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Associations Between Income, Acculturation, Country of Origin, and Type II Diabetes Among African Immigrants to Ontario, Canada

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Dissertation Submitted in Partial Fulfillment

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Abstract

Diabetes has become a longstanding public health challenge around the world. Over the last 3 decades, the number of people with Type II diabetes (T2DM) has grown to an epidemic level in Canada. Prior research indicated African immigrants residing in Ontario, Canada experienced a 2–4 times higher prevalence of T2DM than Canadian-born individuals. The social determinants of health theoretical framework guided this study assessing the relationship of the risk factors with T2DM. A quantitative, cross-sectional design was employed using the 2007–2014 Canadian Community Health Survey data. The random sample included 1,526 African immigrants residing in Ontario, Canada. Descriptive, bivariate, and multivariate analyses were conducted. Study results indicated a lower income level, high acculturation index, and a country of origin significantly associated with T2DM in adjusted and unadjusted binary logistic regression models. Using the results of the study to create a valid and reliable acculturation measurement scale and a cultural-based design of public health programs, increase awareness, and change policies that consider the needs of the sample populations could lead to positive social change by curbing the prevalence of T2DM observed in African immigrants residing in Ontario and Canada at large.

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Dedication

To my beloved family: Muluemebet Haile Abebe, my most precious and most beloved wife; Bezawit Girma Aman, my dearest and lovely daughter; Yoseph Adane Umema, my respected son-in-law; and my lovely and beautiful two grandchildren, Loza Yoseph (Maakedaye) and Elnaam Yoseph (Babaashu).

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Finally, my dedication also goes to the memories of my dearest, unforgettable parents and sister: Abegaz Aman Goshe, my dad; Aregash Ahmed Turemo, my mom; and my ever-remembered sister, Birqe Aman Goshe, for raising me to be a life-long learner.

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Chapter 1: Introduction to the Study

Introduction

In this correlational/cross-sectional study, I examined the associations between the level of income, acculturation (i.e., time since immigration and language proficiency), and country of origins of the African immigrants residing in Ontario, Canada with the prevalence of Type 2 diabetes mellitus (T2DM). In this study, I also assessed the possible relationships between the above indicated risk factors in the presence and the absence of the covariates: the behavioral risk factors (BRFs obesity, physical activity, diet/dietary habits, age, gender, and ethnicity. Chapter 1 will include a discussion of the background, problem statement, purpose of the study, the research questions and hypotheses, the theoretical framework, the nature of the study and its significance, the study limitations, the scope and delimitations, and a summary of the chapter.

Background

Diabetes has increased in its burden and prevalence rate in 69% of adults residing in developing nations, in 20% of adults living in developed countries, including Canada, and reached the unexpected level of epidemic in the last 3 decades (Canadian Diabetes Association [CDA], 2018; Shaw, Sicree, & Zimmet, 2010). Currently, about 422 million people live with diabetes globally, and this burden will rise to 592 million by the year 2030 (Agardh, Allebeck, Hallqvist, Moradi, & Sidorchuk, 2011; Al-Haifi et al., 2013; CDA, 2012; Creatore et al., 2010; Creatore et al., 2013; Dhingra & Vasan, 2012; International Diabetes Federation [IDF], 2013b; Lipscombe & Hux, 2007; Qi, Hu, & Hu, 2008; Stringhini et al., 2012; World Health Organization [WHO], 2018a; Zimmet,

2005). According to the CDA (2012a), “Almost 80% of new Canadians come from populations that are at higher risk for Type 2 diabetes mellitus (T2DM). These include people of Aboriginal, Hispanic, Asian, South Asian, or African descents” (para. 2).

T2DM is a rapidly growing global health challenge, accounting for 90%–95% of all diabetes cases in the world (Azevedo & Alla, 2008; Creatore, 2013; Hu et al., 2006; IDF, 2013b; Qi et al., 2008; Stringhini et al., 2012; Tuei, Maiyoh, & Ha, 2010; WHO, 2012). Both developed and developing countries are also found to be unequally affected by the increase in T2DM (Azevedo & Alla, 2008; Hu, 2011; IDF, 2013b; Shaw et al., 2010). Mortality in more than 80% of population with diabetes who are residing in developing nations, specifically in those countries with middle and low income categories, is mainly attributed to T2DM (Azevedo & Alla, 2008; Hu et al., 2006; IDF, 2013a, 2013b; Mbanya, Forrester, Cooper, & Cruickshank, 2007; Olokoba, Obateru, & Olokoba, 2012; Sobngwi et al., 2001; WHO, 2012).

Furthermore, the current increase in diabetes morbidity around the world has been associated with complex risk factors related to environmental changes, rapid growth in the rate of urbanization, increased migration to industrialized countries, aging, dietary habits and nutrition transitions, changes in levels of income, the adoption of Westernization-focused lifestyles, increased sedentary lifestyles and obesity, decreased physical activity, and the influences of familial genetics (Azevedo & Alla, 2008; Canadian Medical Association Journal [CMAJ], 2010; Gill & Cooper, 2008; Hossain, Kawar, & El Nahas, 2007; Hu et al., 2006; IDF, 2013b; Qi et al., 2008; Renzaho, Mellor,

Boulton, & Swinburn, 2010; Shaw et al., 2010; Stringhini et al., 2012; Tuei et al., 2010; Wild et al., 2004; Zimmet et al., 2001).

Problem Statement

As aforementioned, diabetes has spread in many parts of the world and affects the lives of many people, including Canadians (Creatore et al., 2013; Gill & Cooper, 2008; IDF, 2013b; Stringhini et al., 2012;WHO, 2012). Globally in 2011, there were 4.6 million deaths caused by the risks associated with diabetes (Olokoba et al., 2012) and 6.8% mortality in all ages worldwide (Roglic & Unwin, 2010). Similarly, in recent years, there had been an increase in diabetes-related mortality and morbidity observed among Canadian populations. For example, in 2015, over 9 million people were known to live with prediabetes (i.e., a 22.1% prevalence rate or 5.7 million people) and with diagnosed diabetes (i.e., 9.3% or 3.4 million people) in Canada (CDA, 2012; Creatore et al., 2013). The prevalence rate of diabetes in Canada has been estimated and expected to increase to 12.1% (i.e., 5 million Canadians) by 2025 (CDA, 2018; Ross, Gilmour, & Dasgupta, 2010; Shaw et al., 2010), and about 3.4 million people (i.e., 9.3%) have recently been estimated to have diabetes (CDA, 2018, Creatore, 2013). Of these, in 2013 only, 1,964,874 people in Canada 12 years old or older self-reported that they were diagnosed as diabetic individuals by medical practitioners or health professionals as compared to 1,706,148 people in 2009 (Statistics Canada, 2014). Such an increase in morbidity of T2DM in Canada has been partially attributed to the influx of various at high-risk immigrants from several developing countries, including immigrants from the continent of Africa (CMAJ, 2010; De Maio, 2010; Lysy et al., 2013).

Renzaho et al. (2010) described that migration to affluent industrialized countries, especially the movement of those high-risk susceptible immigrants from developing countries, was strongly associated with elevated risk of developing T2DM, obesity, Cardio Vascular Disease (CVD), and other related chronic diseases or illnesses. Also, according to the speech made by the minister of Citizenship and Immigration Canada (CIC) to partners and stakeholders, approximately "260,000 new permanent residents," were annually accepted as new immigrants through the Canadian Immigration and Integration Program (CIIP; CIC, 2013, para. 1; Evaristo-Neto et al., 2010; Newbold, 2009; Statistics Canada, 2012a, 2012b).

Unfortunately, the number of new African immigrants allowed to enter Canada had always been small as compared to immigrants from Asia and Latin Americans. The total number of African immigrants, as compared to the total number of immigrants who were allowed to enter Canada in 2011, increased bit by bit to 145,700 from what it was in the previous five years since 2006. This slow or limited increase indicated the composition of the African immigrants at the time, which was about 12.5% increase as compared to the total immigrants who entered to Canada in the year 2006 (Chui & Statistics Canada, 2013). Regardless of their low numbers, these African immigrants would have additional attributes on the overall increase in the number of the Canadian at-risk populations and in the prevalence rate of T2DM as well (Chui & Statistics Canada, 2013; Statistics Canada, 2012b). Of note, most immigrants, who were at risk for developing T2DM and arrived in Canada, preferred to settle in the Ontario province, which is the most populous geographical region of Canada. At present, Ontario is

inhabited by 13.6 million people and it has become the central harboring region for about 75% of immigrants entering Canada, including the African immigrants as well (Beran, & Yudkin, 2006; CDA, 2011; CIC, 2013; Creatore, 2013; Evaristo-Neto et al., 2010; Lysy et al., 2013; MESSAGES, 2008; Statistics Canada, 2012a .

In 2011, Ontario was also one of the three provinces (i.e., Nova Scotia, Ontario, and Newfoundland and Labrador) with the highest age-standardized diabetes (i.e., Type 1 diabetes and T2DM) prevalence in Canada as being identified based on the diagnosis of the disease (Public Health Agency of Canada [PHAC], 2011). For example, there had been about 1.2 million people with diabetes in the Ontario province in 2010 only (i.e., a prevalence rate of 8.3%), including the ethnically diverse African immigrants residing in Ontario (CDA, 2012a).

The Agency for Healthcare Research and Quality (AHRQ; 2001) stated, “The burden of diabetes is much higher for racial/ethnic minorities than for Caucasians. Minorities have a higher prevalence of diabetes than Caucasians, and some minorities have higher rates of diabetes-related complications and death” (para. 1). Indicatively, immigrant peoples with African origins had also been reported to carry more risks (e.g., 1.4 to 2.2 times) than the European Canadians for being affected by T2DM (AHRQ, 2001, para. 9). These immigrants comprised approximately 20.6% of the total Canadian population (Chui & Statistics Canada, 2013). Also, these immigrants based on their ethnicity, country of origins, level of income, and level of acculturation as well as changes in lifestyles, experience two to four times higher prevalence of diabetes ranging from 1.3% to 12% as compared to Canadian-born individuals and European Canadians

(Adhikari & Sanou, 2012; Chui & Statistics Canada, 2013; Chui, Tran, Maheux, & Statistics Canada, 2007; Muggah, Dahrouge, & Hogg, 2012; Pottie et al., 2011). The current surge in the age-standardized prevalence rate of T2DM in the Ontario province, from 5.3% in 2008 to an overall prevalence rate of 8.3% in 2010, was assumed to be attributed to the intertwined complex risk factors associated to the indigenous Canadian residents and increased in the influx of African immigrants to this province (CDA, 2012a; CMAJ, 2010; Pottie et al., 2011; Statistics Canada, 2010).

The sustained patterns in the increase in the migration of people of African origins to Canada who are at risk for developing diabetes, and the change in the lifestyles of these populations following their arrivals to the new places of residency were also one of the contributing factors affecting these immigrants (Lysy et al., 2013; CMAJ, 2010). Additionally, the language proficiencies and the duration of time that elapsed since their migrations to the new countries were also reported as the dominant factors influencing the health of these immigrants in their new residing countries (CDA, 2008, 2013). The observed increase in the obesity rate also warranted that these risk factors were the significant contributors of diabetes prevalence in Ontario and Canada (Canadian Diabetes Association Clinical Practice Guidelines Expert Committee, CDA, 2008, 2013; CMAJ, 2010; Hossain, Kawar, & El Nahas, 2007; Lipscombe & Hux, 2007; Lysy et al., 2013). Differences in the income level and socioeconomic status (SES) were previously reported to associate inversely with the prevalence of T2DM in other groups of populations when this risk factor had also been considered alone.

However, the influence of income on the prevalence of T2DM along with the involvement of behavioral risk factors (BRFs), language proficiencies, and the duration of time that elapsed since the original migrations of these African immigrant populations pertaining to their country of origins needs further study and concrete scientific investigations (AHRQ, 2001; Creatore et al., 2010; Dinca-Panaitescu et al., 2011; Lee et al., 2011). Understanding the associations and/or relationships and the complex interactions of the BRFs, the level of income, the acculturation, and the country of origins accompanied to the observance of the direct and indirect influences of these risk factors on the prevalence of T2DM were of paramount importance to this study. Primarily, the results of this study enhanced the existing knowledge and professional practice and positively influenced the improvement of current public health strategies and policies. Secondarily, the results can serve as a prominent guide in the selection of appropriate interventions (e.g., culturally-focused or lifestyle-geared interventions) and control measures that should be carried out accordingly to protect the Canadian populations from preventable risks associated with T2DM (CDA, 2013; Lee et al., 2011; Lysy et al., 2013; Renzaho, Mellor, Boulton & Swinburn, 2010; S. Dinca-Panaitescu et al., 2011). In this study, I conducted a secondary data analysis through the use of a correlational/cross-sectional design to investigate the presence of possible associations or relationships between the prevalence of T2DM and the abovementioned intertwined risk factors among ethnically diverse African immigrant populations in Ontario, Canada.

Purpose of the Study

This research study was a quantitative-based, cross-sectional/correlational study with the aim of examining the possible associations or relationships between the prevalence of T2DM (i.e., the dependent variable) and the level of income, acculturation, and the country of origin (i.e., the independent variables) in the presence or absence of the covariates. I targeted ethnically diverse African immigrant populations residing in Ontario, Canada who participated in the 2007–2014 Canadian Community Health Survey (CCHS) for this study. A representative sample was drawn from the primary data collected by Statistics Canada via the CCHS (Statistics Canada, 2012c). In this study, I aimed to clarify the associations or relationships of the aforementioned independent risk factors with the prevalence of T2DM along with the adjustment of the potential covariates that were assumed to be the confounding factors. The study covariates, which will be explained in more detail in Chapter 2, were the BRFs (i.e., obesity, physical inactivity, and diet/dietary habits); gender; age; and ethnicity.

Research Questions and Hypotheses

RQ1: What is the association/relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada?

$H_0$1a: There is no association/relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1a: There is an association/relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1b: There is no association/relationship between income and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1b: There is an association/relationship between income and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1c: There is no association/relationship between acculturation and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1c: There is an association/relationship between acculturation and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1d: There is no association/relationship between country of origin and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1d: There is an association/relationship between country of origin and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1e: There is no association/relationship between the covariates and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1e: There is an association/relationship between the covariates and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

RQ2: What is the association/relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada?

