable and the combination of different types of predictor variables. The completion of this stage was followed by data analysis, including the description of application of multiple regression technique and other relevant statistical approaches.

Chapter 4: Results

Introduction

This chapter presents the findings from various statistical analyses carried out in relation to the research questions and associated hypotheses. Social determinants of health are responsible for the prevalence of type 2 diabetes in the general, Aboriginal, and non-Aboriginal populations of Canada. These findings include inherent factors that influence the rates of the disease, which is perceived to be disproportionately higher in the Aboriginal population than the non-Aboriginal population of Canada.

The required analyses focused on Canadians, specifically Aboriginals and non-Aboriginals who were 18 and above. In this study, low level of educational attainment refers to participants who dropped out in Canadian grade 13 or below. The medium category represents those who possess Canadian secondary education but do not have a bachelor's degree, while the high education category is for participants who have a bachelor's degree and above. Canadians whose personal income was below CAD$30,000 were classified as low income; those whose income ranged between CAD$30,000 and CAD$59,000 were considered in the medium category, while Canadians whose personal income was CAD$60,000 and above were considered to be high-income earners.

Due to ethical consideration, the Research Data Center responsible for providing the needed data did not approve some of the outcomes of this study for public consumption. This has to do with the issue of focus and the main target population in this stud. These outcomes were considered to be highly sensitive. To this end, some results relating to ethnicity and race which could be used to identify participants were vetted out and not presented.

Research Questions and Hypotheses

Two main research questions were asked to pursue the research goals of this study. Appropriate hypotheses were formulated for each research question in order to test the validity of these claims. First, this study investigated if there was any possible association between social determinants of health and the observed prevalence of type 2 diabetes in the overall population of Canada. This extended to conducting separate investigations within the Aboriginal population and non-Aboriginal populations to determine if there exists any relationship between the social determinants of health and the prevalence of type 2 diabetes within these two distinct Canadian populations. This enabled me to establish the role of race and ethnicity in the prevalence of type 2 diabetes and the perceived higher rates of the disease in the Aboriginal population of Canada. It also helped to identify social determinants of health that could have influenced the prevalence of type 2 diabetes in the general population of Canada, influenced this disease within the Aboriginal population Canada, and are peculiar to the non-Aboriginal population of Canada.

The second main research question emphasized investigating the potential significant differences in terms of the prevalence of type 2 diabetes between Aboriginals and non-Aboriginals in Canada, while considering the effect of modifiable and nonmodifiable risk factors. This entails investigating the individual effects of modifiable and nonmodifiable risk factors in terms of any significant difference in terms of the prevalence of type 2 diabetes between the Aboriginal and non-Aboriginal populations in Canada. This research question helped to control for the individual effects of modifiable risk and nonmodifiable risk factors.

Exploratory Data Analysis

Aboriginal Status of Participants

The total number of participants in this study is 101,080. This includes 3,677 Canadians who described themselves as Aboriginals and 93,639 who described themselves as non-Aboriginal. A total number of 3,765 participants in the study identified themselves as neither Aboriginal nor non-Aboriginal. Therefore, 4% of the participants are Aboriginals, 93% are non-Aboriginals, while 4% did not identify themselves as either Aboriginal or non-Aboriginal (see Table 1).

Table 1

Frequency Distribution of Study Participants by Aboriginal Status

Status	Frequency	Percentage (%)
Aboriginal	3677	3.6
Non-Aboriginal	93639	92.6
Undeclared	3765	3.7
Total	101080	100

Type 2 Diabetes by Aboriginal Status

Table 2 shows the distribution of type 2 diabetes based on Aboriginal status. Approximately 7% of the Canadian population is diabetic. About 4% of Canadians who are diabetic self-declared as Aboriginals, while about 93% of diabetic Canadians self-declared as non-Aboriginals. Also, 4% of non-diabetic Canadians are Aboriginals, while 93% are non-Aboriginals.

Table 2

Distribution of Type 2 Diabetes by Aboriginal Status

Type 2 Diabetes	Overall Population (%)	Aboriginal Population (%)	Non-Aboriginal Population (%)
Yes	6932 (7)	246 (4)	6418 (93)
No	94148 (93)	3431 (4)	87221 (93)
Total	101080 (100)	3677 (4)	92850 (92)

Note: The imbalances are due to respondents who did not declare their Aboriginal status.

The information provided in Table 3 represents the distribution of study participants with type 2 diabetes according to their declared Aboriginal status. This was done with respect to social determinant factors that are statistically significant based on: entire available risk factors, modifiable risk factors, and nonmodifiable risk factors. Some of the significant risk factors were vetted out due to sensitivity of the distribution and ethical concerns. These affected factors have blank columns.

Table 3

Distribution of Having Type 2 Diabetes by Aboriginal Status based on Significant Risk Factors

Factors		Overall Population		Aboriginal Population		Non-Aboriginal Population	
		Type 2 Diabetes (%)		Type 2 Diabetes (%)		Type 2 Diabetes (%)	
	Characteristics	Yes	No	Yes	No	Yes	No
Gender	Male	3846 (55%)	45866 (49%)	133 (3)	1650 (4)	3587 (93)	42524 (93)
	Female	3086 (45%)	48282 (51%)	113 (4)	1781 (4)	2831 (92)	44697 (93)
	Sub-total	6932	94148	246	3431	6418	87221
Marital Status	Unmarried	786 (11%)	23935 (25%)	46 (6)	1194 (5)	717 (91)	22000 (92)
	Common-Law	525 (8%)	11878 (13%)	24 (5)	643 (5)	484 (92)	10827 (91)
	Married	4050 (59%)	46449 (49%)	126 (3)	1217 (3)	3763 (93)	43573 (94)
	Separated	249 (4%)	2518 (3%)	7 (3)	110 (4)	239 (96)	2298 (91)
	Divorced	560 (8%)	4961 (5%)	22 (4)	184 (4)	518 (93)	4583 (92)
	Widow/Widower	746 (11%)	4203 (4%)	20 (3)	83 (2)	697 (93)	3940 (94)
	Sub-total	6916	93944	246	3431	6418	87221

Table continues

Educational Level	Low Education	1686 (25%)	10384 (11%)	75 (4)	648 (6)	1563 (93)	9356 (90)
	Moderate Education	3871 (57%)	55497 (60%)	150 (4)	2308 (4)	3695 (95)	52004 (94)
	High Education	1204 (18%)	26751 (29%)	21 (2)	475 (2)	1160 (96)	25862 (97)
	Sub-total	6761	92632	246	3431	6418	87221
High Blood Pressure (HBP)	Yes	3920 (57%)	14767 (16%)	140 (4)	494 (3)	3619 (92)	13761 (93)
	No	3002 (43%)	78941 (84%)	106 (4)	2937 (4)	2799 (93)	73460 (93)
	Sub-total	6922	93708	246	3431	6418	87221
High Blood Cholesterol (HBCL)	Yes	3187 (46%)	10193 (11%)	108 (3)	262 (3)	2969 (93)	9649 (95)
	No	3667 (54%)	82563 (89%)	138 (4)	3169 (4)	3449 (94)	77572 (94)
	Sub-total	6854	92756	246	3431	6418	87221
Scoliosis	Yes	205 (3%)	3287 (3%)	16 (8)	143 (4)	170 (83)	3062 (93)

Table continues

	No	6706 (97%)	90653 (97%)	230 (3)	3288 (4)	6248 (93)	84159 (93)
	Sub-total	6911	93940	246	3431	6418	87221
Arthritis	Yes	3012 (44%)	18442 (20%)	111 (4)	735 (4)	2793 (93)	17004 (92)
	No	3894 (56%)	75375 (80%)	135 (3)	2696 (4)	3625 (93)	70217 (93)
	Sub-total	6906	93817	246	3431	6418	87221

It can be observed from Table 3 that 55% percent of the participants who are type 2 diabetic are male Canadians. This is an indication that male Canadians are more susceptible to type 2 diabetes than their female counterparts. It can also be observed that, 3% of these males diabetic Canadians are Aboriginals, while 93% are non-Aboriginals. In terms of marital status, married Canadians are observed to represent 59% of type 2 diabetic Canadians. Of this, 3% are Aboriginals, while 93% are non-Aboriginals. The lowest rate of type 2 diabetes is among Canadians who are considered as highly educated. They represent 18%, of which 2% are Aboriginals and 96% are non-Aboriginals. This could suggest the positive impact of been highly educated. Among the participants in this study, 57% have high blood pressure. This could have the potential to influence the prevalence of type 2 diabetes in Canada. In the case of high blood cholesterol or lipid, 46% of the study participants have this condition. This rate could also influence the prevalence of type 2 diabetes in Canada. 3% of study participants suffer from scoliosis, while 97% do not. Arthritis is another health issue of prominent in this study. It was observed that 44% of the study participants suffer from this disease, while 56% do not.