$H_0$2: There is no association/relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a2: There is an association/relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada.

RQ3: What is the association/relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario, Canada?

$H_0$3: There is no association/relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a3: There is an association/relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario, Canada.

In this study, I set the significance level for null hypothesis testing at 5% (0.05), which was the universally accepted level of significance. The null hypothesis failed to be rejected when the statistics were above the stated level of significance ($p > 0.05$), and this indicated that there were no associations or relationships between the risk factors and T2DM. On the other hand, the null hypothesis was rejected when the observed value of the statistics had been found as significant (i.e., when it was less than $p < 0.05$). During such time, the computed test results confirmed the presence of possible associations or relationships between the study risk factors and T2DM. In this study, I did not observe any Type I and Type II errors through the computing of these statistics in multivariable analyses.

Theoretical Framework for the Study

The theoretical framework employed in this study was based on the 2007 social determinants of health (SDH) conceptual framework proposed by the WHO Commission on Social Determinants of Health (CSDH; WHO, 2007). Per the core concepts of this framework, the economic status, the hierarchy in the society, and the social position determine the people's general conditions of where to live, grow, work, learn, and interact in the given community (CITE). This framework has also stated that the SDH affects the circumstances of their age, health status, and the ill-health vulnerability and

the intertwined consequences (CSDH, 2007). Taking in consideration of the principles of the SDH theoretical framework in this study, for example, income (as an indicator of SES) directly or indirectly affects the health of those target populations under study through the enabling of access to essential resources and health care services. In addition, income level is a function of a social environment and economic factors that influence the occurrences of various behaviors, social status, and changes in lifestyles within the society (Dasgupta et al., 2010; Office of Behavioral and Social Sciences Research, National Institutes of Health, 2012; Paskov et al., 2013). As the multiple facets of the SDH, the level of income, the acculturation, and the country of origin of the people profoundly influence how they should communicate, behave, and interact with individuals, societies, their environmental surroundings, and their neighbors. These influencing risk factors also determine the social ranks they occupy within the population and specific communities they live in together (Dasgupta et al., 2010; Health, 2001; Paskov et al., 2013). In doing so, such social influences, which I anticipated to sustain in the indicated sample immigrant populations who are affected by T2DM in this study, may also associated or related with the existing disparity in the level of income, level of acculturation, and country of origins of the immigrants and with the prevalence of T2DM (Dasgupta et al., 2010; Paskov et al., 2013).

To assess these overall conditions, I used the SDH theoretical framework as the leading guide in this research study. I chose this model because it explicitly enabled me to investigate the existing environment, encompassed all the characteristics of the contributing risk factors, and depicted their influences on the prevalence of T2DM much

better than other models. My other rationale for using the SDH conceptual model/theoretical framework in this study was based on the principle that the change in behavior was a function of socially interrelated factors, meaning that the existing context was a function of the interactions in the social environment. The level of income an individual or the society owns, the level of acculturation of the people, and their country of origins or the cultural/racial groups they belong to in the community reflected their social status (Health, 2001; Vermeesch & Stommel, 2014; WHO, 2013a).

Nature of the study

In this study, Icarried out a secondary data analysis employing a quantitative, cross-sectional/correlational design using primary data collected by Statistics Canada (2012c) through the CCHS. The dependent variable of interest in this study was the prevalence of T2DM, whereas the independent variables were income level, acculturation, and country of origin of the sample populations. The covariates were gender, age, ethnicity, and BRFs (i.e., obesity, physical activity, and diet/dietary habits). Based on the study premises, I extracted sociodemographic data and essential health-related information from the 2007–2014 CCHS microdata sets and analyzed them accordingly.

Definitions of Study Variables and Covariates

In this section, I will present the conceptual rather than the operational definitions of the independent variables, the dependent variable, and the covariates presented for further clarity. The operational definitions will be provided in Chapter 3. These

definitions are provided for simplicity and a basic understanding of the key terms repeatedly used in this study.

Country of origin: The geographical areas or nations where the sample immigrant populations originated from who had arrived from Africa to Ontario, Canada. In this study, the African region was used as a country of origin instead due to the sample size limitation and the fluctuations in the use of the country of births variable in the CCHS microdata sets during the indicated study periods.

Diabetes: Also known as diabetes mellitus (DM). A chronic metabolic disorder that often debilitates, and in some conditions become a fatal ailment, whereby a pancreas either fails to produce the required amount of insulin or the body is unable to use the available insulin delivered. This genetically and clinically abnormal condition of health, called hyperglycemia, indicates a high level of glucose amount in the blood that causes unprecedented permanent damage on some of the primary vital organs, nerves, and blood vessels. Insulin is needed to transport glucose into the cell for body energy requirements (American Diabetes Association (ADA), 2009; CDA, 2014).

Diet/dietary habits: The food type, patterns, and frequencies of energy food intake by those target immigrants. This term also indicates healthy diets (i.e., high intake of fruits, vegetables, and fish and reduced fat intake and salt consumption). I accessed diet/dietary habits related information from the CCHS microdata sets (Canada & Health Products and Food Branch (CHPFB), 2011; Earland, Campbell, & Srivastava, 2010; Rivellese et al., 2008; Shamsi, Shehab, AlNahash, AlMuhanadi, & Al-Nasir, 2013;

Siddiqui et al., 2010). For this study, the daily fruit juice consumption frequency was used to assess the possible associations or relationship with T2DM.

Immigrants: Those foreign-born individuals who were granted permanent residence or landed immigrant status in Canada. Immigrants also refer to those people who accept or decline to apply for a citizenship status granted by CIC (Chui & Statistics Canada, 2013). An immigrant can also be a person with a refugee claimant status or with a study or a work permit allowed to stay in Canada entirely for some time (Chui & Statistics Canada, 2013). For this study, the African immigrants residing in Ontario were used as the primary target population.

Income or level of income: The total annual earnings or the total revenue of the household under the indicated study periods. I used the total household income variable of best estimate for this study to assess the association or the relationship with T2DM. The income categories used by Statistics Canada were also employed in this study with some modifications to satisfy the sample size requirements required by each income categories as well (see Dinca-Panaitescu et al., 2011).

Obesity: One of the known independent BRFs of diabetes, cardiovascular diseases (CVDs), hypertension (i.e., high blood pressure), and some other ailments that reflects an abnormal medical condition that appears in those individuals having with a body mass index (BMI) of > 30 kg/m2. It is a state where an accumulation of excess deposition of fat in the body is beyond the person's average weight. There also exists another form of obesity called morbid or extreme obesity, which indicates an abnormal body weight with a BMI of 40 kg/m2 or more (American Heart Association [AHA], 2008; Hossain, Kawar,

& El Nahas, 2007; National Center for Health Statistics [NCHS], 2009; Oza-Frank & Narayan, 2010). For the purpose of this study, the self-reported BMI variable was employed as used in the CCHS.

Physical activity (PA): A general term that depicts an actual body movement of any type that can be aerobic (i.e., use of oxygen) or anaerobic (i.e., no need for oxygen). It can be performed with various intensities, which can be light, moderate, or vigorous, that brings about expenditures of a certain amount of calories of energy. Performing routine planned physical exercises (i.e., cardiovascular, weightlifting, weight loss, and muscle strengthening exercises) encourage any individual or group of people to maintain a healthy body and to execute life-activities of daily living (i.e., swimming, walking, playing tennis, gardening, lawn mowing, etc.). It also increases their participation in any form of task-oriented physical activities (i.e., racing, running, jogging, recreational games, swimming, sports, etc.) at any specific time or in leisure time as well (Canadian Society for Exercise Physiology (CSEP), 2014; Public Health Agency of Canada [PHAC], 2011).

To achieve and maintain a healthy lifestyle, according to the Canadian PA guidelines, adults between the ages of 18 to 64 years old should carry out PAs of aerobic type (i.e., aerobic PA having with various intensity) for a minimum of 150 minutes in a week (CSEP, 2014; PHAC, 2011). Of note, those people aged 65 years old or older were more expected to perform the same PA patterns as people 18 to 64 years old to improve balance and coordination as well as to avoid and prevent any incidents of falls (CSEP,

2014; PHAC, 2011). For this study, the leisure physical activity index variable was used to assess the possible associations or relationships with T2DM.

Time since immigration: In this study, this term signified the total length of time that had elapsed for African immigrants in their new areas of residence following their first arrivals to Western countries. For this study, the entire duration of time in years categorized an interval of 10 years due to the small sample sizes and the vetting rule restrictions of Statistics Canada.

Type 2 diabetes (T2DM) prevalence rate: The percentage of the total number of individuals with self-reported T2DM among the total sample population/target population under study. The number of individuals with T2DM was calculated from the self-reported type of diabetes variable used in the CCHS datasets by employing the logic function created by Statistics Canada for demarcation of the various types of diabetes (see Dinca-Panaitescu et al., 2011).

Significance of the Study

In this study, I assessed the possible associations or relationships between the level of income, acculturation, country of origin, and the prevalence of T2DM in the presence or absence of the covariates. Based on the study findings, core public health strategies that included the use of various public health programs, mainly focusing on prevention and cultural-based promotion approaches, were recommended to be implemented for Ontario residents including the target populations and general Canadians at large. These strategies included enhancing the knowledge and the understanding of the study populations on the influences of the study risk factors on T2DM, diabetes self-

management community programs, and increasing awareness on T2DM prevention and control. My recommendations also included core strategies like the promotion of healthy lifestyles that motivated the study populations to participate in leisure physical activities (e.g., walking programs), healthy eating and living educational sessions, and other public health programs focusing on the reduction of weight and obesity (see Cha et al., 2012; Xu, Pan, & Liu, 2011).

Given the increase in the understanding and awareness of the population, the public health system will have the opportunity to use the findings from this study to design culturally sound and ethnically acceptable programs. Furthermore, through the implementation of the recommended public health strategies, the results of this study will also have paramount importance in their contributions to bringing about a needs-based social change, not only to specifically indicated study population (i.e., the African immigrant populations residing in Ontario) but also to the general Canadian people.

Consideration of the needs of these immigrant populations could also influence policy decision-makers and the public health agency to initiate changes in the existing public health policy in Ontario and Canada. This agency is the responsible organization in Canada who is authorized to distribute resources for selective interventions or appropriate prevention and control programs geared to prevent diabetes, delay the progression, and reduce the existing prevalence of T2DM among these target and other immigrant populations in Canada (Caperchione, Kolt & Mummery, 2009; Creatore, 2013; S. Dinca-Panaitescu et al., 2011).

Delimitations

As I mentioned earlier in this chapter, the SDH theoretical framework was applied to guide this study. I based this study on the SDH framework to test the research questions and hypotheses to determine the presence of any possible relationship or associations between the independent variables and the dependent variable in the presence and absence of the covariates.

Assumptions

In this study, the core assumption was that the secondary data abstracted from the CCHS microdata were assumed to be normally distributed data fulfilling the parametric statistics test. However, due to the categorical nature of the study dependent variable (i.e., dummy variable), the initially set assumption of normality of the extracted data did not fulfill the parametric test as initially assumed. This study showed that the normal distribution assumption had been violated.

Also, the other assumption of the parametric test was the linearity of the data. This meant that the extracted secondary data were assumed to show linear relationship with the study dependent variable, T2DM. However, this assumption was violated and the data did not show any established linear relationship as assumed. In addition, the level of significance for the probability occurrences of Type I error was set at $p < 0.05$ and the power of the study also set at 0.80 (80%) along with a medium effect size of 0.20. These assumptions were not violated.

Limitations

The limitations that I anticipated in this study were mainly related to the specific nature of the cross-sectional research design that was employed in this study. This type of cross-sectional study design usually limits the power of the study to make inferences of causality and to provide evidence based interpretations on the causality of the independent variables on the dependent variable, the prevalence of T2DM (Creswell, 2009).

Another limitation I anticipated in this study was the use of data that were self-reported in nature and secondary in their sources. Secondary data analysis could lead to the possibility of the occurrences of a threat to the external validity and the introduction of unwanted biases. Reporting or recalling biases are types of informational biases that usually contaminate the internal validity and the quality of the outcomes of a research study (Delgado-Rodriguez, 2004).

I collected the required secondary data and information from CCHSs, which were conducted by Statistics Canada, and were mostly self-reported data. The respondents might have difficulty recalling their first diagnosis with T2DM, and they might have trouble remembering previous years. This condition might have also affect the validity of the data; so, I considered it to be one of the other limitations of this study.

The survey respondents during the census might have also failed to recall the occurrences of hypoglycemic events in the past. Since some of the participants had been diagnosed with diabetes previously, forgetting whether they had those events in the past might have also influenced the study and would create a recall bias as well.

Participants with diabetes might have also had an optimistic bias, a kind of bias where clinical patients perceive as if they would have a lower diabetic risk in developing complications (Delgado-Rodriguez, 2004; Klein, 2013). I will discuss the details of the limitations and the methods used to lessen their effects in greater detail in Chapter 3.

Summary

T2DM is known to affect the global populations, including Canadians. Several pieces of evidence have shown that T2DM is caused by the interactions of many complex knowns and unknown environmental, social, behavioral, biological, and individual risk factors (CITE). Of these influencing factors, I assessed the associations and relationships of BRFs, income, acculturation, and the country of origin with the prevalence of T2DM in this study.

I conducted a quantitative, cross-sectional study using a secondary data analysis guided by the SDH theoretical framework. As part of this study, I also conducted a literature review to identify current gaps in research evidence and knowledge about the above indicated risk factors. The understanding of the possible associations or relationships between the response and criterion variables as well as the individual and the combined effects of these risk factors on the prevalence of T2DM has not been sufficiently explored in the field and there was a lack of sufficient evidence on the ethnically diverse African immigrant populations residing in Ontario, Canada. The gaps that I identified through the literature review provided me with an additional venue to investigate the existence of the possible association and/or relationship of the study risk factors with T2DM.