Age of Participants with Type 2 Diabetes by Aboriginal Status

In general, as presented in Table 4, the average age of people with type 2 diabetes is 63 years with standard deviation of 11, while the average age of those without type 2 diabetes is 47 years with a standard deviation of 18. The same values in terms of age and standard deviation are also observed in the non-Aboriginal population of Canada. These observations in the general population and non-Aboriginal population, where people with type 2 diabetes are older than those without type 2 diabetes are similar to the observation in the Aboriginal population. It can therefore be said that people with type 2 diabetes are older than those without type 2 diabetes in the Aboriginal population, non-Aboriginal population and in the general population of Canada. This could be a potential indication that age plays a crucial role in the prevalence of type 2 diabetes in Canada. That is, as Canadians grow older their likelihood of having type 2 diabetes increases.

Although the average age of people with type 2 diabetes in the Aboriginal population of Canada is also higher than those without type 2 diabetes as observed in the general population and non-Aboriginal population, but while the average age in the general population and non-Aboriginal population are both 63 years, the average age in the Aboriginal population is 58 years with a standard deviation of 11. This implies that, type 2 diabetes affects younger people in the Aboriginal population of Canada than in the non-Aboriginal population and in the overall general population of Canada. This observation could also indicate the possibility of an early onset of type 2 diabetes in the Aboriginal population of Canada when compared to non-Aboriginal or the general population of Canada.

Table 4

Age Distribution of Type 2 Diabetes by Aboriginal Status

Factors		Overall Population		Aboriginal Population		Non-Aboriginal Population	
		Type 2 Diabetes		Type 2 Diabetes		Type 2 Diabetes	
Factors	Measures	Yes	No	Yes	No	Yes	No
Age	# Participants	6932	94148	246	3431	6418	87221
	Average age	63	47	58	41	63	47
	Standard deviation	11	18	11	16	11	18

The information in Table 5 represents the outcome of univariate analysis carried out through the use of logistic regression to determine the individual effect of each social determinants of health factor on having type 2 diabetes. This analysis enabled the evaluation of the social determinants health factors which have significant effect at 10% significant level on having type 2 diabetes. Therefore, with the exception of Aboriginal status which is the main predictor of focus, daily smoker and lifetime illicit drug injection which are not significant in this study at 10% significant level shall not be considered in the further analyses.

Table 5

Univariate Analysis between Type 2 Diabetes and Each of the Risk Factors

Effect	DF	Wald Chi-square	P-value
Daily Smoker	1	0.0363	0.8489
Aboriginal Status	1	0.1346	0.7137
Personal Income	2	166.6996	<.0001

Table continues

Household Income	2	826.7348	<.0001
BMI	3	1968.404	<.0001
Regular Fruit Consumption	1	74.3982	<.0001
Food Security	1	68.7433	<.0001
In-house Smoking Allowed	1	48.8022	<.0001
Someone Smoked Inside House	1	60.1866	<.0001
Educational Level	2	1174.597	<.0001
Lifetime Illicit Drug Injection	1	0.3322	0.5644
Sedentary Activities	1	4.9515	0.0261
Has Depression	1	75.6216	<.0001
Gender	1	117.754	<.0001
Dwelling ownership	1	15.7692	<.0001
Marital Status	5	1280.124	<.0001
Depression Severity	1	20.4627	<.0001
Has Migraine	1	43.4398	<.0001
Has HBCL	1	5466.409	<.0001
Has HBP	1	5646.426	<.0001
Has Osteoporosis	1	324.0254	<.0001
Has Back Problems	1	387.4248	<.0001
Has Arthritis	1	2018.542	<.0001
Has Fibromyalgia	1	166.1699	<.0001
Has Scoliosis	1	5.3248	0.021
Has Sleep Apnea	1	1362.174	<.0001

Table continues

# Weekly Hours of Sedentary Activities (Minus Reading)	1	4.9758	0.0257
# Weekly Hours of Sedentary Activities	1	4.967	0.0258
Family Size	1	565.7807	<.0001
Age	1	4764.066	<.0001
Smoking Status	2	173.4874	<.0001
Employment Status	1	1764.899	<.0001
Regular Drinker	1	624.5222	<.0001

RQ1

RQ1: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the general population of Canada?

$H_0$1: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes in the general population of Canada.

H_a1: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes in the general population of Canada.

In order to answer this research question, it was hypothesised that, social determinants of health and other prognostic factors have no association with the prevalence of type 2 diabetes in the general population of Canada. This thereby represents the null hypothesis. The alternative hypothesis on the other hand stated that, social determinants of health and other prognostic factors have association with the prevalence of type 2 diabetes in the general population of Canada. Therefore, after the exclusion of daily smoker and lifetime illicit drug injection which are not significant at 10% significant level, the remaining social determinants health factors were subjected to further analyses through the application of multiple logistic

regression analysis. In the subsequent analysis, social determinants health factors which have significant associations at 5% significant level with having type 2 diabetes are presented in Table 6 along with their respective degrees of freedom, chi-square statistics and P-values. This implies that, the social determinants health factors listed in Table 5, but not present in Table 6 are not significant at 5% significant level.

Table 6

Significant Association between Risk Factors and Type 2 Diabetes

Effect	DF	Wald Chi-Square	P-value
Aboriginal Status	1	4.7834	0.0287
Has HBP	1	635.717	<.0001
Age	1	1332.05	<.0001
Has HBCL	1	959.915	<.0001
BMI	3	745.448	<.0001
Gender	1	108.514	<.0001
Has sleep apnea	1	130.607	<.0001
Household size	1	98.9638	<.0001
Educational Level	2	69.9849	<.0001
Dwelling ownership	1	62.5591	<.0001
Food security	1	27.6431	<.0001
Has migraine headaches	1	4.9166	0.0266
Marital Status	5	45.207	<.0001
Has scoliosis	1	9.4633	0.0021
Personal Income	2	47.3567	<.0001
Has osteoporosis	1	4.6998	0.0302

As shown in Table 6, these social determinants health factors have significant associations with having type 2 diabetes at significant at 5% significant level. This implies that, Aboriginal status, having high blood pressure, age, having high blood cholesterol / lipids, BMI, gender, having sleep apnea, household size, educational level, dwelling ownership, food security, having migraine headaches, marital status, having scoliosis, personal income and having osteoporosis are significantly associated with having type 2 diabetes in the general population of Canada. To this end, the significant social determinants health factors, which are considered to have relationships with being diabetic are interpreted using odds ratio. These odds ratios are presented in Table 7.

Table 7

Odds Ratio of Risk Factors with Having Type 2 Diabetes

Variables	Levels	Point Estimate	95% Confidence Limits	
Aboriginal Status	Aboriginal vs Non-Aboriginal	1.192	1.018	1.396
Has HBP	Yes vs No	2.294	2.151	2.447
Age		1.052	1.049	1.055
Has HBCL	Yes vs No	2.745	2.575	2.926
BMI	Underweight Vs Obese	0.37	0.256	0.534
	Normal Vs Obese	0.346	0.318	0.376
	Overweight Vs Obese	0.506	0.472	0.541
Gender	Male Vs Female	1.415	1.325	1.51
Has Sleep Apnea	Yes vs No	1.688	1.543	1.846
Household Size		1.145	1.115	1.177
Educational Level	Low Vs High	1.518	1.376	1.675
	Medium vs High	1.198	1.109	1.296

Table continues

Dwelling Ownership	Own vs Rent	0.748	0.696	0.804
Food Security	Yes vs No	0.852	0.802	0.904
Has Migraine	Yes vs No	0.881	0.787	0.985
Marital Status	Married Vs Single	0.85	0.764	0.946
	Living Common Law Vs Single	0.822	0.718	0.942
	Widowed Vs Single	0.725	0.626	0.839
	Separated Vs Single	1.198	1.001	1.433
	Divorced Vs Single	1.035	0.901	1.189
Has scoliosis	Yes vs No	0.748	0.622	0.9
Personal income	Low Vs High	1.317	1.218	1.425
	Medium vs High	1.188	1.098	1.284
Has osteoporosis	Yes vs No	0.886	0.793	0.988