With this study, I aimed to fill these gaps to enhance the understanding and awareness of the target population, enrich the existing knowledge and evidence, and strengthen the current professional practices. The findings from this study are also anticipated to improve public health strategies and influence changes in public health program designs and policies to satisfy the integration of the cultural factors and the considerations of the needs of these African immigrant populations residing in Ontario and to benefit other Canadians as well.

In this Chapter, I elucidated the merits of the use of SDH framework that guided this study and discussed the background, problem statement, purpose of the study, and the research questions and hypotheses. The chapter also included a discussion of the nature of the research, definitions of the study variables and the covariates at a conceptual level, the significance of the study, the delimitations, the assumptions, and the limitations of the research study.

In Chapter 2, I will discuss the previous research findings accumulated through my literature review of similar research areas and the gaps I identified from that. Chapter 3 will include a discussion of the research methodology, research design and rationale, data collections, and data analysis. In Chapter 4, I will present the results and the overall outcomes of the study. Finally, in Chapter 5, I will provide a discussion of the results, my interpretations, and the conclusion of the study.

Chapter 2: Literature Review

Introduction

Diabetes has been one of the major public health challenges affecting many populations around the globe (Agyemang et al., 2016; Anderson et al., 2016; Dinca-Panaitescu et al., 2011; Hill et al., 2013; Lin et al., 2013; Sherifali, 2012; Weber et al., 2012). T2DM is still been recognized as one of the primary disease outcomes attributed to intertwined behavioral, biological, genetical, environmental, psychosocial, and other complex risk factors that are dominantly affecting immigrants from developing countries, including Africans (Agyemang et al., 2016; Anderson et al., 2016; Creatore et al., 2010; Dinca-Panaitescu et al., 2011; Hill et al., 2013; Lin et al., 2013; Sherifali, 2012; Venkatesh et al., 2013; Weber et al., 2012; Zheng et al., 2012;).

Over the last 3 decades, the rapid increase in T2DM-related morbidity and mortality in various countries in the world, the increasing trends of changes in lifestyles, and the unexpected rapid increase in the prevalence of obesity in developing nations has motivated researchers to shift their focus towards the study of diabetes. The increase in global migration of at-risk individuals (e.g., T2DM susceptible African immigrant populations) to Western countries and the recent shift in trends in the prevalence of T2DM in developing countries has also aroused the interest of many researchers to carry out various types of population-based studies on T2DM (Agyemang et al., 2016; Creatore et al., 2010; Hicks, Rodriguez, & Lopez, 2012; Hossain et al., 2007; Lysy et al., 2013; Sherifali, 2012; Weber et al., 2012). The increase in the costs of diagnosing, treating, and managing T2DM and obesity has also prompted scholars to investigate the associations

or relationships between the attributable risk factors contributing to T2DM. Consequently, there has been an increase in the interest of many researchers in these areas, which was followed by the proliferation of various publications exploring such associations or relationships of multiple potential risk factors with T2DM in among numerous populations (Agyemang et al., 2016; Anderson et al., 2016; Hill et al., 2013; Lin et al., 2013; Lysy et al., 2013; Shaw et al., 2010; Sherifali, 2012 ; Venkatesh, et al., 2013).

Literature Search Strategy

In this literature review, I condensed the available empirical and quantitative evidence on the associations of BRFs, level of income, acculturation (i.e., time since immigration and language proficiencies), country of origin, and T2DM among ethnically diverse African immigrants residing in Ontario, Canada. To accomplish this, I accessed the Medline, Medline with Full Text, CINHAL, CINHAL with Medline, ProQuest, Psych Info, PubMed, and PubMed Central databases. EBSCO and Google Scholar were used as the core engines in searching for popular peer-reviewed articles, original research literature, and in discerning important additional grey literature (i.e., students' dissertation research, unpublished papers, proceedings from conferences, workshops, etc.). I accessed these databases through the Walden University Library.

I also searched other sources of information including Canadian government websites, the Public Health Agency of Canada, CDA, and other collaborative reference libraries. The principal keyword search terms I used for this literature review were *diabetes, Type I diabetes, Type II diabetes, T2DM, physical inactivity, physical activity,*

obesity, diet or dietary habits, sedentary lifestyles, acculturation (time since immigration and language proficiencies), country of origin, income, level of income, SES or socioeconomic status, diabetes in Africa, and *diabetes in Canada*. My literature search was focused on research studies published in the English language between 2000 and 2018. I intentionally started my literature search for sources published in the year 2000 to include some critical articles or publications necessary to this study and to maximize the search and mitigate the associated bias (e.g., bias related to publication materials).

Theoretical Foundation

The theoretical framework that I used in this study was based on the 2007 SDH theoretical framework proposed by the WHO CSDH (WHO, 2007). According to the concepts of this framework, level of income directly or indirectly affects the health of populations through maintaining social status and enabling access to essential resources and health care services (Agardh, 2011; Dasgupta, Khan, & Ross, 2010; Dinca-Panaitescu et al., 2011, 2012; Lee et al., 2011; Lysy et al., 2013; Smith, Matheson, Moineddin, & Glazier, 2007). Income is a function of a social environment factor influencing the occurrences of various psychosocial and health-related behaviors (CITE). Level of income, as the determining and enabling element of social status, also shapes the behaviors and lifestyles of individuals in society (Dasgupta et al., 2010; Dinca-Panaitescu et al., 2011; Health, 2001; Lysy et al., 2013; Office of Behavioral and Social Sciences Research, National Institutes of Health, 2012; Paskov, Gërxhani, & Werfhorst, 2013).

As one of the SDH, inequality in the level of income influences a person's social status and how people communicate, interact, and behave with other individuals (Dasgupta et al., 2010; Dinca-Panaitescu et al., 2011; Paskov et al., 2013). The BRFs, acculturation, and country of origin might be decisive factors that influence the prevalence of T2DM and interact with the existing disparity in gender, age, and level of income observed among these African immigrant populations (Dasgupta et al., 2010; Hossain et al., 2007; Paskov et al., 2013; Smith et al., 2007).

As such, the SDH was particularly appropriate to this study due to the principle that the change in behavior was a function of the interaction in the social environment that had also been influenced by the level of income an individual or group of people or the society owned (see Dasgupta et al., 2010; Paskov et al., 2013). As Marmot (2005) stated, the higher the social status, the healthier the individual occupants. The theoretical framework also indicated that the SDH was frequently linked with social gradients of health in health inequalities. Hence, this theoretical framework guided this study by providing a model through which to examine the underlying research questions and hypotheses to assess the possible existence of associations or relationships among the study risk factors of BRFs, age, gender, ethnicity, acculturation, country of origin, the level of income, and the prevalence of T2DM among ethnically diverse African immigrants in Ontario, Canada.

Literature Review Related to Key Variables

Country of Origin and T2DM

Several data from prior studies depicted that the country of origin played a determinant role in the prevalence of T2DM (Adhikari & Sanou, 2012; Herman & Zimmet, 2012; Spanakis & Golden, 2013). T2DM morbidity has disproportionately increased in the world and affected many low- and middle-income developing countries (CITE). For example, sub-Saharan Africans, Asian, African American, Latin American, Caribbean American, and other immigrants with non-European origins were disproportionately affected by the rise in the risk of T2DM as compared to the White people or people with European backgrounds (Agyemang et al., 2016; Abate, Chandalia, & et al., 2007; Adhikari & Sanou, 2012; Anderson et al., 2016; Beagley et al., 2014; Bennet et al., 2011; Guariguata et al., 2011; Herman & Zimmet, 2012; Rotermann, 2011; Shaw et al., 2010; Spanakis & Golden, 2013)

Even after controlling for the known covariates, the risk of T2DM was more than three times greater in South Asian immigrants and two times greater in immigrants from sub-Saharan Africa, Latin America, and the Caribbean as compared to those with European origins (Agyemang et al., 2016; Creatore et al., 2010). Based on their country of origin, immigrants might also be faced with various health-related challenges including health disparities to access health care services (Creatore et al., 2010; De Maio, 2010; Shah, Vittinghoff, Kandula, Srivastava, & Kanaya, 2015).

In recent studies, other researchers described that higher prevalence of T2DM and health disparities in diabetes and other chronic diseases were evident among immigrants

from developing countries, including those from Middle East and African immigrants (Bennet et al., 2011; Bennet, Agardh, & Lindblad, 2013; Grant & Retnakaran, 2012; Hicks et al., 2012; Prus, Tfaily, & Lin, 2010; Shah et al., 2015; Spanakis & Golden, 2013; Valore Project et al., 2013)

Immigrants who had been born in low- and middle-income developing countries also carried out a higher incidence of T2DM risks as compared to those who were born and resided in Western nations (Oza-Frank, 2013; Vermeesch & Stommel, 2014). For example, Latinas who had been born in Mexico showed a higher diabetes risk than other Latinas who had been born in the United States (Afable-Munsuz, 2013; Oza-Frank, 2013). Furthermore, the level of homogeneity of such disadvantaged groups of immigrants and the extent of variations in their country of origins also had a particular impact on their level of acculturation and on the prevalence of T2DM (Hicks, Rodriguez, & Lopez, 2012; Vermeesch & Stommel, 2014).

In line with this, African immigrants to Ontario also had remarkably vivid variations in their ethnicity and country of origin that conferred the presence of heterogeneity among these populations (IDF, 2013; Naidoo, 2014). Hence, the apparent absence of homogeneity among ethnically diversified African immigrants to Ontario and the relationships with the variations in the country of origin along with the higher risks of T2DM carried by such ethnic/racial minority groups of populations should significantly be assessed, clarified, or explored in depth. Therefore, I conducted this study intending to accomplish this task to explain the associations and/or relationships of the country of

origin and the prevalence of T2DM among the ethnically diversified African immigrant population residing in Ontario, Canada.

Acculturation and T2DM

Acculturation is defined as a dynamic and complex process comprising of several intertwined dimensions or proxies (Johnson-Agbakwu et al., 2016; Anderson et al., 2016). It is also a process by which newcomers (i.e., immigrants) quite often experience sociocultural and psychological changes and adopt the values, attitudes, behaviors, and the cultures of the people in the host countries where they arrived or preferred to live in as the new place of residences (Anderson et al., 2016; Johnson-Agbakwu et al., 2016; Mainous, Diaz, & Geesey, 2008; O'Brien et al., 2014; Rodriguez et al., 2012;). Acculturation has been reported to be one of the main risk factors attributed to diabetes disease management, self-reporting behaviors, and an increase in the prevalence of T2DM, a chronic clinical illness that affected the most disadvantaged ethnic/racial minority populations immigrated to affluent industrialized nations (Dasgupta, Khan, & Ross, 2010; Garduno-Diaz & Khokhar, 2012; Venkatesh et al., 2013;). Acculturation is also one of the predictors associated with a higher prevalence of T2DM among most culturally/racially diverse groups of immigrant populations studied so far, including Canadian Aboriginals (Anderson et al., 2016; Afable-Munsuz, Mayeda, Pérez-Stable, & Haan, 2013; Cha et al., 2012; Garcia et al., 2014; Kandula et al., 2008; Oza-Frank, Chan, Liu, Burke, & Kanaya, 2013; Rotermann, 2011; Vermeesch & Stommel, 2014).

Although acculturation indicated the level of adapting the person's own ethnic or racial specific culture with the new one in other portal countries, actually, there is no a

universally accepted measurement scale or an agreed upon a one-fit-for-all global measurement of acculturation scale about all immigrants to the developed countries. However, as mentioned in several prior research studies, time since immigration or the duration of time of residence in the host countries, language proficiencies, culture, diet/food preferences, as well as citizenship/nativity predictors, had frequently been utilized as the most proxy variables for representing and defining acculturation. These predictors individually or in combination used for creating an acculturation measurement scale that to be employed, based on the cultural/racial identities, for various groups of immigrants to the western countries (Anderson et al., 2016; Cha et al., 2012; Deng, Zhang, & Chan, 2013; Garcia et al., 2014; Hicks et al., 2012; Johnson-Agbakwu et al., 2016; Mainous et al., 2008; O'Brien et al., 2014; Venkatesh, & Weatherspoon, 2018; Rodriguez et al., 2012; Zheng, 2012).

In this study, the following two proxies were used to represent and measure acculturation level in the target populations. In doing so, along with the consideration of the contextual situations, the duration of time since migration to the new country of residence and the language proficiencies the immigrants adopting in their host countries were employed as the main proxies to be used for acculturation measurement (Cha et al., 2012; Dasgupta et al., 2010; Gee et al., 2004; Venkatesh et al., 2013).

Furthermore, for example, if the length of time since immigration considered as a proxy variable of acculturation, those foreign-born immigrants who were long-term residents of Canada and the United States reported a high prevalence of T2DM. Not only these residents, but those who identified themselves as individuals with culturally/racially

from non-European origins were also quite often reporting a high prevalence of T2DM as compared to Whites and those group of populations who had been born in Canada and in other industrialized countries as well (Anderson, 2016; Ford, Narayan, & Mehta, 2016; Hicks et al., 2012; Oza-Frank et al., 2011, 2013; Rotermann, 2011; Venkatesh et al., 2013; Zheng, 2012).

As aforementioned, when we had taken language proficiency as a measure of acculturation, and its influences in the risk of diabetes, Zheng et al. (2012) reported that those Tamil speaking Indians were at a higher risk for T2DM as compared to English speaking Indians residing in Singapore. They indicated that Tamil language speakers were found to be disadvantaged in accessing health services for T2DM in places where the English language was dominant. Language-related health disparities among these groups of populations observed as a leading factor in the indicated previous research.

Besides, Okrainec, Booth, Hollands, and Bell (2015) also reported in their study that higher complications of diabetes observed in those immigrants to Ontario Canada having with language barriers. Those less educated, unmarried, and older immigrants living in rural neighborhoods along with the prevailed language barriers were more likely to have diabetes complications and would be at higher risk of diabetes than those without English language barriers. Thus, as one of the main proxies to measure acculturation, language proficiency should profoundly be considered concerning its association or relationships with the prevalence of T2DM as well.

Contrarily, in few research studies, acculturation had been regarded as a positive influence among highly acculturated individuals and had shown a lower obesity rate and

a lower risk of T2DM as compared to the low acculturated groups of immigrant populations. For example, Canadian aboriginals had shown a lower risk of developing T2DM when they consumed traditional based diets and had participated in physical exercises using traditional based instruments or tools rather than using the technology-based physical activity tools. Some aboriginals (e.g., Oji-Cree) had also shown to have a lower risk of developing T2DM than non-performers when traditional-based physical activities indicated (Al-Dahir et al., 2013; Feuer, 2001; Venkatesh et al., 2013;). In addition, other conflicting previous study results showing that language acculturation did not associate with the risk of diabetes in among Mexican American population born in Mexico and who lived in the United States as opposed to those highly acculturated US born Mexican American populations who had shown a high prevalence of diabetes (Afable-Munsuz et al., 2013; Anderson et al., 2016; Garcia et al., 2012).

Given these conflicting findings, the researchers had suggested that the existing associations between acculturation and the prevalence of T2DM in the immigrants might be dependent on the nature of the populations besides to the specific circumstances and the social characteristics of the host country they lived in (Venkatesh et al., 2013). It might be related to the complex nature of acculturation that could not be explained by one or two proxy variables, or it might be due to other mediating factors affecting the relationship. It might also be due to the lack of a reliable and valid acculturation measurements scale that to be used explicitly for all immigrants to the western countries.

Though the two proxies mentioned above were being selected to measure acculturation in this study, there was no valid and reliable acculturation measurement

scale currently available individually for the African immigrants to the western countries as compared to other groups of Asian and Hispanic immigrants who were having their acculturation scales. It might be one of the main challenges, or knowledge gaps existed at present to explain the acculturation levels, in defining the acculturative process, and to measure its associations or relationships with T2DM in among ethnically diverse African immigrants residing in Ontario Canada. Hence, the current variations in acculturation and the non-existence of acculturation measurement scale warrant that further research studies were needed to clarify the association or the relationships of acculturation with the prevalence of T2DM in among ethnically diversified African immigrant populations residing in Ontario. This cross-sectional study was designed to fill this gap and to evaluate or assess the existence of possible associations or relationships between acculturation and the prevalence of T2DM in the target populations.

Income and T2DM

Association of diabetes (T2DM) and level of income had been documented to vary among countries with different level of income categories (Dinca-Panaitescu et al., 2011; Hosseinpoor et al., 2012; Lysy et al., 2013; McIntosh, Finès, Wilkins, & Wolfson, 2009). Income disparity affected T2DM-related mortality and morbidity or the prevalence of T2DM among immigrants to Canada, the United States and to other industrialized countries (Jarvandi, Yan, & Schootman, 2012; Roglic et al., 2005; Wilkinson & Pickett, 2009).

In prior studies, many researchers had also found that the elevation of T2DM prevalence associated with low level of income (Agardh et al., 2011; Creatore et al.,

2010; Dasgupta et al., 2010; Dinca-Panaitescu et al., 2011, 2012; Lee et al., 2011; Lysy et al., 2013; McIntosh et al., 2009). Additionally, Rabi et al., (2006) explained "Diabetes may be up to two times more prevalent in low-income populations as compared to wealthy populations" (*p*.2). The disparity in income level was found primarily in among immigrants from developing countries who were affected in one way, or another with behaviorally associated various complex risk factors (Creatore et al., 2010; Dinca-Panaitescu et al., 2011; Jarvandi, 2012).

Immigrants tended to dwell or settled more in areas with low-income neighborhoods than in high-income neighborhoods due to financial constraints and in search of their peers living in the surrounding cities, urban/ suburban areas (Glazier, Creatore, Cortinois, Agha, & Moineddin, 2004). In recent studies, the prevalence of diabetes in Canada was found to be high in ethnically diverse and low-income immigrant populations (Dinca-Panaitescu et al., 2011; Lysy et al., 2013; Stratton, Mowat, Wilkins, & Tjepkema, 2012). As per the healthy immigrant effect, most immigrants arrived being healthy; but, they did decline in the status of their health as they resided longer in the new host country (Garcia & Da, 2011; Gushulak et al., 2011; Newbold, 2009).

Moreover, immigrants with lower family income or categorized in lower individual income gradients had experienced higher morbidity of health-related problems and elevated level of disparity in life expectancy and mortality (Canadian Diabetes Association Clinical Practice Guidelines Expert Committee,2008; McIntosh et al., 2009; MESSAGES, 2008; Roglic et al., 2005; Tuei, Maiyoh, & Ha, 2010; Wilkinson & Pickett, 2009). Furthermore, the effects of the low level of income, its influence on many health

outcomes and its impact on developing T2DM, as well as experiencing social inequalities related to immigration also well documented. Such influencing effects of the level of income on health outcomes were reported in prior research findings as well to elucidate that the level of income had been more related to the differences observed in immigrant populations. These variations were based on differences in age, gender, ethnicity/race, and duration of residency (time since immigration) in western countries like Canada, United States, and other developed industrialized countries (Creatore et al., 2010; Muggah et al., 2012; Glazier, 2004; Gushulak et al., 2011; Pampalon, Hamel, & Gamache, 2010; Wilkinson & Pickett, 2009).

Although several studies had reported on the level of income and their associations with the prevalence of T2DM in other immigrants, there had been limited research studies conducted about the ethnically diversified African immigrants. These immigrant populations were experiencing apparent income disparities, and they were found to be living with T2DM as well (Dinca-Panaitescu et al., 2011; Lysy et al., 2013; Ross, Gilmour, & Dasgupta, n.d.; Stratton et al., 2012).

Conversely, few researchers had presented recent findings contrary to those mentioned above long established thought and evidence about the relationship, i.e., income negatively associated with the prevalence rate of T2DM. Hosseinpoor et al. (2012) described that in the lower income countries (LICs), "Diabetes prevalence was positively associated with wealth and education" (*pp*. 10 — 14). Their data had indicated T2DM was a disease of the wealthy people rather than the poor one in the lower income countries. They had also stated that this association varies in among the countries with

different levels of income and socioeconomic resources. Of note, this study had presented a conflicting research finding as opposed to many other previous research studies that had reported T2DM was a disease of the people with low-income rather than the wealthy one in the affluent industrialized nations.

However, Hosseinpoor et al. (2012) had also indicated some other possible explanations for the conflicting trends of their findings with the previous researches regarding T2DM. They stated that their results biased due to methodological issues or the people with T2DM from the low-income countries might be underdiagnosed due to limited access to health professionals. They also depicted that there might be an underestimation of the observed prevalence of T2DM in those study populations as opposed to the wealthy people who were living in those countries with limited income and resources (Acosta et al., 2010; Hosseinpoor et al., 2012).

On another thought, they had also indicated that their findings might be reflecting the intertwined relationship existed in among complex variables such as overweight, obesity, wealth, diabetes, physical inactivity, and other behavioral risk factors as well (Reddy, 2002). Regardless, the positive relationship of diabetes prevalence and level of income had also been reported in other studies in the Dominica Republic, a country with lower income as well (Acosta et al., 2010).

Thus, clarification of the conflicting research results and evaluation of the associations or the relationships of T2DM with the level of income in such specific target populations were very crucial to this study and would augment additional knowledge in science. Ignoring the influences of the level of income on the prevalence of T2DM in

among such ethnically diverse populations with the different country of origins might compromise the existing prevention intervention measures and the control efforts at large. Therefore, this study might clarify the associations and the relationships of the level of income with T2DM in among these target populations.

Obesity and T2DM

Currently, obesity and obesity-linked ailments had become a major and a growing concern of public health in many countries in the world, and it also recognized as the primary independent risk factor for being at risk to T2DM. The globally alarming increase in the prevalence of obesity especially, its occurrence as an epidemic in many developing and developed nations in the world had been well documented since the last four decades (Hasselbalch, 2010; Hossain et al., 2007; Lovasi, Hutson, Guerra, & Neckerman, 2009; Monda et al, 2008; Ogden et al., 2007; Qi & Cho, 2008; Samper-Ternent & Al Snih, 2012; Tran, Nair, Kuhle, Ohinmaa, & Veugelers, 2013; Xiao et al., 2013).

Over the past couple of decades, the changes in society, governmental policies, and environments were some of the significant contributors to the increased rate of obesity in the world. The existence of complex associations and interactions between the social environment, genes, physical activity, and diet had also been known to influence the development of obesity or overweight in many populations as well (Al-Haifi et al., 2013; Candeias, Armstrong, & Xuereb, 2010; Hossain et al., 2007; Monda et al., 2008; Ogden et al., 2007; Papas et al., 2007; Qi & Cho, 2008; Sallis & Glanz, 2009).

Obesity, in many countries similar to Canada and the United States, had been identified as one of the leading and most influential risk factor for the fastest increase in the incidence and prevalence of T2DM and CVD. It had also been documented in several prior research findings as one of the well-established risk factors to contribute to gender and ethnic-based disparities observed in T2DM prevalence especially in among various immigrant populations to western countries (Creatore et al., 2010; Hossain et al., 2007; Lipscombe & Hux, 2007; MESSAGES, 2008; Monda et al., 2008; Razak et al., 2005; Sallis & Glanz, 2009; Tuei, Maiyoh, & Ha, 2010; Ziraba et al., 2009)

In addition, several previous research literature also had concretely indicated that those obese study participants (with BMI score over 30 kg/m2), regardless of variations in BMI rating among both genders, were found to show a high prevalence of self-reported T2DM as compared to those individuals having with a BMI score of 25.0 through 29.9 for overweight and a <= 24.9 BMI score for the normal and underweight immigrant participants (Ade, Rohrer, & Rea, 2010; Agyemang et al., 2016; CDA, 2008; Mawaw et al., 2017; Ngoubene-Atioky & Williamson-Taylor, 2016; O'Brien et al., 2014; Staimez, Weber, Narayan, & Oza-Frank, 2013; Tuei, Maiyoh, & Ha, 2010; Ziraba et al., 2009)

BMI and other measures of obesity (e.g., self-reporting of obesity or overweight) also vary by ethnic groups and these differences might also attribute to the variations in the screening of people with actual obesity, overweight, and metabolic abnormalities associated with T2DM. A recent report had also indicated that obesity varied not only in gender or sexes, but also it differed in age and ethnic/racial groups in among women of

adult ages. Such variations in obesity that had contributed to the increase in the risks of developing T2DM in women were related to having strong associations and interactions with multiple & complex risk factors (Astrup, 2001; Ogden et al., 2007; Razak et al., 2005; Tjepkema, n.d.; Wilkinson & Pickett, 2009; Xiao et al., 2013). According to available robust evidence from longitudinal, cross-sectional, randomized controlled trials, and prospective studies, these complex risk factors influence the variations in the development of obesity in among Africans, Asians, and Hispanic immigrant populations. These variations in overweight or obesity levels were the results of the interactions of genes with the environment, the increased availability of high energy foods, the consumption of diets with high fat, continued adoption of sedentary lifestyles, and a reduced physical activities (Astrup, 2001; Lovasi et al., 2009; Ogden et al., 2007; Papas et al., 2007; Qi & Cho, 2008; Ziraba et al., 2009). Unfortunately, obesity and overweight had been one of the public health significant challenges observed within the lives of most Canadians including the target African immigrants to Ontario (Janssen, 2013; Tjepkema, 2005; Torrance, Hooper, & Reeder, 2002). The prevalence of obesity in Canada had dramatically increased over the last four decades. For that matter, this increase was remarkably observed in Canadians who were comprised of 36.1% overweight, estimated 9 million (Tjepkema, n.d.) and 26% obese (estimated 7 million) adults including the African immigrants and immigrants from other geographical regions of the world (Janssen, 2013; Roberts et al., 2012; Tran et al., 2013). The variations in the prevalence of obesity in Canada were also sustained on critical demographic characteristics including age, ethnicity/race, gender, geographical locations, SES (level of education and

income), country of origin, and places of residence (urban vs. rural) as well (Hasselbalch, 2010; Janssen, 2013; Monda et al., 2008; Roberts et al., 2012; Shields, Carroll, & Ogden, 2011; Tran et al., 2013).

Moreover, almost a third of the adult Canadian population was believed to be at an elevated risk for chronic diseases, functional disability, and unexpected early death due to obesity (Shields et al., 2011; Starky, 2005; Tran et al., 2013). The estimated obesity prevalence in Ontario increased from 20 to 24% in 2003 through 25 to 29% in 2011(Health Council of Canada, 2013). Also, more than 50 % of adults and approximately 20 % of youths residing in Ontario Canada significantly identified as overweight (Queens Printer for Ontario, 2012). Such unprecedented condition of overweight or obesity had been a scary event, which was given due attention by the Ontario government towards focusing on prevention and management of overweight and obesity to mitigate the prevalence of T2DM in the province as well.

Given the global increases in obesity rate and T2DM, the influences of obesity on the prevalence of T2DM, the existence of ethnically diverse and susceptible African immigrant populations in Ontario Canada should be given considerable attention by researchers and public health policy and decision-makers. Besides the above, the rapid appearance of changes in sedentary lifestyles of the people, the sustained age and gender-based disparities in obesity, the increase in the costs of treating and managing excess weight and obesity needed special attention. Specifically, this existing condition of obesity inquired further clarification in its associations or relationships with the prevalence of T2DM. Hence, acknowledging the above indicated conspicuous realities of

obesity, observing the actual variations in obesity, and clarifying its relationship with the increase in the prevalence of T2DM among such groups of African immigrant populations should have paramount importance to the present study.

Physical Activity and T2DM

Physical activity was a well-known modifiable risk factor that had an inverse association with the prevalence of T2DM and with other chronic illnesses or diseases (Gill & Cooper, 2008; Juneau & Potvin, 2010; Liu, Wade, Faught, & Hay, 2008; Lovasi et al., 2009; Monda et al., 2008). Physical activity lifestyle behavior had also varied from among various immigrants and ethnic/ racial groups of populations (Juneau & Potvin, 2010; Liu et al., 2008; Monda et al., 2008; Qi, Hu, & Hu, 2008).