By considering the confidence limit of each risk factor in Table 7, it can be observed that only the relationship between having diabetes and marital status with respect to divorced versus single has its boundary to include 1. This implies a non-significant association. Hence this relationship shall not be interpreted. For Aboriginals in Canada, the odds of having type 2 diabetes are 1.12 times more than the odds for being non-Aboriginals in Canada to have type 2 diabetes. In terms of high blood pressure, the odds of having type 2 diabetes are about 2.3 times higher for Canadians who have high blood pressure than the odds of Canadians without high blood pressure to have type 2 diabetes. With focus on age, for every year increase in the age of Canadians, the odds of having type 2 diabetes against not having type 2 diabetes increase by 1.1. Similar to high blood pressure, the odds of having type 2 diabetes are about 2.8 times higher for Canadians who have high blood cholesterol/lipid than the odds

of Canadians without high blood cholesterol/lipid to have type 2 diabetes. While referencing obese as the baseline category for the BMI, the odds of having type 2 diabetes as against not having the disease are 63% less likely for Canadians who are underweight than the odds of Canadians who are obese. The odds of having type 2 diabetes as against not having the disease are 65% less likely for Canadians who are normal than the odds of Canadians who are obese. Also, the odds of having type 2 diabetes as against not having the disease are 49% less likely for Canadians who are overweight than the odds of Canadians who are obese. In terms of gender, for male Canadians, the odds of having type 2 diabetes are 1.42 times higher than the odds for female Canadians to have type 2 diabetes. The odds of having type 2 diabetes are 1.69 times higher for Canadians who have sleep apnea than the odds of Canadians without sleep apnea to have type 2 diabetes. For every increase in the size of household in Canada, the odds of having type 2 diabetes against not having type 2 diabetes increase by 1.12. While considering the educational attainment, the odds of having type 2 diabetes as against not having the disease are 1.52 higher for Canadians with low education than the odds of Canadians with high education to have the disease. Similarly, the odds of having type 2 diabetes as against not having the disease are 1.2 higher for Canadians with moderate education than the odds of Canadians with high education to have the disease. For Canadians who own their dwelling house, the odds of having type 2 diabetes are 25% less likely than the odds for Canadians who rent their dwelling place to have type 2 diabetes. Also, for Canadians who have food security, the odds of having type 2 diabetes are 14% less likely than the odds for Canadians who do not have food security to have type 2 diabetes. Those who suffer from migraine headache in Canada have the odds of having type 2 diabetes to be 12% less likely than the odds of those who do not suffer from migraine headache to have type 2 diabetes. In terms of marital status of Canadians, with reference to being single as the baseline category, the odds of having type 2 diabetes as against not having it are 15% less likely for married

Canadians than the odds of single Canadians to have the disease. For Canadians who are into common law relationship, the odds of having type 2 diabetes are 18% less likely than the odds for Canadians who are single to have the disease. Similarly, for Canadians who are widowed, the odds of type 2 diabetes are 27% less likely than the odds of Canadians who are single to have the disease. In the case of Canadians who are separated, the odds of having type 2 diabetes are 1.2 times higher than the odds of Canadians who are single to have the disease. For Canadian who suffer from scoliosis, the odds of having type 2 diabetes are 25% less likely than the odds of those who do not suffer from scoliosis to have type 2 diabetes. While considering the impact of personal income, the odds of having type 2 diabetes are 1.3 times higher for Canadians who belong to the low personal income cadre than the odds of Canadians who belong to the high personal income cadre to have the disease. Also, the odds of having type 2 diabetes are 1.2 times higher for Canadians who belong to the middle personal income cadre than the odds of Canadians who belong to the high personal income cadre to have the disease. Finally, the odds of having type 2 diabetes are 11% less likely for Canadian who are suffering from osteoporosis than the odds of Canadians who are not suffering from osteoporosis to have type 2 diabetes. The prevalence of type 2 diabetes in the general population of Canada is associated with social determinants of health such as Aboriginal status, having high blood pressure, age, having high blood cholesterol or lipid, BMI, gender, having sleep apnea, household size, level of educational attainment, dwelling ownership, food security, having migraine, marital status, having scoliosis, personal income, and having osteoporosis.

RQ2

RQ2: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the Aboriginal population of Canada?

H_02: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes among Aboriginals in Canada.

H_a2: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes among Aboriginals in Canada.

The null hypothesis to answer this research question stated that, social determinants of health and other prognostic factors have no association with the prevalence of type 2 diabetes among Aboriginals in Canada, while the alternative hypothesis stated that, social determinants of health and other prognostic factors have association with the prevalence of type 2 diabetes among Aboriginals in Canada. Through the application of multiple logistic regression analysis technique, with focus only on the Aboriginal population of Canada, the following results are obtained, as presented in Table 8. These results are the social determinants health factors that are significant at 5% significant level in relation to having type 2 diabetes in the Aboriginal population of Canada. They are age, BMI, high blood pressure, high blood cholesterol/lipids, scoliosis, and smoking status

Table 8

Associations between Risk Factors and Type 2 Diabetes in the Aboriginal Population of Canada

Effect	DF	Wald Chi-Square	P-value
Has HBP	1	38.3891	<.0001
Age	1	139.2732	<.0001
Has HBCL	1	60.3625	<.0001
BMI	3	70.0292	<.0001
Has Scoliosis	1	4.3602	0.0368
Smoking Status	2	9.4517	0.0089

In order to the determine the level of impact and the magnitude of these factors with regard to type 2 diabetes in the Aboriginal population of Canada, the concept of odds ratio shall be used to interpret the influence of these risk factors (see Table 9). This ensured that each social determinants of health and its impact is comprehensively interpreted. This interpretation is limited to factors that were significant at 5% significant level.

Table 9

Odds Ratio of Risk Factors with Type 2 Diabetes in the Aboriginal Population of Canada

Variables	Levels	Point Estimate	95% Confidence Limits	
Has HBP	Yes vs No	2.355	1.796	3.089
Age		1.059	1.049	1.069
Has HBCL	Yes vs No	2.986	2.266	3.934
BMI	Underweight Vs Obese	0.383	0.081	1.813
	Normal Vs Obese	0.140	0.087	0.225
	Overweight Vs Obese	0.602	0.461	0.785
Has Scoliosis	Yes vs No	1.689	1.033	2.761
Smoking Status	Current Vs Never	1.754	1.225	2.513
	Past vs Never	1.494	1.057	2.110

Contrary to other associations with having type 2 diabetes as shown in Table 9, the confidence limit for the association between having type 2 diabetes and BMI: underweight against obese overlaps 1, thereby indicating lack of significant relationship. This particular association shall not interpreted. Therefore, it can be inferred that, the odds of having type 2 diabetes as against not having the disease are 86% less likely for Aboriginals in Canada who

have normal BMI than the odds of Aboriginals in Canada who are obese to have type 2 diabetes. Also, the odds of having type 2 diabetes as against not having the disease are 40% less likely for Aboriginal Canadians who are overweight than the odds of Aboriginal Canadians who are obese to have type 2 diabetes. With regards to high blood pressure, the odds of having type 2 diabetes is about 2.6 times higher among Aboriginal Canadians with high blood pressure than the odds of Aboriginal Canadians without high blood pressure to have type 2 diabetes. In terms of age, for every year increase in the age of Aboriginals in Canada, the odds of having type 2 diabetes as against not having the disease increase approximately 1.1 times. This is similar to what was observed in the general population. The observation for high blood cholesterol/lipid is similar to that of high blood pressure. It can be observed that, the odds of having type 2 diabetes is about 3 times higher for Aboriginal Canadians who have high blood cholesterol/lipid than the odds of Aboriginal Canadians without high blood cholesterol/lipid to have type 2 diabetes. Based on suffering from scoliosis, the odds of having type 2 diabetes are 1.7 times higher for Aboriginals in Canada who have scoliosis than the odds of Aboriginals in Canada who do not have scoliosis to have type 2 diabetes. Finally, the odds of having type 2 diabetes are 1.8 times higher for Aboriginal Canadians who currently smoke than the odds of Aboriginal Canadians who never smoked to have type 2 diabetes. Also, the odds of having type 2 diabetes are 1.5 times higher for Aboriginal Canadians who are past smokers than the odds of Aboriginal Canadians who never smoked to have type 2 diabetes.

High blood pressure, age, high blood cholesterol or lipid, BMI, scoliosis and smoking status are the social determinants of health that are observed to be associated with type 2 diabetes in the Aboriginal population of Canada. Hence, this observation revealed that these social determinants of health are associated with the prevalence of type 2 diabetes in the Aboriginal population of Canada. The number of these factors are lesser than the number

associated with type 2 diabetes in the general population of Canada. In addition, smoking status was found to be peculiar to the Aboriginal population, while the remaining factors also influenced type 2 diabetes in the general population of Canada.

RQ3

RQ3: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the non-Aboriginal population of Canada?

H_03: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes among non-Aboriginals in Canada.

H_a3: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes among non-Aboriginals in Canada.

. The null hypothesis stated that social determinants of health and other prognostic factors have no association with the prevalence of type 2 diabetes among the non-Aboriginals in Canada, while the alternative hypothesis stated that, social determinants of health and other prognostic factors have association with the prevalence of type 2 diabetes among the non-Aboriginals in Canada. Table 10 provides the findings from the statistical analysis performed with focus on only the non-Aboriginals in Canada. That is, the social determinants of health that are significant at 5% significant level.