Quite often, physical activity had been a significant risk factor in preventing T2DM when carried out on a regular pattern. It had substantial and satisfactory contributions to the reduction of risks that predisposed to T2DM in specific groups of populations (Gill & Cooper, 2008; Liu et al., 2008). For example, high or moderate levels of physical fitness or physical activity for a minimum of 30 minutes per day combined with lifestyle changes including diet or dietary habits had been shown to have a beneficial effect in health. Modification of nutrition and physical activities could have essential roles in preventing the progression of risks to T2DM & metabolic syndromes (Anderssen, Carroll, Urdal, & Holme, 2007; Gill & Cooper, 2008; Hu, Lakka, Kilpeläinen, & Tuomilehto, 007; Hu, Rico-Sanz, Lakka, & Tuomilehto, 2006;Lovasi et al., 2009; Qi et al., 2008).

In another example, Qi et al., (2008) had shown that regular physical activity during an occupation, commuting, leisure time exercises or daily life activity reduces the risk of T2DM by 15-60%. They also reported that lifestyle interventions, including counseling for physical activity, nutrition, and body weight could also reduce the risk of T2DM by 40-60% among adults with impaired glucose tolerance and by about 20% among the populations.

As Qi et al.(2008) also indicated, most prior researchers agreed on the benefits that physical activities or physical activities along with lifestyle changes including diet conferred additional advantages on lessening the risks of T2DM. Some of these advantages include reducing the progression of T2DM, preventing further risks and the risks of developing T2DM, as well as reducing the chances of acquiring T2DM-related illnesses (Gill & Cooper, 2008; Hu et al., 2007; Liu et al., 2008; Monda et al., 2008).Moreover, Guerin, Diiriye, Corrigan, and Guerin, B (2003) reported that regularly maintained PA contributed to the social, mental, and physical wellbeing of the individual health; and also, it did add to the community and the society as well. Hence, encouraging or promoting PA in such diverse African immigrants would provide more benefits than the health effects of physical inactivity (Cleland et al., 2010; Guerin et al., 2003).

However, some variations in thoughts among researchers on some crucial points related to PA observed. These variations based on the duration of time and the level of intensity (light, moderate, and high) of the PA needed to achieve a reduction in the prevalence of T2DM. Whether the mostly agreed-upon duration of time (30 minutes/day or 150 minutes/week) was safe and effective to be implemented in across all populations

had not been concluded. It needed further exploration in this regard along with the additional thought whether individual activity or a combination of PA with other behavioral risk factors had benefited the African immigrant populations in Ontario (Gill & Cooper, 2008; Kriska, 2000; Lee et al., 2005; Ross, Freeman, & Janssen, 2000;).

For example, Gill and Cooper (2008) opposed in having a One-size-fit-all (para. 1) approach in implementing guidelines or in designing physical activity programs aiming to reduce the risks of T2DM in among various ethnic immigrant groups. They described that such population-based T2DM geared according to the level of risks of the disease the individual ethnic groups (those individuals with the history of diabetic families, obesity, etc.) had had at their baseline measures to achieve success in management and reduction of T2DM in that specific population. In addition, Lee et al. (2012), Gill & Cooper (2008), Renzaho et al. (2010), and Hu et al. (2007) elucidated that if aimed to achieve satisfactory outcomes in reducing the risks of T2DM and obesity, a 150 mins/week or a 30 mins/day strategy of a PA program needed to be strictly followed. They also stated that, in doing so, those high-risk and susceptible ethnic or racial groups would benefit more from diabetes and obesity prevention programs than the low-risk groups.

In contrast, Kriska (2000) argued that such a reduction in the risks of developing T2DM and obesity would be substantial if there had been a long-term commitment from the target audiences with increasing and persistently partook in a highest or moderate level of physical activities. Such obligations and conditions quite often were not practical when we had considered the reality of most immigrants in Canada, and it remains to be a

challenge because of low compliance in their participation in PA programs. For example, in specific groups of Asians (e.g., Chinese, Asian Indians or South Asians) as compared to other ethnics in Asia, lifestyle-based interventions were more successful in diabetes prevention than other control and prevention measures (MESSAGES, 2008; Weber, Oza-Frank, Staimez, Ali, & Venkat Narayan, 2012).

Furthermore, the use of different types of interventions in these specific population groups might impair the prevention or control efforts managed by public health professionals, policy decision-makers, governmental agencies, stakeholders, and health care providers. Also, it poses significant influences on existing clinical and public health practices in relation to diagnosis, therapy, and treatment of T2DM provided to these groups of immigrant people in Canada (CDA, 2008; Creatore et al., 2010; Tuei, Maiyoh, & Ha, 2010; Weber et al., 2012). Thus, attention significantly needed on selecting the appropriate interventions which should be based on the needs of the target audience to mitigate the effects of the physical inactivity influencing the health of this target immigrant populations living with T2DM.

In Canada, walking is a public physical activity for most adults without any differences in the level of income, BMI, gender, and age groups (Bryan & Katzmarzyk, 2009). Even though walking had been popular among adult Canadians, however, only about 30% of the people actively involved in the physical activity through having regularly scheduled walking programs in contrast to 70 % of the population walked once over three months (Bryan & Katzmarzyk, 2009).

Physical inactivity had been remained a challenge in among women immigrants of various ethnic & racial groups residing in Canada (Bryan, Tremblay, Pérez, Ardern, & Katzmarzyk, 2006; Cleland et al., 2010; Mansfield, Ducharme, & Koski, 2012). The reduced PA level among these immigrant women mainly associated with lack of self-efficacy/knowledge, cultural factors, lack of support for caring their children, lack of time, and low interest or motivation to participate in the PA program. Not only the above impending factors, but also the lack of social encouragement, living in neighborhoods with low-income, and residing in communities with low walkable areas additionally contributed for the reduced participation in PA among women African immigrants and others (Booth et al., 2013; Bryan & Katzmarzyk, 2009; Cleland et al., 2010; Liu et al., 2008; Maier, Ozel, Wagnerberger, Bischoff, & Bergheim, 2013).

Surprisingly, in Canada, the walking patterns and regularity, as well as the prevalence of physically active individuals, also varied. These variations had been observed in among ethnic & some other social subgroups linked with the conditions associated with the neighborhoods walking environments (Booth et al., 2013; Maier et al., 2013). The recent research findings from CCHS, on self-reported PA level (leisure time PA level), conferred the existence of such variations in walking patterns and regularity of PA among the Canadian populations including the study target African immigrants (Bryan & Katzmarzyk, 2009; Bryan et al., 2006; Monda et al., 2008).

In general, several findings indicated that majority of Canadians did not meet the expected physical activity level and instead they continued to live more sedentary lifestyles which would be challenging to the public health system in the years to come

(Bryan et al., 2006; Bryan & Katzmarzyk, 2009; Juneau & Potvin, 2010; Liu et al., 2008; Monda et al., 2008). Due to various impending factors on PA, achieving high compliance and obtaining a regular pattern with a long-time commitment by most immigrants would be one of the core barriers or the main challenges to maintain and keep up with the expected level of PA in Canada. Especially, achieving such compliance on PA would be very challenging for many of the ethnically diverse African immigrants residing in Ontario who experienced various constraints, ups, and downs including financial problems, and who were struggling to live and accommodating with different cultures and norms as well.

Also, it would be challenging, in the fact that, these immigrants had had various needs of soliciting financial and social supports to settle & survive in their new living areas before attending in such an active and patterned physical activity programs (Mansfield et al., 2012). Quantifying the prevalence of regular PA, identifying the types of PA preferred by these specific populations, and determining the required amount of physical activities to be exercised or performed in leisure time inquired a well-designed approach.

In addition to the above, understanding of the indicated immigrants' country of origins, their degree of acculturations, and searching for appropriate methods to reach these target populations also needed more focus and inquired a thoughtful professional approach to achieve the intended objectives in the level of PA. Designing and maintaining culturally-based PA programs with the intention of reducing the risks of T2DM as well as preventing the progression of the disease in among these populations

were very timely and crucial for public health programs. Hence, this study would seek to address the existing gaps in knowledge, practice, and scientific data concerning leisure time PA and T2DM. To achieve the reduction in the prevalence of T2DM and in designing culturally based public health programs as well as to motivate, promote, and maintain PA programs in among these ethnically diverse African immigrant populations, the needs and availability of such scientific study and data were very crucial.

Diet/Dietary Habits and T2DM

Physical inactivity and Unhealthy diets were the well-established influencing behavioral risk factors for most of the known noncommunicable diseases such as obesity, diabetes especially T2DM, cancer, stroke, chronic respiratory diseases, and CVDs. These ailments were identified as the leading causes accounting for 60% of all mortalities in the world (Candeias, Armstrong, & Xuereb, 2010; Lovasi et al., 2009). As per WHO (2013) fact sheet reports on diabetes, "Healthy diet, regular physical activity, maintaining normal body weight, and avoiding tobacco use can prevent or delay the onset of Type 2 diabetes" (para. 1).

A healthy diet had also been known to correlate with a reduction in obesity and obesity-linked ailments such as T2DM, CVD, and other related chronic illnesses as observed in many ethnic groups of populations in the world (Lovasi et al., 2009; WHO, 2013). Many previous and recent research findings also indicated that the rate of obesity prevalence increased mainly due to changes in the total food system in the globe along with local environments through promotion of processed and cost friendly marketable

food more often than before (Holmboe-Ottesen & Wandel, 2012; Kourlaba et al., 2008; Popkin, 2006; Swinburn et al., 2011).

At present, a global shift in the diet and dietary behaviors observed through moving universally from a decreased intake of dietary fibers to a higher consumption rate of animal products. Not only this, but an increase in the use of partially processed hydrogenated fat accompanied by increased urbanization and access to foods due to a dramatic decrease in prices of foods had also affected the dietary habits or behavior. Along with the use of the above-indicated diet, the patterns of PA (PA at leisure time, work, home and travel) were also reported to shifting in a fastest pace towards a sedentary lifestyle and a decreased level of energy expenditures which led to the increase in the prevalence of T2DM (Holmboe-Ottesen et al., 2012).

Of note, all these intertwined complex risk factors were found to be prevailing that would affect the diet and dietary habits and the apparent health of the immigrant populations to western countries (Chiu et al., 2011; Holmboe-Ottesen et al., 2012; Hu, 2011; Popkin, 2006). In addition, as prior research studies had reported, the majority of the immigrants from developing countries were more susceptible to the new host environments (i.e., adaptation to western-lifestyles) and easily being exposed to energy-dense, high sugar, high fat, high salt, and unstandardized low-cost foods (Candeias et al., 2010; Popkin, 2006; Shetty & Schmidhuber, 2011). Furthermore, frequent exposures to unhealthy dietary patterns, energy imbalances, and unhealthy diet accompanied by financial constraints, as well as an elevated rate of physical inactivity, and an increasingly sedentary lifestyle behavior had been reported to have a negative influence on the overall

life of immigrants. These diet-related influencing factors contributed to the increase in the prevalence rate of obesity and T2DM in majority of the immigrant people from the middle and low-income countries (Candeias et al., 2010; Galesloot, McIntrye, Fento, & Tyminski, 2012; Holmboe-Ottesen et al., 2012; Hu, 2011; Popkin, 2006; Shetty & Schmidhuber, 2011). For example, Arabs, Chinese, African, and South Asian immigrants who recently immigrated to Ontario, especially women with their origins from the above ethnic groups, were at increased risk for the development of T2DM. Due to the above diet-related risk factors, immigrants became susceptible to T2DM in short period as compared to those long-time inhabitants of Ontario (Creatore et al., 2010; Chiu, Austin, Manuel, Shah, & Tu, 2011; Galesloot et al., 2012).

It also reported that the majority of immigrants were known to eat healthy diets and were arriving to host western countries in good health. Though, depicted in several prior research studies that the health of immigrants dramatically changed in few years of residing in their new host countries, due to several intertwined complex factors including their diets and dietary habits, dietary pattern among immigrants was not given due attention globally (Astrup et al., 2008; Austin et al., 2011; Creatore et al., 2013; Galesloot et al., 2012; Hyman, Guruge, akarchuk, Cameron, & Micevski, 2002; Merchant et al., 2009; Sallis & Glanz, 2009). Thus, this study would attempt to show the possible associations or relationships of diet/dietary habits and T2DM. It would also address the existing gaps in consideration of the dietary patterns and culturally appropriate diet preferences along with the culture-based nutritional practices of the African immigrant populations residing in Ontario. The results from this study would enhance the

effectiveness of the public health policy and enforce the public health agency of Canada to pay attention to the diet, and dietary patterns of these immigrant populations to curbing down the increase in the prevalence of T2DM observed in Ontario and Canada as well.

Other Known Covariates

Age. Age was one of the covariates included in this study. Several prior studies indicated that the risk of T2DM increased with age. Older adult populations were found to be at a higher risk for T2DM than the younger and middle age groups (Inoue, M., Inoue, K., & Akimoto, 2012; Yang et al., 2016). In this regard, the relationships or associations of Age and the prevalence of T2DM would be assessed in among the ethnically diverse African immigrant population residing in Ontario.

Gender. Gender was one of the covariates considered in this study. In doing so, gender variations in the prevalence of T2DM reported in various prior research studies. Based on the existed gender variations, previous research findings depicted that females from low-income status were more likely to be at a higher risk of T2DM than males who were with the same SES, e.g., income status (Ross, Gilmour, & Dasgupta, 2010; Yang et al., 2016).

On the other hand, in contrary to the findings from the previous results reported by Ross et al, (2010) and Yang et al., (2016), variation in the prevalence of T2DM was seen between both genders and it indicated that males did show a higher prevalence of T2DM as compared to females. A recent study was elucidating that due to a shift in lifestyle (e.g., a sedentary lifestyle seen in males), the prevalence of T2DM had recently been reported more in men rather than in women (Asaduzzaman et al., 2018, Færch,

2014). Thus, men had been found to be more at risk of T2DM than women in current evidence. This study would also clarify the associations or relationships of gender, as a covariate, with T2DM and also assess the gender variations in the prevalence of T2DM as well.

Ethnicity. Ethnicity had been one of the covariates studied in this dissertation research. In several prior research findings, it had been reported that there exist variations in the prevalence of T2DM among various ethnic minority groups including the sample African immigrants residing in Ontario Canada as well (Andersen, 2015; Bennet et al., 2014; Jenum et al., 2012; Meeks et al., 2016; Tzur et al., 2012). Blacks and Latinos did also experience the most socioeconomic disadvantage as compared to the Asian immigrants and the non-Hispanic Whites (Alang, McCreedy, & McAlpine, 2015; Mohan, Seedat, & Pradeepa, 2013; Yi et al., 2014). Ford, Narayan, and Mehta (2016) and Meeks et al. (2016) also reported that Blacks racial/ethnic population and South Asians/ Indians (Gray, 2010; Garduño-Diaz & Khokhar, 2012; Weber et al., 2012a) experienced the highest diabetes burdens as compared to other ethnic minority groups (Abate, Chandalia, & et al., 2007; Adhikari & Sanou, 2012). Thus, this study designed to examine or assess the associations or relationships of ethnicity, as a covariate, and the prevalence of T2DM in among the study populations.

Summary and Conclusions

Age and gender-based disparity in the level of income, the degree of acculturation, gender, as well as the variations in the country of origins along with BRFs reported to affect T2DM related morbidity or the prevalence of T2DM in among diverse

African immigrants to industrialized countries (Dasgupta et al., 2010). In the various prior research literatures, the increase in risks and elevated prevalence rate of T2DM had been reported to associate with varied level of income, the degree of acculturation, BRFs, and the country of origins of immigrants to wealthy industrialized nations.

Moreover, obesity and obesity-linked ailments, the extent of acculturation, and its relationship with the increase in T2DM had also become the dominant and growing concerns of public health in many countries in the world. Obesity already recognized as the leading independent risk factor for being at risk in developing T2DM. Understanding the influences of obesity on T2DM, the decrease in PAs, the increase in sedentary lifestyles, and changes in diet & dietary habits, variations in acculturation and country of origins in target population would help to curb down the observed prevalence of T2DM in Ontario and Canada as well.

In Canada, walking had been a public physical activity for most adults without any differences in the level of income, BMI, gender, and age groups. Even though this physical activity was favorite in among adult Canadians, physical inactivity had been a challenging issue in immigrants of various ethnic & racial groups residing in Canada. Therefore, quantifying the prevalence of cultural-based regular PA, assessing and identifying the types of PA preferred by these specific populations, and determining the required amount of physical activities to be exercised in leisure time, and searching for appropriate methods to maintaining the PA was very crucial.

Therefore, the rapid appearance of changes in the lifestyles, a persistent global shift in the diet and dietary behavior, accompanied by increased urbanization and access

to foods as well as the difference in the patterns of behavior towards decreased PA remained to be the chronic problems in Canada. Also, the increase in the costs of treating and managing of excess weight & obesity, the sustained age and gender-based disparities in the level of income, obesity, and T2DM among immigrants and Canadians should not be overlooked unresolved. Observing the underlying causes of the variations in those attributable-risk factors and their sustained associations or relationships with the prevalence of T2DM was very crucial for this study. This study was carried out to explore and clarify the relationships of acculturation, country of origin, and level of income and the covariates with the prevalence of T2DM in African immigrants residing in Ontario. At last, based upon the study findings, their needs would be identified; possible changes in public health strategies and policies would be recommended to consider and integrate the needs of the people to attain a possible decrease in the prevalence of T2DM in African Immigrants residing in Ontario and in all other Canadians too. In next chapter, chapter 3, I will be discussing about the details of the research method that includes the methodology, research design and rationale, research question(s) and hypotheses, dataset and data sources, sampling and sampling procedures, data analysis plan, threats to validity, limitations, ethical procedures and the executive summary.

Chapter 3: Research Method

Introduction

In Chapter 3, I will also discuss the methodology, target populations, study sites, sample and the recruitment approach employed, and the components of the various variables (i.e., dependent and independent variables as well as the covariates) that will be explored in this study. This section will also include the accessibility of the datasets or data sources (i.e., access to the CCHS primary data), the operationalization of the study risk factors, and the instrumentation that will be used in this quantitative, cross-sectional/correlational study. In this chapter, I will also attempt to explain the procedures for the selection of participants (i.e., inclusion and exclusion criteria), extraction of secondary data, conducting data analysis, the ethical issues addressed, and the various validity threats considered in this quantitative research study. In this study, I aimed to investigate and clarify the possible relationships or associations that existed between the income level, acculturation, country of origin, and the prevalence of T2DM along with the covariates (i.e., BRFs, age, gender, and ethnicity) in African immigrant populations who were the residents of Ontario and participated in the 2007–2014 CCHS.

Research Design and Rationale

In this study, level of income, acculturation, and country of origin were the independent variables, whereas T2DM was the dependent variable. I also considered some prospective confounding factors, such as age; sex/gender ethnicity; and BRFs (i.e., obesity, physical inactivity lifestyle, and diet/dietary habits), as the essential demographic covariates investigated at present study.

In this study, I aimed to use primary data that had been collected by Statistics Canada, through the 2007–2014 CCHS from Canadian populations (Statistics Canada, 2012c). In doing so, I used a quantitative study approach as the preferred research methodology to satisfy the evaluation or assessment of the possible associations or relationships of the influencing variables with the prevalence of T2DM. The quantitative, cross-sectional design employed in this study provided the venue for the appropriate statistical and numerical analysis. This design was the proper tool for data extraction and abstraction, statistical data analysis, in making logical predictions and evidence-based inferences, and for interpretation of the final results about the possible associations or relationships that existed among the different variables of interest (see Creswell, 2009; Hopkins, 2000).

Research question(s) and hypotheses

RQ1: What is the association or relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada?

$H_0$1a: There is no association or relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1a: There is an association or relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1b: There is no association or relationship between income and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1b: There is an association or relationship between income and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1c: There is no association or relationship between acculturation and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1c: There is an association or relationship between acculturation and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1d: There is no association or relationship between country of origin and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1d: There is an association or relationship between country of origin and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

$H_0$1e: There is no association or relationship between the covariates and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a1e: There is an association or relationship between the covariates and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada.

RQ2: What is the association or relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada?

$H_0$2: There is no association or relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a2: There is an association or relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada.

RQ3: What is the association or relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario, Canada?

$H_0$3: There is no association or relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario, Canada.

H_a3: There is an association or relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in

ethnically diverse African immigrant populations residing in Ontario, Canada.

As mentioned earlier in this section, instead of qualitative, I used a quantitative methodology as the primary approach in this study. A quantitative inquiry is a closed-ended study that has been used to test the research questions and hypotheses; theories; assumptions; raw data organization and management (i.e., collection, analysis, and interpretations) for statistics and numbers with known variables as compared to the qualitative ones. Why I didn't select the qualitative study? This is because, the characteristics of a qualitative study are exploratory, open-ended, and mostly applied with unknown variables to test new ideas or phenomenon which has not been established or explored previously (Creswell, 2009).

In this study, I employed the postpositive (or post positivism) philosophical worldview as the central epistemological worldview to guide this quantitative study through the use of the SDH theoretical framework. Postpositive or post positivism holds multiple characteristics of philosophy serving as both deterministic and reductionist in nature (CITE). This worldview is used to elucidate what causes the determining factor to bring about the observed effects, results, or intended outcomes (Creswell, 2009). In the case of this study, the deterministic nature of postpositivism assumes that the income level, degree of acculturation, country of origin, and covariates determine the prevalence of T2DM in such specific ethnically diverse African immigrants residing in Ontario. As a reductionist philosophy, post positivism also assumes that the central concept of the study will be broken down or reduced into various variables to build up research questions and

hypotheses to test the already identified theoretical lens that directs or guides this research study, which in this case, was the SDH theoretical framework (see Creswell, 2009). Instead of the deterministic philosophical view, I implemented the reductionist view to test the research questions and hypotheses in this study.

Recently, through the application of various research designs, including cross-sectional studies, many researchers have started employing the use of nationally collected aggregated data on the study variables mentioned above to address the gaps in research and knowledge about the management of various chronic diseases and their outcomes in different groups of populations. Alaszewski (2007) indicated that to fill gaps in knowledge or to get answers to research questions, researchers should go further beyond experimental studies and the collection of primary data and should also consider the merits of using a representative sample of secondary data from trusted sources. In this quantitative study, I chose a secondary data analysis as the appropriate venue to test the research questions and hypotheses.

Dataset and Data Sources

Several researchers have indicated that secondary data could be collected through conducting interviews and population survey using a predetermined questionnaire (CITE). Researchers have reported the importance of secondary data as accepted and invaluable to most observational research studies, like cross-sectional studies (Rotermann, 2011; Statistics Canada, 2013a). For example, with the 2007–2014 CCHS datasets, I was able to use the vast volume of primary data collected through those surveys. These data were used as the primary sources of data with which I conducted a

secondary data analysis in this study and could also be exploited, with permission from Statistics Canada, for future similar research as well.

The CCHS datasets are primary sources of secondary data frequently accessed by researchers, social service governmental agencies, medical and public health professionals, policy decision-makers, academia, and health care planners. It is also a source of information for several media, nonprofit and charitable organizations, and others in Canada due its prosperous and richness in information as well as its representativeness of the existing multiethnic Canadian populations. The CCHS data have been representative for many years because it is always collected from a randomly selected sample of the general Canadian people (Statistics Canada, 2013a).

CCHS is conducted to obtain primary data directly from respondents through employing a well-designed questionnaire along with the use of a computer-assisted interviewing (CAI; Statistics Canada, 2014a). CAI is described "as the questions were developed, the associated logical flow into and out of the questions was programmed" (para. 3). Of note, my primary rationale for selecting the CCHS datasets for this study was based on the nature and characteristics of the CCHS data. They are enormously enriched and organized as aggregated data and information that can be used for secondary data analysis at any point in time. These CCHS datasets also contained invaluable information and essential data on most of the study variables (i.e., the BRFs [obesity, physical inactivity, and diet/dietary habits]; level of income; SES; time since immigration and language proficiency [i.e., acculturation]; ethnicity; country of origin; immigrant status; cultural/racial backgrounds; socio-demographic information; and other

important health-related information which were decisive to the current dissertation study; see Statistics Canada, 2014a).

Utilizing secondary data has several benefits and associated risks in cross-sectional study design. Some of the known benefits are:

As the data collected through the CCHS are a nationally representative data, the findings from these surveys can easily be extrapolated or generalized into the larger Canadian populations. The primary data collected through these surveys confer advantages on providing the general picture of self-reported diabetes & types of diabetes, the burden of T2DM, and help to design the appropriate strategies that to be followed to handle or manage the disease in the directions as advised by medical/public health professionals (Cengage Learning Inc., 2014; Institute for Work & Health, 2008; PHAC, 2011).

The availability of such secondary data pool, in a short time organized in the form of aggregated datasets, also enables the researchers to proceed with their studies without taking undue longer time. Besides, they may serve as a data pool for selecting large sample populations for conducting other similar cross-sectional studies with minimal barriers or challenges.

Moreover, the validity and reliability of the study may also be enhanced due to the utilization of large volume of such a data pool which increases the value and quality of the proposed research study the investigator initially designed to proceed with (Cengage Learning Inc., 2014; Institute for Work & Health, 2008).

Time and cost can be minimized as compared to conducting a separate individual research study intended to collect a specific primary data which can take more resources and time than abstracting the secondary data, which are usually obtained from samples through nationally representative surveys.

For example, collecting secondary data eliminates some challenges of the research activities and workloads on the:

- selection of the required sample sizes, and on identifying the appropriate sampling procedures,
- overall time needed to carry on a primary data collection, and
- processing of such a vast aggregated datasets that usually takes more time and costs as well (Cengage Learning Inc., 2014; Institute for Work & Health, 2008).

Aggregated data may be helpful in increasing the efficiency of the research study due to the availability of more variables and a large volume of datasets collected from several cross-sectional studies at a national level for such a research purpose (Institute for Work & Health, 2008). Secondary data may also be very beneficial at certain times or in a situation when data collections cannot be possible with the use of direct means, i.e., when obstacles to collect primary data have sustained and cannot be resolved in a short time (Cengage Learning Inc., 2014).

Though secondary data are beneficial, there are also some inherent risks associated with the use of it (Cengage Learning Inc., 2014; Institute for Work & Health, 2008). These include:

The primary data source considered for extracting the secondary data may have many errors, missing data or contain insufficient & incorrect information and may also have incomplete data; hence, the quality of the data should be cross-checked. Sometimes the population may not be ideal enough to draw the required sample population for the intended study. Use of secondary data has little control by the principal investigator on the data type and know-how of data collection methods, and most importantly, it has not been intended to satisfy the needs of the current researcher who carries on the secondary data analysis. Not timely and may be outdated; so, it needs wise and appropriate decision to utilize it for study in the present time.

Thus, secondary data analysis inquires extra effort on the part of the researcher to assess the accuracy, the timeliness, and the validity of the data, examine the data for possible bias and cross-checks whether it satisfies the need of the current ongoing study. The researcher is also expected to check for the measurement units and possible confounders that should be appropriately identified and measured accordingly before the start and during the time of the study (Cengage Learning Inc., 2014; Grady, Cummings, & Hulley, n.d.; Institute for Work & Health, 2008).

Methodology

Population

As indicated in the previous chapters, the intended target populations focused under this study were the ethnically diverse African immigrants in Canada. Then, to select the final study/sample population, the above-indicated target populations were furtherly screened according to specific inclusion criteria, i.e., adults with the age of 15

years & above and who were participating in the CCHS from Ontario Canada between the periods from 2007 through 2014.

Sampling and Sampling Procedures

As depicted above, this quantitative study based on utilizing the primary data that had been collected by Statistics Canada via CCHS conducted from 2007 through 2014. In doing so, the final study sample populations were selected from this original data pool. A probability sampling strategy was used to select the required sample sizes. Random selection (stratified random selection) was carried out during sampling to avoid contamination of the confounders or the covariates and to increase the study power. In this research, the assumptions about the study power, the level of significance, and the expected relationships/associations among or between the study variables were stated to reflect the details of the power of the study to reject the false null hypothesis. In this regard, the 'priori' power of the present study was assumed to be >= 0.80 (equal to or exceeding 80%) without considering of the indicated covariates and with anticipated minimum effect size of 0.20 (20%) to detect the presence of any differences between the reported independent variables against the dependent variable, i.e., the prevalence of T2DM. A universally accepted alpha of 5% level of significance was assumed for the test as the probability of the occurrence of Type 1 error along with the Pearson moment correlation coefficient of $r = 0.90$ with assumptions of the existence of strong associations between the above-indicated study variables.