Table 10

Associations between Risk Factors and Type 2 Diabetes among Non-Aboriginal Population of Canada

Effect	DF	Wald Chi-Square	P-value
Has HBP	1	612.4197	<.0001
Age	1	1240.7023	<.0001
Has HBCL	1	924.2414	<.0001

Table continues

BMI	3	695.5439	<.0001
Gender	1	112.4743	<.0001
Has Sleep Apnea	1	119.2188	<.0001
Household Size	1	86.6884	<.0001
Educational Level	2	68.7229	<.0001
Dwelling Ownership	1	60.1545	<.0001
Food Security	1	31.6889	<.0001
Has Migraine	1	6.3421	0.0118
Marital Status	5	43.1817	<.0001
Has Scoliosis	1	13.7276	0.0002
Personal Income	2	44.8842	<.0001
Has Osteoporosis	1	5.0563	0.0245
Has Asthma	1	10.7571	0.0010

All the risk factors in Table 10 are significant at 5% significant level. Apart from the exclusion of Aboriginal status from and the inclusion of asthma to the list of risk factors that are associated with the prevalence of type 2 diabetes in the general population of Canada, all other social determinants of health factors in Table 10 are observed to be associated with the prevalence of type 2 diabetes in the non-Aboriginal population of Canada. Table 11 provides the interpretation using odds ratio.

Table 11

Odds Ratio of Risk Factors with Type 2 Diabetes in the non-Aboriginal Population of Canada

Variables	Levels	Point Estimate	95% Confidence Limits	
Has HBP	Yes vs No	2.302	2.155	2.459
Age		1.051	1.049	1.054
Has HBCL	Yes vs No	2.751	2.577	2.937
BMI	Underweight vs Obese	0.372	0.256	0.542
	Normal Vs Obese	0.353	0.324	0.385
	Overweight Vs Obese	0.505	0.471	0.541
Gender	Male Vs Female	1.437	1.344	1.537
Has sleep apnea	Yes vs No	1.674	1.526	1.836
Household size		1.141	1.110	1.173
Educational Level	Low Vs High	1.525	1.379	1.686
	medium vs high	1.194	1.104	1.293
Dwelling Ownership	Own vs Rent	0.747	0.694	0.804
Food Security	Yes vs No	0.839	0.789	0.892
Has Migraine	Yes vs No	0.860	0.765	0.967
Marital Status	Married Vs Single	0.862	0.773	0.963
	Living Common Law Vs Single	0.847	0.737	0.975
	Widowed Vs Single	0.734	0.632	0.853
	Separated Vs Single	1.228	1.021	1.475
	Divorced Vs Single	1.058	0.918	1.220

Table continues

Has scoliosis	Yes vs No	0.691	0.568	0.840
Personal income	Low vs High	1.317	1.215	1.427
	Medium vs high	1.176	1.086	1.274
Has osteoporosis	Yes vs No	0.879	0.785	0.984
Has Asthma	Yes vs No	1.192	1.073	1.323

The confidence limit between having type 2 diabetes and marital status: divorced versus single includes 1, an indication of insignificance of the relationship between having type 2 diabetes and marital status in terms of divorced against single. This association shall not be interpreted. Therefore, it can be said that, the odds of having type 2 diabetes are about 14% less likely for non-Aboriginal Canadians who are married than the odds of non-Aboriginal Canadians who are single to have the disease. The odds of having type 2 diabetes are about 15% less likely for non-Aboriginal Canadians who are into common law relationship than the odds of non-Aboriginal Canadians who are single to have the disease. The odds of having type 2 diabetes are about 27% less likely among non-Aboriginals in Canada who are widowed than the odds of non-Aboriginals in Canada who are single to have type 2 diabetes. Also, the odds of having type 2 diabetes are approximately 1.2 times higher among non-Aboriginal Canadians who are separated than the odds of non-Aboriginal Canadians who are single to have the disease. Considering the effect of high blood pressure, it can be observed that, the odds of having type 2 diabetes are about 2.3 times higher for non-Aboriginal Canadians who have high blood pressure than the odds of non-Aboriginal Canadians without high blood pressure to have type 2 diabetes. In terms of age, for every year increase in the age of non-Aboriginals in Canada, the odds of having type 2 diabetes increase 1.1 times. The odds of having type 2 diabetes are 2.8 times higher for non-Aboriginal Canadians who have high blood lipid/cholesterol than the odds of non-Aboriginal

Canadians without high blood lipid/cholesterol to have the disease. The odds of having type 2 diabetes as against not having the disease are 63% less likely for non-Aboriginals in Canada who are underweight than for non-Aboriginals in Canada who are obese to have type 2 diabetes. The odds of having type 2 diabetes as against not having the disease are 65% less likely for non-Aboriginals in Canada who are normal than for non-Aboriginals in Canada who are obese to have type 2 diabetes. Also, the odds of having type 2 diabetes as against not having the disease are 49% less likely for non-Aboriginal Canadians who are overweight than the odds of non-Aboriginal Canadians who are obese to have type 2 diabetes. For males in the non-Aboriginal population of Canada, their odds of having type 2 diabetes are 1.44 times higher than the odds for females in the non-Aboriginal population of Canada to have type 2 diabetes. Non-Aboriginal Canadians with sleep apnea problem have the odds of having type 2 diabetes to be 1.65 times higher than the odds of non-Aboriginal Canadians without sleep apnea to have type 2 diabetes. For every additional member to the family size in the non-Aboriginal population of Canada, the odds of having type 2 diabetes increase 1.14 times. Among non-Aboriginals in Canada with low educational attainment, the odds of having type 2 diabetes are 1.53 times higher than the odds of non-Aboriginals in Canada with high educational qualification to have the disease. Also, for non-Aboriginals in Canada with moderate education, the odds of having type 2 diabetes are 1.2 times higher than the odds of non-Aboriginals in Canada with high education. The odds of having type 2 diabetes are 25% less likely for non-Aboriginal Canadians who own their dwelling place than the odds of non-Aboriginal Canadians who rent their dwelling place to have type 2 diabetes. For non-Aboriginals in Canada who are food secured, the odds of having type 2 diabetes are 16% less likely than the odds of non-Aboriginals in Canada who lack food security to have the disease. The odds of having type 2 diabetes are 14% less likely among non-Aboriginals in Canada who suffer from migraine than the odds of non-Aboriginals in Canada who do not suffer from

migraine to have type 2 diabetes. In terms of suffering from scoliosis, the odds of having type 2 diabetes are 31% less like for non-Aboriginals in Canada who suffer from scoliosis than the odds of non-Aboriginals in Canada who do not suffer from scoliosis to have type 2 diabetes. For those who belong to the low personal income cadre in the non-Aboriginal population, the odds of having type 2 diabetes are 1.32 times higher than the odds of non-Aboriginal Canadians who belong to the high personal income cadre to have type 2 diabetes. Also, for those non-Aboriginals in Canada that belong to the moderate class in terms personal income category, the odds of having type 2 diabetes are 1.18 times higher than the odds of non-Aboriginals in Canada who belong to the high cadre in the personal income classification to have the disease. For non-Aboriginal Canadians who have osteoporosis, the odds of having type 2 diabetes are 12% less likely than the odds of non-Aboriginal Canadians who do not have osteoporosis to have type 2 diabetes. Finally, non-Aboriginal Canadians who suffer from asthma have the odds of having type 2 diabetes to 1.19 times higher than the odds of non-Aboriginal Canadians who do not suffer from asthma to have type 2 diabetes. There exists an association between the social determinants of health and the prevalence of type 2 diabetes in the non-Aboriginal population of Canada. Having high blood pressure, age, having high blood cholesterol or lipid, BMI, gender, having sleep apnea, household size, educational level, dwelling ownership, food security, having migraine, marital status, having scoliosis, personal income, having osteoporosis, and having asthma are the social determinants of health that are associated with the prevalence of type 2 diabetes in the non-Aboriginal population of Canada.

RQ4

RQ4: Is there any association between the social determinants of health and other prognostic factors and the prevalence of type 2 diabetes in the non-Aboriginal population of Canada?

H_04: Social determinants of health and other prognostic factors are not associated with the prevalence of type 2 diabetes among non-Aboriginals in Canada.

H_{a4}: Social determinants of health and other prognostic factors are associated with the prevalence of type 2 diabetes among non-Aboriginals in Canada.

The difference between the focus of this research question and the previous ones is that, this research question investigates if there exists any significant difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada while controlling for the effect of each of the significant variables. Based on this, it was hypothesised that, there is no significant difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada, while controlling for the impact of both modifiable and non-modifiable risk factors. The association between having type 2 diabetes and Aboriginal status served as the baseline for subsequent associations to be examined.