Accordingly, a G*Power software (version 3.1.9.2) written by Franz Faul from the University of Kiel in Germany (1992 - 2014) used for power analysis and a priori

sample size determination (Faul, Erdfelder, Buchner, & Lang, 2009). Based on this software [using seven study predictors, alpha error probability of 0.05, and a power (1-Beta error probability) of 0.80 kept constant], an estimated total sample size of 103 individuals (when an effect size of 0.15 assumed) or 725 individuals (when an effect size of 0.20 considered) were needed as a priori total sample sizes to satisfy the requirements for the success of this study. Actually, for the priori sample size determination, the effect sizes, the alpha error probability, and the universally accepted power (1-Beta) were used as core inputs for computing the priori sample size in the G*Power analysis with the use of the F-statistical test (selecting specifically the Linear multiple regression option: Fixed model, R^2 deviation from zero). No option for logistic regression computation model yet found in the G*power software for a priori sample size determination. However, considering the advantages and the recommendations from many prior research studies, Linear multiple regression F-tests were chosen for the computation in this study as it usually enhances the efficiency of the model more than the logistic regression model does in the determination of the priori sample sizes. Overall, the above-stated parameters were employed to detect any possible existence of associations or relationships among the independent variables, the covariates, and the dependent variable (Creative Research Systems, 2012; Kadam & Bhalerao, 2010).

Therefore, for the current study, 1,526 sample populations participated in the 2007-2014 CCHS from the province of Ontario were probabilistically drawn from the total African immigrant populations residing in Canada (N=4,373). Of these sample populations, unweighted 123 individuals were self-reported to have T2DM, which were

the subsample population of interest in this study. This total sample sizes (N=1,526) were, in fact, above the overall sample sizes required in this study, as indicated above with the use of both effect sizes in G*Power computation of 'priori' sample size determination, to detect any effects on the presence of associations or relationships between the study variables.

Exclusion criteria. Those African immigrants living with either of the types of diabetes (e.g., T1DM, or gestational diabetes; ADA, 2009) prior to their entry in Canada, those who were in Canada at the time of the surveys and living with T1DM and those under 15 years old with T2DM, and women with gestational diabetes were excluded from the study.

Inclusion criteria. Only those African immigrants with the age of 15 years and above who were the residents of Ontario Canada and participated in the 2007-2014 CCHS were included in the present study as the sample populations.

Instrumentation and Operationalization of Constructs

The instrumentation in this study focused on the use of the CCHS survey which was designed with representative sample structured questionnaires repeatedly tested and used at a national level. CCHS has been routinely conducted by Statistics Canada on an annual basis to collect important sociodemographic and health-related data to evaluate the health of Canadians time to time using several standard parameters. Important and relevant data have persistently been collected through the CCHS for the above-indicated purpose since the year 2000.

As indicated above, CCHS is:

> A cross-sectional survey operates on a two-year collection cycle. The first year of the survey cycle ".1" is a large sample, general population health survey, designed to provide reliable estimates at the health region level. The second year of the survey cycle ".2" has a smaller sample and is designed to provide provincial level results on specifically focused health topics. (Statistics Canada, 2007, para. 4).

Of note, until 2007, CCHS has been a known biannual task and a yearly Canadian survey after that that is led by Statistics Canada, as aforementioned, for collecting significantly relevant health-focused data from people who reside in privately owned houses in all provinces and territories in Canada. The survey designed to collect data pertaining to determinants of health, utilization of health care services, anthropometric measures (such as weight, height), BRFs (such as obesity, physical activity, sedentary lifestyles, smoking & alcohol consumptions, diet/dietary habits), injuries, and chronic health conditions as well as on the use of health care services. Also, it accumulates relevant primary data on income level, some socio-demographic characteristics, current labor force, and on the status of Canadians general health as well (Statistics Canada, 2013).

CCHS is conducted from January through December with a total coverage of about 98% of the adult Canadians between the ages of 12+ years (except in some areas with 90%, 92%, and 97% coverage observed with the privately owned households in Yukon, Nunavut, and Northwest Territories respectively). For example, in 2013 CCHS survey, about 65,000 adults participated in an interview who lived in "110 health regions or combined health regions" that were carefully and randomly selected as sample

populations for the survey from all three territories and 10 Canadian provinces (Statistics Canada, 2013a, 2014a, para. 8). These participants were the standard sample populations that were involved in the CCHS survey; and also, they were carefully selected with a multistage cluster sampling techniques and through the use of the inclusion criteria defined by Statistics Canada for such purpose mentioned above.

Moreover, CCHS survey uses a "multi-stage sample allocation strategy," to provide the provinces and the health regions with equal opportunity of being selected into the survey (Statistics Canada, 2013a, 2014a, para. 11). In addition to this, to select the required household samples, the CCHS employs the use of three different types of sampling frames. These samples were from 40.5% area frame, 58.5% telephone numbers list frame, and 1% of them obtained from a "Random Digit Dialing (RDD) sampling frame," (Statistics Canada, 2014a, para. 12).

Contrary to the inclusion of participants in the study, the CCHS survey also excluded some individuals residing in some areas and institutions. These excluded populations include people from the crown lands, natives living on Indian Reserves, Canadian Armed forces who are full-time members, institutional residents including individuals from healthcare facilities as well as those who live on some remote Canadian regions as well (Statistics Canada, 2013a).

Operationalization

The operationalization section discussed on the detail descriptions of the variables under the current study, their operational definitions, how each of the study variables was going to be measured, and the associated scores that to be manipulated or calculated. It

also discussed how the indicated scores or measures vividly presented as required. In this regard, the operational definitions and the details of the variables were presented here below in the following orders:

Level of income. Level of income usually influences the risks of developing T2DM by its way of modulating the access to resources that are useful in contributing to the health of the populations (Dinca-Panaitescu et al., 2011; Ross, Gilmour, & Dasgupta, 2010). Income in this study mainly anticipated to reflecting the best estimate of the income of the total households who were reporting their total annual earnings from the previous years.

Accordingly, based on the statistics Canada classification of income, the following three categories of income variables were employed to characterize the level of income in the present study. These categories of income variables were: less than $15,000; $45,000 - $90, 000; and over $91, 000 (reference category; Dinca-Panaitescu et al., 2011,*p.* 117). These income categories were balanced the total sample size requirements needed in each of the categories, as per the vetting rule requirements of Statistics Canada; and also, it enabled the possibility of comparisons among the income variables based on the extent of their level of influences on the prevalence of T2DM (Dinca-Panaitescu et al., 2011).

Country of Origin. Due to limitations on the country of birth data collected through CCHS, in this study, country of origin merely indicated the whole African continent as a place of origin instead of the various individual African countries. African origins, currently refers to the indigenous populations of East, West, Southern Africa, and

the Ethiopians (The Hamito-Semites) as well as the people who have viewed themselves as African based on the settlement of their fore-parents in this continent for more extended period of time and the generations thereafter (Naidoo, 2014). Of these ethno cultural or racial groups, the main ones include the British, those people with Jewish descents, Afrikaner-Dutch, the Portuguese, Europeans having mixed with other origins, and Indians from Asia with Hindu, Muslim and Christian religious faith and cultural backgrounds (Naidoo, 2014).

Acculturation (Language Proficiencies and Time since immigration)

Acculturation has been represented by several proxies that reflect the overall dimensions whereby the new immigrants experienced changes in psychological behavior, cultural adaptation, food preferences, social interactions, as well as the adoptions of the host country language proficiencies through the duration of time since immigrated to the new country of residence as well (Albright et al., 2005; Anderson et al., 2016; Johnson-Agbakwu et al., 2016; O'Brien et al., 2014; Rodriguez et al., 2012).

In doing so, acculturation in this study was represented by two proxies as used in the CCHS: the language (English and French languages) proficiency and the time since immigration to Ontario Canada. Language proficiency, as a proxy of acculturation, was also comprised of two variables: first official language learned or still understands and the spoken language at home. The language proficiency measurements used in the CCHS were: English only, French only, English and French, English, French & others, neither English nor French, and all other languages.

As a proxy of acculturation, the language proficiency measurements were grouped into three acculturation levels. Those who had their first official languages learned/still understood, and the spoken language at home was:

- English only or French only grouped as high (given a score of 3),
- English and French or English, French & others classified as moderate (a score of 2), and
- Neither English nor French or all other languages grouped as Low acculturation level (given a score of 1).

In addition, as a proxy of acculturation, the duration of time since immigration to Ontario Canada was classified into three categories: those who reside in Ontario for less than 10 years grouped as low (with a score of 1), 10-20 years categorized as moderate (with a score of 2) and greater than 20 years as high (with a score of 3).

Thus, in the combination of both the language proficiency and the duration of time since immigration proxies, the following acculturation level indices were created. These levels were:

- those who were highly proficient in English only or French only and who resided in Ontario for more than 20 years were categorized as having high acculturation level (with acculturation index of 3)
- those who were moderately proficient in English and French/ English, French & others and resided in Ontario for 10-20 years were categorized as having moderate acculturation level (with acculturation index of 2)

- those who were not proficient in neither English nor French/ spoke all other languages other than English or French and resided in Ontario Canada for less than ten years were categorized as having low acculturation level (with acculturation index of 1).

Covariates

In this study, as mentioned above, the covariates were the BRFs, age, gender, and ethnicity which were adjusted or controlled for during the multivariable analysis (i.e., binary logistic regression) and for the presence of any multicollinearity during bivariate analyses as well. The detailed definitions of the covariates were also discussed here below as follows:

a. *Age*: Age, in this study, assumed to be a continuous variable measure that merely reflected the ages of all adults above 15 years old who were emigrated initially from Africa and participated in the CCHS in the above-indicated study period. Accordingly, based on the sample sizes, age was classified into three groups: under 45 years, 46 - 74 years, and over 75 years old.

b. *Gender*: Gender, in this study, refers to the adult male and female African immigrant populations residing in Ontario Canada and who had been participated in the 2007-2014 CCHS.

c. *Ethnicity*: Ethnicity was determined based upon the questions asked and the answers given by the participants in the CCHS survey questionnaires explicitly reflecting the ethnic/racial parameter measures. In this study, ethnicity described the

responses of the immigrants with African origin having with a black racial and cultural background or not.

d. *Obesity*: Body mass index (BMI) has been a globally accepted and most frequently used index for measuring obesity and for categorizing the weight of adult persons and to assessing the level of health risks associated with the apparent weight-related issues in the population, i.e., overweight or obesity (Agyemang et al., 2016; Hossain, Kawar, & El Nahas, 2007; Starky, 2005; WHO, 2018). This universally accepted obesity index (BMI) refers to the arbitrary anthropometric measure that is calculated from the self-reported height (meter square), and weight (Kg) of the immigrants participated in the CCHS surveys. BMI measures were obtained by dividing the actual weight (kg) by the square of the height (m2) of the participants involved in the CCHS (Kaholokula et al., 2008; Starky, 2005; WHO, 2018;). These BMI values or indices have been previously used by several researchers for various obesity-related population studies, and they are still used as a standard system for classification of weight in Canada, US, and other countries including WHO as well (Kaholokula et al., 2008; WHO, 2018).

For the sake of the current study, the BMI values were presented in categories that were used as absolute indices to differentiate people with the normal & under-weight, the overweight, and the obese individuals observed in among the study populations. Hence, the following BMI standard of weight indices were utilized as main categories in this study: Underweight and average weight (less than 24.9 kg/m2); overweight (25.0 - 29.9 kg/m2); and obese, BMI >=30.0 kg/m2 (Hossain et al., 2007; WHO, 2018).

e. Physical Activities (PA): Physical activity enhances the body's metabolic function and helps in protecting the body from the ill-effects of chronic diseases like T2DM (Ford, 2002; Reddigan, Ardern, Riddell, & Kuk, 2011). In this study, data abstracted from those participants of the CCHS who were responding to a question related to their participation in the leisure-time physical activity. Then, their responses were dichotomized into two PA categories or indices: Active and inactive.

f. *Diet/Dietary habits*: Diet therapy was an essential venue and had been reported as one of the known cornerstones in the management of T2DM (Siddiqui, Gul, Ahmedani, Masood, & Miyan, 2010). Hence, in this study, data on the diet/dietary habits were abstracted from the CCHS microdata based on one variable, i.e., the total consumption frequency of fruit juice servings per day. Two categories were contained in this variable: those individuals with total consumption frequencies of fruit juice >= 0.3 servings per day and those with < 0.3 servings per day (Canada & Health Products and Food Branch, 2011; Earland et al, 2010; Shamsi et al., 2013; Siddiqui et al., 2010).

Data Analysis Plan

In this study, the data were extracted from the 2007-2014 CCHS microdata and analyzed as a secondary data through the use of IBM SPSS Statistics 24.0 (SPSS for Windows version 24.0) and SAS 9.3 software alternatively. As this secondary data were obtained from the nationally representative Canadian sample population through the CCHS, the distribution of the collected microdata from such sample populations was assumed to be normal along the X-Y Axis. In this regard, the Q-Q plots test was employed to check whether the extracted or the abstracted CCHS data were having a

characteristic nature of a normal distribution as per our assumptions (NIST/SEMATECH Agency, U.S. Commerce Department, 2013). Then, the Q-Q plots test finally confirmed that the abstracted secondary data failed to satisfy the normality assumption as depicted in the assumptions section.

In regards to the quality of the data, Statistics Canada employs its quality control mechanisms every year in the form of pre and post survey (CCHS) screening techniques during design and through a validation program of the datasets after that. In this study, prior rechecking of the extent of the missing data in the datasets, and the prescreening of the normality distributions of the secondary data were also carried out in perspectives to increase the quality of the abstracted data, the outcomes, and the validity of the study indeed.