Table 12

Relationship between Type 2 Diabetes and Aboriginal Status Alone

Variables	Point Estimate	95% Confidence Limits		P-value
Aboriginal Status	0.976	0.855	1.113	0.7137

Aboriginal status is not significant at 0.5 significant level (see Table 12). This implies that, there is no significant difference in the prevalence of type 2 diabetes between the Aboriginal population and non-Aboriginal population in Canada. This is also corroborated by the 95% confidence limit of the odds ratio that overlaps 1. The influence of these various prognostic social determinants of health factors are tested by controlling for their effects. The outcome of the examination for potential difference in the prevalence of type 2 diabetes

between the Aboriginals and non-Aboriginals in Canada, while controlling for the individual effects of each of the social determinants of health factors is presented in Table 13. Only age and educational level are significant after controlling for the individual effects of various social determinants of health factors. The associated confidence limits of each factor also testified to this observation. Therefore, it can be said that, while controlling for the increasing effect of age, the odds of Aboriginals in Canada to have type 2 diabetes are 1.4 times higher than the odds of non-Aboriginal to have type 2 diabetes. Also, by controlling for the effect of educational level, the odds of Aboriginals in Canada to have type 2 diabetes is 18% less likely than the odds of non-Aboriginals in Canada to have the disease.

Table 13

Type 2 Diabetes and Aboriginal Status, while Controlling for Individual Effects of Other Factors

Control Variables	Explanatory Variable	Point Estimate	95% Confidence Limits		P-value
Age	Aboriginal Status	1.402	1.223	1.608	<.0001
Gender	Aboriginal Status	0.977	0.857	1.115	0.7344
BMI	Aboriginal Status	0.9	0.784	1.033	0.1352
Personal Income	Aboriginal Status	0.944	0.827	1.077	0.3905
Dwelling Ownership	Aboriginal Status	0.965	0.846	1.101	0.5986
Food Security	Aboriginal Status	0.986	0.863	1.127	0.8351
HBP	Aboriginal Status	1.015	0.885	1.164	0.8335
Education	Aboriginal Status	0.819	0.715	0.938	0.004
HBC	Aboriginal Status	1.113	0.97	1.275	0.1262

Table continues

Sleep apnea	Aboriginal Status	0.947	0.829	1.082	0.2289
Family size	Aboriginal Status	1.004	0.88	1.146	0.9545
Marital status	Aboriginal Status	1.037	0.909	1.184	0.5889
Has Migraine	Aboriginal Status	0.992	0.869	1.132	0.9059
Has scoliosis	Aboriginal Status	0.979	0.858	1.116	0.7469
Has osteoporosis	Aboriginal Status	0.99	0.867	1.129	0.8765
Employment	Aboriginal Status	0.954	0.835	1.089	0.4839
Has Arthritis	Aboriginal Status	0.95	0.831	1.086	0.4514
Regular Fruit Consumption	Aboriginal Status	0.966	0.842	1.109	0.6228
In-house Smoking Allowed	Aboriginal Status	0.939	0.809	1.089	0.4037

In addition to the previous findings about the significant differences in terms of prevalence of type 2 diabetes in Canada between the Aboriginals and non-Aboriginals, while controlling for individual effects of social determinants of health factors, the joint effects of various combinations of social determinants of health factors are all significant. This means that, there is significant difference in the prevalence of type 2 diabetes between the Aboriginal population and non- Aboriginal population in Canada, while controlling the joint effect of age and educational attainment, age, educational attainment, and gender, age, educational attainment, and BMI, age, educational attainment, and personal income, age, educational attainment, and dwelling ownership, age, educational attainment, and food security, age, educational attainment, and high blood pressure, age, educational attainment,

and high blood cholesterol or lipid, age, educational attainment, and sleep apnea, age, educational attainment, and marital status, age, educational attainment, and family size, age, educational attainment, and migraine, age, educational attainment, and scoliosis, and age, educational attainment, and osteoporosis. As shown in Table 14, Aboriginals in Canada have higher odds of having type 2 diabetes than non-Aboriginals in Canada when considering the joint effects of various combinations of social determinants of health factors. The lowest odds of 1.21 time was observed in the joint effect of age, education and BMI. This implies that, while controlling for the joint effect of age, educational level and BMI, the odds of Aboriginals in Canada to have type 2 diabetes are 1.21 times higher than the odds of non-Aboriginals in Canada to have the disease.

Table 14

Type 2 Diabetes and Aboriginal Status, while Controlling for Joint Effects of Other Factors

Control Variables	Explanatory Variable	Point Estimate	95% Confidence Limits		P-value
Age + Education	Aboriginal Status	1.274	1.107	1.466	0.0007
Age + Education + Gender	Aboriginal Status	1.28	1.112	1.474	0.0006
Age + Education + BMI	Aboriginal Status	1.207	1.041	1.399	0.0127
Age + Education + Income	Aboriginal Status	1.261	1.095	1.451	0.0013
Age + Education + Dwelling	Aboriginal Status	1.248	1.084	1.437	0.0021

Table continues

Age + Education + Food Security	Aboriginal Status	1.284	1.113	1.48	0.0006
Age + Education + HBP	Aboriginal Status	1.239	1.073	1.43	0.0034
Age + Education + HBCL	Aboriginal Status	1.334	1.155	1.542	<.0001
Age + Education + Sleep Apnea	Aboriginal Status	1.239	1.075	1.428	0.0032
Age + Education + Marital Status	Aboriginal Status	1.279	1.111	1.472	0.0021
Age + Education + Family Size	Aboriginal Status	1.274	1.107	1.467	0.0007
Age + Education + Has Migraine	Aboriginal Status	1.277	1.11	1.47	0.0007
Age + Education + Has Scoliosis	Aboriginal Status	1.281	1.113	1.474	0.0006

Table continues

Age + Education + Has Osteoporosis	Aboriginal Status	1.276	1.108	1.469	0.0007

Comparing the Impact of Risk Factors across the Three Sampled Canadian Populations

This study also considered how each of the significant risk factors that are associated with each of the 3 sampled populations in Canada differ in terms of their impacts. This is done by comparing the size and magnitude of the odds ratios associated with the risk factors across the populations under consideration (see Table 15). By looking at the impact of each significant risk factor based on their associated odds ratios, among Canadians who have high blood pressure, those who belong to the Aboriginal population in Canada have the highest odds of 2.4 times higher to have type 2 diabetes, while the odds of Canadians who also have high blood pressure, but belong to the non-Aboriginal population in Canada have the odds of having type 2 diabetes to be 2.3 times higher, which is the same with the odds of 2.3 observed in the general population of Canada. In terms of the impact of having high blood cholesterol or lipid, similar to what was observed while considering the impact of high blood pressure. It can be seen that Aboriginals in Canada who have high blood cholesterol or lipid, just like those of them who have high blood pressure also have the highest odds of having type 2 diabetes when compared to the non-Aboriginals and the general population of Canada. They have the odds of having type 2 diabetes to be 3 times higher, while non-Aboriginals with the same condition of high blood cholesterol or lipid have the odds to have type 2 diabetes to be 2.8 times higher. The general population has the odds to be 2.7 times higher. Aboriginal population in Canada also have the highest odds of having type 2 diabetes when looking at effect of age. As Aboriginal people grow older every year, their odds of having type 2 diabetes increase by 6%, while the odds of non-Aboriginals increase by 5%, which is also the same odds for the general population of Canada. This study discovered that, scoliosis which is a health condition that relates to the abnormal curve of the backbone is also significantly associated with type 2 diabetes but had

opposing and different effects on the Aboriginal population compared to the non-Aboriginal population and the general population.

Table 15

Comparing of the Odds Ratios among General, Aboriginal, and Non-Aboriginal Populations

Factors	Levels	General Population			Aboriginal Population			Non-Aboriginal Population		
		Point Estimate	95% C.L		Point Estimate	95% C.L		Point Estimate	95% C.L	
Aboriginal Status	Aboriginal vs Non-Aboriginal	1.192	1.018	1.396						
Has HBP	Yes vs No	2.294	2.151	2.447	2.355	1.796	3.089	2.302	2.155	2.459
Has HBCL	Yes vs No	2.745	2.575	2.926	2.986	2.266	3.934	2.751	2.577	2.937
Age		1.052	1.049	1.055	1.059	1.049	1.069	1.051	1.049	1.054
Has Scoliosis	Yes vs No	0.748	0.622	0.9	1.689	1.033	2.761	0.691	0.568	0.84
BMI	Underweight Vs Obese	0.37	0.256	0.534	0.383	0.081	1.813	0.372	0.256	0.542
	Normal Vs Obese	0.346	0.318	0.376	0.14	0.087	0.225	0.353	0.324	0.385
	Overweight Vs Obese	0.506	0.472	0.541	0.602	0.461	0.785	0.505	0.471	0.541
Has Sleep Apnea	Yes vs No	1.688	1.543	1.846				1.674	1.526	1.836
Personal Income	Low Vs High	1.317	1.218	1.425				1.317	1.215	1.427

Table continues

	Medium vs High	1.188	1.098	1.284	1.176	1.086	1.274
Educational Level	Low Vs High	1.518	1.376	1.675	1.525	1.379	1.686
	Medium vs High	1.198	1.109	1.296	1.194	1.104	1.293
Dwelling Ownership	Own vs Rent	0.748	0.696	0.804	0.747	0.694	0.804
Osteoporosis	Yes vs No	0.886	0.793	0.988	0.879	0.785	0.984
Food Security	Yes vs No	0.852	0.802	0.904	0.839	0.789	0.892
Gender	Male Vs Female	1.415	1.325	1.51	1.437	1.344	1.537
Has Migraine	Yes vs No	0.881	0.787	0.985	0.86	0.765	0.967
Has Asthma	Yes vs No				1.192	1.073	1.323
Household Size		1.145	1.115	1.177	1.141	1.11	1.173
Marital Status	Married Vs Single	0.85	0.764	0.946	0.862	0.773	0.963
	Common Law Vs Single	0.822	0.718	0.942	0.847	0.737	0.975
	Widowed Vs Single	0.725	0.626	0.839	0.734	0.632	0.853
	Separated Vs Single	1.198	1.001	1.433	1.228	1.021	1.475

Table continues

	Divorced Vs Single	1.035	0.901	1.189				1.058	0.918	1.22
Smoking Status	Current Vs Never				1.754	1.225	2.513			
	Past Vs Never				1.494	1.057	2.11			

While scoliosis was observed to reduce the odds of having type 2 diabetes by 25% in the general population of Canada and by 31% in the non-Aboriginal population of Canada, scoliosis was rather discovered to increase the odds of Aboriginal in Canada to having type 2 diabetes by 70%. This is a significant discovery by this study. Comparing the effects of BMI on type 2 diabetes among the Aboriginals, non-Aboriginals and the general population of Canada revealed that, Aboriginals in Canada with normal BMI have the odds of having type 2 diabetes to be 86% less likely than the odds of Aboriginals in Canada who are obese to type 2 diabetes. The non-Aboriginals in Canada with normal BMI have the odds of having type 2 diabetes to be 65% less likely than non-Aboriginals in Canada who are obese. The odds of having type 2 diabetes in the general population are also 65% less likely for Canadians with normal BMI than Canadians with BMI considered as obese. This shows that Aboriginals in Canada with normal BMI are less likely than non-Aboriginals with similar normal BMI to have type 2 diabetes when both are compared to their obese counterparts in their respective populations. As it can be observed in Table 15 that, the risk factors that are associated with both the prevalence of type 2 diabetes in the general population and the non-Aboriginal population of Canada all have similar odds of having type 2 diabetes. To this end, it can be concluded that, there exists significant difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada, while controlling for the individual and joint effects of modifiable and non-modifiable risk factors.

Summary

The conduct of data analysis using various statistical techniques enhanced the provision of appropriate answers to all the research questions in this study. The results from the data analyses show that, in terms of the first research question, Aboriginal status, having high blood pressure, age, having high blood cholesterol / lipids, BMI, gender, having sleep apnea, household size, educational level, dwelling ownership, food security, having migraine headaches, marital status, having scoliosis, personal income and having osteoporosis are significantly associated with the prevalence of type 2 diabetes in the general population of Canada. Considering the second research question, it was observed that age, BMI, having high blood pressure, having high blood cholesterol / lipids, having scoliosis and smoking status are the risk factors found to be associated with the prevalence of type 2 diabetes in the Aboriginal population of Canada. Based on the third research question, other than the exclusion of Aboriginal status and the inclusion of having asthma, all the risk factors that were discovered to be associated with the prevalence of type 2 diabetes in the general population are also associated with the prevalence of type 2 diabetes in the non-Aboriginal population of Canada. Regarding the fourth research question, it was observed that, Aboriginal status was not enough to determine the prevalence of type 2 diabetes while considering the impact of both modifiable and non-modifiable factors. This implies that, there is no significant difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada. But the introduction of other risk factors such as age and educational level into the relationship between the prevalence of type 2 diabetes and being Aboriginal or otherwise resulted into a significant difference between these two distinct sub Canada populations. Also, the joint effects of various combinations of risk factors resulted in significant differences in terms of the prevalence of type 2 diabetes between Aboriginals and non-Aboriginals in Canada.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

This chapter provides a comprehensive discussion regarding the outcomes of various statistical analyses carried out. This discussion relates to how these findings would impact the targeted population and also enhance positive change in society. In addition to providing a general overview, this chapter also discusses findings and their implications based on the specific population of interest.

The prevalence of type 2 diabetes in Canada is increasing, but the rates have disproportionately affected the Aboriginal population. This study focused on examining the impact of social determinants of health in order to prove Aboriginal Canadians are disproportionately affected by the rates of type 2 diabetes in Canada. One distinctive feature that separates this study from other studies on the topic of type 2 diabetes in relation to the Aboriginal population in Canada is that, rather than focusing on a single population, this study focused on three different sampled populations the Aboriginal, non-Aboriginal, and overall populations in Canada. This enhanced the ability to examine the risk factors that are peculiar to Aboriginals, non-Aboriginals in Canada, and the entire Canadian population. This allowed for the ability to make objective inferences and compare the impacts of various risk factors for the three sampled populations under consideration.

Findings and Implications: General Population of Canada

The result of the univariate analysis in Table 5 showed the individual associations of each risk factor with type 2 diabetes. This assisted in focusing this study on the risk factors that predict the prevalence of type 2 diabetes in Canada. The initial univariate analysis revealed that being Aboriginal or otherwise in Canada cannot singularly determine the possibility of having type 2 diabetes. Therefore, race or ethnicity alone as a social determinant of health is not likely to be responsible for the prevalence of type 2 diabetes in

Canada. This also indicates that there is no significant difference between the Aboriginal and non-Aboriginal population in terms of the prevalence of type 2 diabetes in Canada. However, when other prognostic risk factors are considered along with being Aboriginal or otherwise, they significantly influenced the prevalence of type 2 diabetes in Canada. Also, the effect of Aboriginal status was significant when controlling for the effects of various risk factors in relation to the prevalence of type 2 diabetes in Canada.

Based on RQ1, it was observed that the prevalence of type 2 diabetes in the general population of Canada is significantly associated with and influenced by combination of various risk factors. These include Aboriginal status, high blood pressure, age, high blood cholesterol/lipids, BMI, gender, sleep apnea, household size, educational level, dwelling ownership, food security, migraine headaches, marital status, scoliosis, personal income, and osteoporosis. The odds of having type 2 diabetes are 12% higher for Aboriginals than the odds of non-Aboriginals. The CDA (2013) said that Aboriginal Canadians are at the highest risk of developing diabetes and associated complications. Another significant risk factor is BMI. The Harvard School of Public Health (2014) reported that being obese or overweight is a major significant factor that is crucial to the development of type 2 diabetes. This was confirmed through this study. Canadians who have normal BMI are 65% less likely to have type 2 diabetes than Canadians who are obese. Canadians who are underweight are 63% less likely than Canadians who are obese to have type 2 diabetes. Canadians who are overweight are 49% less likely than Canadians who are obese to have type 2 diabetes. This shows the danger that is inherent in being obese or overweight. The International Diabetes Federation (2014) said that being overweight or obese among other factors are associated with type 2 diabetes.

Canadians are also more likely to have type 2 diabetes as they grow older. This is based on the fact that with every year increase in age, the odds of Canadians having type 2

diabetes increase by 5%. High blood pressure is another risk factor that is strongly associated with the prevalence of type 2 diabetes in the general population of Canada. Canadians who have high blood pressure are 2.3 times higher than Canadians without high blood pressure to have the disease. Another risk factor that is significant and similar to high blood pressure is high blood cholesterol/ lipid. This study shows that Canadians who have high blood cholesterol/lipid are 2.8 times more likely than Canadians who do not have high blood cholesterol/lipid to have type 2 diabetes.

According to Diabète Québec (2014a), men are more at risk of developing type 2 diabetes than women. This study also confirmed this. Male Canadians are 42% more likely than female Canadians to have type 2 diabetes. Another prominent factor for the prevalence of type 2 diabetes is level of education. The International Diabetes Federation (2014) said that education is a determinant of type 2 diabetes. Canadians who lack education are 52% more likely than Canadians who are highly educated. The same goes for Canadians who are moderately educated; they are 20% more likely than Canadians who are highly educated to have type 2 diabetes. A crucial factor that could influence the direction and magnitude of other risk factors is income. Good housing, food security, and higher educational attainment could all be a function of personal income. This study revealed that Canadians who are low income earners are 30% more likely than high income earners to have the disease. Also, Canadians who belong to the middle level in terms of personal income have the odds to be 20% more likely than the odds of high income earners to have the disease.

This study revealed certain new risk factors that could potentially be responsible for the prevalence of type 2 diabetes in Canada. These are health conditions that have not been associated with type 2 diabetes in previous research studies. Some of these health conditions are found to reduce the odds of having type 2 diabetes. They could be new potential discoveries in relation to the prevalence of type 2 diabetes in Canada. These health conditions

include sleep apnea, migraine headaches, scoliosis, and osteoporosis. They are all significantly associated with the prevalence of type 2 diabetes in Canada. In the general population, Canadians who suffer from sleep apnea are 69% more likely than Canadians without sleep apnea to have the disease. Also, Canadians who suffer from migraine headaches are 12% less likely than Canadians who do not to have type 2 diabetes. In the case of scoliosis, Canadians with this health condition are 25% less likely than Canadians who do not to have type 2 diabetes. Canadians who have osteoporosis are 11% less likely than Canadians who do not suffer from this health condition to have type 2 diabetes. This finding could necessitate the need to conduct some further medical or clinical studies to understand the reason behind this relationship.

Although overcrowding was said to be a peculiar risk to the Aboriginals in Canada (Willows et al., 2012), this study revealed that overcrowding could be a risk factor for the general population of Canada when it comes to type 2 diabetes. For every additional person in a household in Canada, the odds of having type 2 diabetes as against not having it increase by 12%. Another risk factor for the Aboriginal population in Canada is housing (Dyck et al., 2015). This study revealed that the effect of housing is relevant to the general population of Canada in relation to the prevalence of type 2 diabetes. Canadians who own are 25% less likely Canadians who rent to have type 2 diabetes. Food security is another risk factor for type 2 diabetes for the Aboriginal population in Canada (Dyck et al., 2015). In this study, it was found to influence the prevalence of type 2 diabetes in the whole Canadian population. Canadians who have food security are 14% less likely than Canadians who do not have food security to have type 2 diabetes. Tait et al. (2013) said that specific determinants of health such as Aboriginal status, race, social exclusion, disability, food security, education, early lifestyle, gender, employment and working conditions, health services, housing, income and

income distribution, social safety net, and unemployment and job security are associated with the Aboriginal population in Canada.

Another risk factor associated with the prevalence of type 2 diabetes in Canada is marital status. Being single is considered as the reference category for all classes of marital status in Canada. Therefore, married Canadians have the odds of having type 2 diabetes to be 15% less likely; Canadians who engage in common law relationships have their odds of having type 2 diabetes to be 18% less likely; Canadians who are widowed have the odds of type 2 diabetes to be 27% less likely; whereas Canadians who are separated have the odds of having type 2 diabetes to be 20% more likely than the odds of Canadians who are single to have the disease. The reason for the change of pattern in the later class of marital status could be an issue to be further investigated in the future.

Findings and Implications: Aboriginal Population of Canada

Age, high blood pressure, BMI, high blood cholesterol/lipid, and scoliosis are part of risk factors that significantly influenced the prevalence of type 2 diabetes in the general population of Canada. But these five risk factors also associate significantly with the prevalence of type 2 diabetes in the Aboriginal population of Canada. The only additional to these 5 risk factors which is not associated with the general population of Canada is smoking status. This implies that, smoking status is a peculiar risk factor for the prevalence of type 2 diabetes in the Aboriginal population of Canada. This resonates with Ley et al. (2011), where it was reported that diabetes in the Aboriginal population is associated with high prevalence rates of obesity and smoking. This study revealed that, by referencing Aboriginals in Canada who never smoked to Aboriginals in Canada who are either current smokers or smoked in the past, Aboriginals in Canada who are current smokers have the odds of having type 2 diabetes to be 80% more likely; and Aboriginal Canadians who are past smokers have the odds of having type 2 diabetes to be 50% more likely to have type 2 diabetes.

Similar to what was observed in the general population of Canada, Aboriginals in Canada are also more likely to have type 2 diabetes as they grow older. This inference was based on the revelation that for every year increase in the age of Aboriginals in Canada, their odds of having type 2 diabetes versus not having it increase by 6%. This odds of 6% is the highest when compared to the odds of the general population and non-Aboriginal population, which are both 5% each. Although, this is slightly higher. This could support earlier observation that Aboriginals in Canada could experience an early onset of type 2 diabetes in comparison to non-Aboriginals in Canada and the general population.

High blood pressure is another risk factor that played a significant role in the prevalence of type 2 diabetes in general population of Canada and also in the prevalence of the disease in the Aboriginal population of Canada. It was observed that Aboriginals in Canada who have high blood pressure have the odds of having type 2 diabetes to be 2.4 times higher than the odds of Aboriginal Canadians without high blood pressure to have the disease. Similarly, Aboriginal in Canada with high blood cholesterol/lipid have the odds of having type 2 diabetes to be 3 times higher than the odds of Aboriginal Canadians without high blood cholesterol/lipid to have type 2 diabetes. These findings are in support of the previous study that, high blood pressure, and people who are Aboriginals, Africans, Asians, and Latin-Americans are at higher risk of type 2 diabetes (Diabète Québec, 2014a).

This study also revealed that by referencing Aboriginals in Canada who are obese, Aboriginal in Canada with normal BMI have the odds of having type 2 diabetes to be 86% less likely; even Aboriginals in Canada who are considered to be overweight have the odds of having type 2 diabetes to be 40% less likely than the odds of Aboriginal Canadians who are obese. Another health condition that is associated with the prevalence of type 2 diabetes in the Aboriginal population of Canada is having scoliosis. Although this health condition is also associated with type 2 diabetes in the general population of Canada, but contrary to the

observation in the general population that suffering from scoliosis reduces the odds of type 2 diabetes by 25%, Aboriginals in Canada who also suffer from scoliosis rather have the odds of having type 2 diabetes to be 70% more likely than the odds of Aboriginals in Canada who do not suffer from this disease to have type 2 diabetes.

Findings and Implications: Non-Aboriginal Population of Canada

This study revealed that, apart from the inclusion of having asthma as a risk factor, all the factors found to be associated with the prevalence of type 2 diabetes in the general population of Canada are also discovered to be associated with the prevalence of the type 2 diabetes in the non-Aboriginal population of Canada. In addition to the discovery that, all the risk factors found to be associated with the general population are also associated with the non-Aboriginal population of Canada, these risk factors also have the odds to have type 2 diabetes in the general population of Canada to be very similar to the odds of having the disease in the non-Aboriginal population of Canada. Based on this this, it can be said that the risk factors of type 2 diabetes in the non-Aboriginal population of Canada can as well be regarded as the risk factors for type 2 diabetes in the general population of Canada,

Findings and Implication based on Modifiable and Nonmodifiable Risk Factors

As observed in this study that ethnicity/race in the form of Aboriginal status is not associated with the prevalence of type 2 diabetes in Canada, which implies that there is no significant difference between Aboriginals and non-Aboriginals in relation to the prevalence of type 2 diabetes in the Canadian population. But age and educational attainment were observed to be significant when controlling for the individual effects of all the available risk factors on the relationship between Aboriginal status and type 2 diabetes in Canada. It was also observed that, controlling for joint effects of various risk factors resulted in the significant difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada. By controlling for the effect of age, the odds of Aboriginal people in

Canada to having type 2 diabetes are 40% more likely than the odds of non-Aboriginals in Canada to have type 2 diabetes. This discovery could also attest to the earlier observation that Aboriginal people in Canada could experience an early onset on type 2 diabetes when compared to non-Aboriginals in Canada. Educational attainment being another risk factor that made the prevalence of type 2 diabetes to be significantly different between Aboriginal and non-Aboriginal also revealed that, the odds of Aboriginals in Canada to have type 2 diabetes is 18% less likely than the odds of non-Aboriginals in Canada to have the disease.

Controlling for the joint effects of other risk factors also revealed significant difference in the prevalence of type 2 diabetes between the Aboriginals and non-Aboriginals in Canada. It was observed that Aboriginals in Canada have higher odds of having type 2 diabetes than non-Aboriginals in Canada when considering all the joint effects of various combinations of social determinants of health factors. The lowest odds of 1.21 time was observed in the joint effect of age, education and BMI on the relationship between Aboriginal status and type 2 diabetes in Canada. Therefore, in general, the significance of individual and various joint effects are in line with the with findings of Brooks, Darroch and Giles (2013), where it was stated that determinants of health interact in a variety of levels and ways to influence the health, therefore, it is uncommon for a single determinant to influence the health of an individual or community.

Summary of Findings

A significant contribution of this study to the body of knowledge about type 2 diabetes as it relates to the overall population of Canada is about the discovery of potentially new significant association between type 2 diabetes and some health conditions such as sleep apnea, osteoporosis, asthma, scoliosis and migraine. These 5 risk factors have not been identified in any previous studies as having any potential association with the prevalence of type 2 diabetes. Apart from the discovery of potentially new risk factors to be associated with

the prevalence of type 2 diabetes, another revelation is about the opposing impact and the huge margin that scoliosis disease has on the prevalence of type 2 diabetes when compared Aboriginals to non-Aboriginals and the general population of Canada. This study showed that suffering from scoliosis disease reduces the odds of type 2 diabetes by 25% and 31% in the general population of Canada and non-population of Canada respectively, but Aboriginals who suffer from scoliosis in the same country have the odds of having type 2 diabetes to be 70% more likely. This discovery could be used to support the claim that there is the existence of disproportionality in the prevalence of type 2 diabetes when comparing Aboriginals to non-Aboriginals in Canada.

This could also prove that Aboriginals in Canada generally suffer the consequences and effects of health conditions more than their non-Aboriginals counterparts in Canada. In addition, based on BMI, this study revealed the importance of Aboriginals in Canada having normal BMI. It was revealed that, Aboriginals in Canada have largest reduction of odds of having type 2 diabetes if they have normal BMI. Their odds of having type 2 diabetes are 85% less likely than obese Aboriginals, compared to non-Aboriginal with the same normal BMI, who have the odds of type 2 diabetes to be 65% less likely than obese non-Aboriginals. This study also showed that while high blood pressure is significantly associated with the 3 sampled populations under consideration in relation to having type 2 diabetes, it was however observed that Aboriginals in Canada with the same high blood pressure condition have the highest odds of having type 2 diabetes disease. It was also revealed that, Aboriginal people in Canada also suffer higher effect of type 2 diabetes than non-Aboriginals who suffer from the same condition of high blood cholesterol or lipid.

Another crucial revelation is that, apart from the fact that similar risk factors are responsible for the prevalence of type 2 diabetes in the general population and in the non-Aboriginal population of Canada, these risk factors also have similar odds of having type 2

diabetes in both of these populations in Canada. This indicates that the non-Aboriginals in Canada reflect the picture of the overall population of Canada when it comes to the prevalence of type 2 diabetes and its effects and vice versa, this thereby would likely conceal the true picture of the prevalence of type 2 diabetes and its effect in the Aboriginal population in Canada.

As against the popular perception based on prior studies on type 2 diabetes that risk factors such as housing, overcrowding, and food security are only associated with type 2 diabetes among the Aboriginals, this study revealed that, these risk factors are also associated with type 2 diabetes in the general population of Canada and non-Aboriginal population of Canada. Being highly educated could reduce the chance of developing type 2 diabetes, based on the notion that higher level of education could have exposed people more to health behaviours and choices that influence the chance of developing of type 2 diabetes, thereby enabling those highly educated individuals to make appropriate and informed decisions that could reduce the chance of type 2 diabetes.

Limitations of the Study

This research study was conducted by the use of a secondary data. Therefore, the validity, reliability and accuracy of the instruments used in the collection, collation and compilation of the data lies in the hands of Statistics Canada. Secondly, according to CCHS 2016, which is the title of the survey used for this study, some of the data and information in this survey are self-reported. Therefore, this study could also suffer from limitations that are associated with prior studies that used self-reported data. Some these issues could include falsification of responses and social desirability bias on the part of respondents. To this end, the accuracy and relevance of the outcomes of this study depend to a large extent on the level of accuracy and validity of the instruments used in the data collection; honest response from participants and the correct use of the sampling technique in determining the sample frame or

unit to be interviewed. All these if properly done would enhance true representativeness of the sample, hence the generalisation of the findings.

Social Change Implication of this Study

The increasing unabated rate of type 2 diabetes in Canada demands the immediate attention of concerned individuals, government and other public health stakeholders within and outside Canada. Apart from the high cost of dealing with this problem, Canadians who suffer from this disease experience worsening quality of life, they are prone to various cardiovascular diseases and many other health problems associated with being diabetic. They are as well prone to untimely death. Social change refers to an alteration in the cultural, structural, population, or ecological characteristics of a social system (Crossman, 2015). The problem of diabetes in the Aboriginal population of Canada is believed to be the outcome of various factors, which also include wrong personal choices such as sedentary and unhealthy lifestyles, genetic composition, and socioeconomic induced problems such as poverty, unemployment, lack of education, lack of access to sound healthcare system, etc. These risk factors can as well be classified as modifiable and non-modifiable risk factors. Age, gender and ethnicity/race are considered as non-modifiable factors because they cannot be altered, while factors such as employment, BMI, income, etc., which can be altered are considered as modifiable risk factors.

Obesity and overweight have been associated with chronic diseases, including diabetes, cardiovascular diseases and cancer (WHO, 2013). Obesity and overweight is the consequence of an energy imbalance, which implies the consumption of too many caloric foods and less engagement in substantial physical activity (CDC, 2012). This means that factors that promote or enhance obesity and overweight need to be checkmated if the prevalence of type 2 diabetes in the Aboriginal population and in the general population of Canada must be addressed. This means tackling the problem of sedentary lifestyle and

unhealthy diet and behaviours. According to Peters (2004), halting and reversing the epidemic will require multi-factorial solutions, including implementing cognitive coping strategies and mounting an effective social change movement.

This study has successfully proved that in the Aboriginal population of Canada, age, high blood pressure, BMI, high blood cholesterol or lipid, smoking and suffering from scoliosis are risk factors that are strongly associated with the prevalence of type 2 diabetes within this population. Although some of these risk factors are also associated with the general population of Canada and the non-Aboriginal population of Canada, but the odds of these risk factors to having type 2 diabetes are the highest in the Aboriginal population of Canada. Therefore, in order to tackle the prevalence of type 2 diabetes in the Aboriginal population, the strategy must focus on how to solve the risk factors that are considered as modifiable. These are high blood pressure, BMI, high blood cholesterol or lipid and smoking. Scoliosis is a disease that is naturally associated with curved spine or backbone. Hence it could not be considered as a modifiable risk factor but rather a non-modifiable. On personal level, the problem of high blood pressure, BMI, high blood cholesterol or lipid, and smoking can resolved by creating awareness about the dangers than inherent in smoking, being obese or overweight, having blood pressure and having high blood cholesterol or lipid. Also advocating for a change of lifestyle from sedentary lifestyle to a more active lifestyle and making healthy food choices.

Beyond the personal level approach is the promotion of upstream approaches which would be championed by the government at all levels across Canada and other concerned authorities. These approaches would include the provision of quality education, opportunities that would enable the Aboriginals in Canada to make the right healthy choices. These provisions include safe and secured neighbourhoods that would enable the inhabitants to freely engage in active exercises and other healthy activities. They would also include

provision of equal distribution of opportunities such as employment, education, access to quality healthcare system, etc. These provisions would enhance the ability to purchase healthy foods and attain higher educational level. This study revealed the importance of education in fighting type 2 diabetes in the Aboriginal population of Canada. It was observed that when education was introduced into the relationship between Aboriginal status and having type 2 diabetes, the relationship did not only become significant, but also show that the odds of Aboriginal in Canada to have type 2 diabetes was 18% less likely than the odds of non-Aboriginals in Canada to have the disease. This could be an indication that if Aboriginals in Canada are provided with quality education, their odds of having type 2 diabetes would be considerably reduced.

To this end, in relation to the Aboriginal Peoples of Canada, a social change would require the government and public health programs and policies to focus on public awareness with emphasis on the dangers that are inherent in engaging in unhealthy lifestyles, poverty alleviation programs, provision of access to quality health care and affordable healthy food, quality education, among many others.

Recommendations for Future Research

Due to uncertainty in the validity of data because of potential falsification of responses and social desirability bias on the part of respondents, future researches should avoid the use of self-reported data, but rather focus on face to face data collection; conducting medical test to determine the actual diagnosis of diseases and the use of medically or clinically obtained data from hospitals, clinics and any other health service providers.

Health issues such as sleep apnea, scoliosis, osteoporosis, migraine and asthma could be considered as potentially new risk factors that are associated with the prevalence of type 2 diabetes in Canada. These risk factors could be further investigated to determine their clinical association with type 2 diabetes. Considerable attention should be given to scoliosis which

has opposing impacts, where it significantly increases the likelihood of type 2 diabetes among Aboriginals in Canada, but significantly decreases the chance of type 2 diabetes in the non-Aboriginal population of Canada.

Conclusion

This study has been able to establish that various risk factors, also known as social determinants of health are associated with the prevalence of type 2 diabetes in the general population of Canada, Aboriginal population and in the non-Aboriginal population of Canada. These findings thereby support the prior studies on type 2 diabetes in Canada that age, BMI, having high blood pressure, having high blood cholesterol or lipid, personal income, educational attainment, food security, smoking, etc. are all associated with type 2 diabetes. A significant contribution of this study to the body of knowledge in relation to type 2 diabetes in Canada is the new revelation that suffering from health conditions such as sleep apnea, migraine, asthma, scoliosis and osteoporosis are also risk factors that are associated with the prevalence of type 2 diabetes in Canada.

In addition, while risk factors that are associated with the prevalence of type 2 diabetes in the Aboriginal population are also associated with the prevalence of this same disease in the non-Aboriginal and the general population of Canada, the odds of having this disease are the highest among the Aboriginals in Canada.

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