In doing so, the study results were presented and discussed through the use of standard statistical techniques appropriate to this correlational/cross-sectional study. In this study, the correlates or the associations of the IVs with T2DM were primarily assessed through the use of some known inferential statistical analysis models such as Chi-square good-fit test of independence and multivariable regression specifically the binary logistic regression model.

As aforementioned in previous sections, the 95% confidence level and the use of confidence interval, and the odds ratio along with the standard 5% alpha level of significance ($p<0.05$) were employed for statistical test analysis and presentation of the study results. A binary logistic regression model was applied as the primary model to

analyze the characteristics of the independent risk factors or the criterion variables under this study against T2DM.

Moreover, as mentioned in prior research studies, during data analysis, the entry and the interpretation of the continuous variables using multiple regression models had not yet been implicated with any constraints as compared to the categorical variables. However, entry of the categorical variables into the models and their interpretation would be challenging unless they transformed into a k-1 level of new types of variables through a process of data coding system called simple coding or dummy coding, "The process of creating dichotomous variables from categorical variables is called dummy coding," (Stockburger, n.d., para. 10).

In doing so, in the present study, the following continuous variables were recategorized as follows:

- Income level: under $45,000, $45,000-$90,000, and over $91,000,the reference category;
- Diet/dietary habits: consumption of fruit juice with greater or equal to 0.3 servings per day, the reference category, and consumption of fruit juice with less than 0.3 servings per day.
- Age in years: less than 45 years, the reference category, 46-74 years, and over 75 years old.

Also, the following categorical variables were also furtherly re-classified in this study as depicted here below:

- leisure physical activity index: active and inactive, the reference category;

- Acculturation index: low, the reference category, moderate, and high;
- BMI scale in Kg/M^2: less than 24.9, under and normal weight, the reference category], 25.0-29.9 (overweight), and over 30 (obese);
- Gender: male and female the reference category
- Cultural/racial origin Black: Black or non-Black (White)
- Country of origin: Africa and others.

Hence, as aforementioned above, the indicated categorical variables with two, three, or four levels were coded into K-1 dummy coded categories or into new levels of categorical variables, where K represented the total number of groups in the variables.

Furthermore, as part of the analysis plan, the analyses of the research questions and the test hypotheses were also made accordingly. In this model, the hypothesis was tested through the use of Spearman's correlation as income was a continuous criterion variable whereas the dependent variable T2DM was a categorical variable. Also, the abstracted income data was not a normally distributed data; then instead of the Pearson correlation coefficient, the nonparametric test was used in this model, i.e., Spearman's correlation coefficient to depict the relationship of income with T2DM.

I computed the Chi-Square test of associations instead of the Spearman's correlation coefficient in the testing of the models for associations of the individual hypotheses containing the categorical independent variables depicted above in the RQs for acculturation, country of origin, and the covariates (except the frequency of consumption of fruit juice variable) with the prevalence of T2DM.

Threats to Validity

As the current dissertation research was a cross-sectional study, which was mainly depended on self-reported data, it was challenging in making a cause-effect inference between the study IVs and the DV. This might affect the generalizability of the current findings, and there might also be some probability for the possible occurrences of threats to its external validity too. For example, CCHS collected data and information on people with high blood pressure, a known risk factor for developing kidney disease and for increasing other complications in people with T2DM (Medicine Net, Inc., 1996-2014). Though high blood pressure was identified as one of the influencing risk factors affecting diabetes, this variable not included in the present study. So, it might have some confounding effect and might interfere with the outcomes of the research which would be a threat to external validity as well.

As stated by Statistics Canada, CCHS has been partly modified every year depending upon the survey situation. In this instance, there might also be a threat to the internal validity in which case it might miss some portions of the behavioral questions that should be included in the survey questionnaire. In addition to this, there may be unexpected occurrences or events of adverse situation that enforce the manipulating or deleting or missing of the critical content that addresses the importance of the key variables that should be measured in this study. So, such adverse conditions might have also threatened the internal validity of the present study (e.g., the threat to the content validity of the survey) (Delgado-Rodriguez, 2004).

The other threat to external validity was related to the small sample sizes of the African immigrants with T2DM residing in Ontario Canada. Because all the African immigrants in Canada not included, it was assumed that there might be other pools of African immigrants not participating in the 2007-2014 CCHS which in turn might affect the external validity of the current study.

Limitations

As aforementioned in Chapter 1, the barriers that were anticipated to occur in this study was mainly related to the nature of the research design that was employed in this study, i.e., the inherent characteristics of the cross-sectional study design. This type of research design was usually limited in making causal inferences and interpretations between the independent risk factors and the dependent risk factor.

The other limitation in this study was the use of data that were of solely self-reported in nature and secondary in their sources. Secondary data extracted in such a way led to the occurrences of a threat to the external validity and the possibilities of introduction of biases. Reporting or recalling biases are the types of informational biases that usually contaminate the quality and the outcomes of a research study (Delgado-Rodriguez, 2004). In the same regard, the information collected through CCHS cycles, which were conducted by Statistics Canada, were mostly self-reported data in nature and the respondents might have difficulty recalling the initial time of their diagnosis with T2DM and might cause a recalling bias. Participants might have trouble remembering what happened in previous years and some other past events. As aforementioned, the survey respondents during census might also fail to recall the occurrences of

hypoglycemia or hyperglycemia events in the past since they diagnosed with T2DM; and that, such events might influence the situation and would create a recall bias. Also, participants with diabetes might have an optimistic bias, a kind of bias clinical patients perceive as if they would have a lower diabetic risk in developing complications (Klein, 2013; Delgado-Rodriguez, 2004). In general, all the above adverse situations might affect the internal and external validity of this study.

Ethical Procedures

In this study, there were no direct communications or involvements with the study participants or with any human subjects. IRB approval (IRB approval #: 04-10-15-0251237) from Walden University was obtained to conduct this dissertation research. Hence, this study, as a quantitative based cross-sectional study design, would be expected to extract secondary data from the 2007-2014 CCHS datasets held by Statistics Canada to conduct the quantitative secondary analyses.

In doing so, the venue on accessing the aggregated microdata from the above-indicated datasets needed some clear understanding and formal communications. Gaining access to the CCHS microdata files was possible through an official contact made with Statistics Canada, which was the governmental organization authorized by law to approve such research-based study requests on health-related data and demographic information. Then, the official application forwarded to the appropriate department in the organization and, based on the response, a legal agreement between myself and the indicated institute convened. This step was the final stage to get access to the CCHS datasets and to start abstracting the required secondary data for this study.

Anonymous data collected according to the study need and to satisfy the procedure in maintaining confidentiality. The privacy and confidentiality of the data were kept in the study period through the use of coding, locking the access to computer and datasets with strong passwords, as well as preventing access to the computer room indeed. Data stored in a separate external drive with a two terabyte capacity and it was only accessible by me, the principal investigator.

In regarding to the disseminating and management of the data, the files were protected in a password and updated accordingly with a timely manner. I am obliged and expected to handle the microdata safely, as per the protocol, and the access to the datasets in an appropriate way. Only those who were authorized to access the datasets and disseminate the relevant information would act on behalf, the coinvestigator.

Finally, following the end of the study, the collected data would be safely managed to maintain privacy and confidentiality throughout the process and later it would be destroyed off with the consultations of the appropriate departments.

Summary

The current study had been designed to assess or evaluate the presence of possible associations or relationships among the independent variables, the covariates and the dependent variable (i.e., the prevalence of T2DM) in among ethnically diverse African immigrants residing in Ontario Canada from the period of 2007 through 2014. A cross-sectional design offered an appropriate fit to guide the research study and to collect the required secondary data from the CCHS micro datasets. A quantitative method of inquiry

employed as it offered accessibility and easiness to the use of numbers, detail statistics, statistical analysis, and for a presentation of results.

Besides explaining the methodology applied and the study populations targeted, the accessibility of the intended secondary data, the operationalization and the instrumentation used in this quantitative study, were thoroughly discussed. Besides, sampling and sampling frame, selection of participants, secondary data collection and its accessibility, data analysis and interpretations, the ethical issues addressed, and the consideration of the several types of threats affecting the validity of the study outcomes were explored in their appropriate sections.

Of note, the next section will be discussing the contents and elements of Chapter 4. This chapter was mainly focusing on activities related to the representativeness of the sample population, on determining of the time frame on the secondary data collection, organization & data management.

Also, it discussed how the data were collected from CCHS datasets through establishing an official communication with Statistics Canada. In addition to the presentation of the data, an in-depth assessment of the demographic and descriptive characteristics of the target populations and the presence of any confounder were also carried out. Following this step, the analyses and interpretations of the results and details of the report on observed changes and study findings along with descriptions were submitted in particulars using relevant statistical tests and analysis as appropriate. Finally, the study outcomes formally disseminate to the appropriate institutions including to Walden University for publications and records.

Chapter 4: Results

Introduction

In this study, I aimed to clarify the possible relationship between the prevalence of T2DM, income, acculturation, and country of origin among African immigrant populations in Ontario, Canada. I also intended to investigate whether the identified sociodemographic factors (e.g., age, gender, and ethnicity) and the BRFs (i.e., obesity, physical activity, and diet/dietary habits) confounded the relationships between the prevalence of T2DM, the dependent variable, and the aforementioned independent variables under the study. In this study, I assessed not only the association or relationship but also attempted to assess whether there had been any significant variabilities explained by those study predictors over the prevalence of T2DM after adjusting for those known confounders. To facilitate the data analyses and for additional clarity, I classified the covariates and the independent variables into three major groups: the BRFs (i.e., BMI, diet/dietary habits, and physical activity); sociodemographic factors (i.e., age, gender, ethnicity, and level of income); and sociocultural factors denoting acculturation level (which was created by the combination of the time since immigration and the language proficiency variables initially used in the CCHS).

In this study, I used a cross-sectional design to answer the three research questions and address the above stated relationships or associations.

RQ1. What is the association or relationship between income, acculturation, country of origin, the covariates, and T2DM in ethnically diverse African immigrant populations residing in Ontario, Canada?

I developed the primary research question to assess whether the sociodemographic factors (i.e., income, gender, age, ethnicity, and country of origin); the sociocultural factor (i.e., acculturation); and the BRFs (i.e., obesity, physical activity, and diet/dietary habits) were associated or had a relationship with T2DM among ethnically diverse African immigrant populations in Ontario, Canada. The null hypothesis for the primary research question stated that there were no significant relationships between the sociodemographic, sociocultural, BRFs, and T2DM. The alternative hypothesis stated that there were significant relationships between the sociodemographic, sociocultural, BRFs, and T2DM.

RQ2: What is the association or relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario, Canada?

In here, I also created the secondary research question to evaluate whether any relationship existed between the sociodemographic factors (i.e., income and country of origin) and the sociocultural factor (i.e., acculturation) with T2DM among ethnically diverse African immigrant populations after adjusting for BRFs (i.e., obesity, physical activity, and diet/dietary habits) and the sociodemographic factors (i.e., age, gender, and ethnicity). The null hypothesis for the second research question stated that there was no significant relationship between the sociodemographic factors (i.e., income and country of origin) and the sociocultural factor (i.e., acculturation) with T2DM, even after adjusting for BRFs (i.e., obesity, physical activity, and diet/dietary habits) and the sociodemographic factors (i.e., age, gender, and ethnicity). The alternative hypothesis

stated that there was a significant relationship between the sociodemographic factors (i.e., income and country of origin) and the sociocultural factor (i.e., acculturation) with T2DM, even after adjusting for BRFs (i.e., obesity, physical activity, and diet/dietary habits) and the sociodemographic factors (i.e., age, gender, and ethnicity).

RQ3: What is the association or relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario, Canada?

Finally, I developed the tertiary research question to assess whether any relationship exists between BRFs (i.e., obesity, physical activity, and diet/dietary habits) and the sociodemographic factors (i.e., age, gender, and ethnicity) with T2DM after adjusting for some sociodemographic factors (i.e., income and country of origin) and the sociocultural factor (i.e., acculturation) in ethnically diverse African immigrant populations in Ontario, Canada. The null hypothesis for the third research question stated that there was no significant relationship between the BRFs (i.e., obesity, physical activity, and diet/dietary habits) and the sociodemographic factors (i.e., age, gender, and ethnicity) with T2DM, even after adjusting for some sociodemographic factors (i.e., income and country of origin) and the sociocultural factor (i.e., acculturation). The alternative hypothesis stated that there was significant relationship between the BRFs (i.e., obesity, physical activity, and diet/dietary habits) and the sociodemographic factors (i.e., age, gender, and ethnicity) with T2DM after adjusting for some sociodemographic factors (i.e., income and country of origin) and the sociocultural factor (i.e., acculturation).

I conducted secondary data analyses using descriptive and inferential statistical tests to answer the research questions. General characteristics and a snapshot summary of the selected and the excluded population were also assessed and will be discussed in this chapter to evaluate the representativeness of the study population. I will also present the descriptive statistics and the baseline sociodemographic and the health-related characteristics of the sample population in this chapter. My rationale for selecting the appropriate statistical analyses to assess the research questions will also be described in detail, and the final results of the data analyses will be presented.

Data Collection

I conducted this study as a secondary data analysis using a cross-sectional study design in a quantitative research approach. I used the primary data, collected and held by Statistics Canada through the CCHS (Statistics Canada, 2011) as the primary source of secondary data for this research. As Statistics Canada (2011) described, "The CCHS is a cross-sectional survey that collects information related to health status, health care utilization and health determinants for the Canadian population" (para., 1). Through this annual survey, the appropriate health-related data are collected at health regions from eligible individuals who resided in 10 Canadian provinces and three territories (2011). On average, 65,000 participants who have been living in several private dwellings are carefully sampled and interviewed by Statistics Canada to meet the stated objectives of the CCHS Statistics Canada (2011). Later in this chapter, I will describe how the sample populations are selected, how representative they were, the sampling procedures, and provide some additional details on sampling frames.

The total sample sizes selected for the CCHS from all health regions were statistically predetermined through a sampling allocation strategy with the use of a "multistage stratified cluster design" (Statistics Canada, 2011a, para. 2). During the design stages, to have a fair estimation and distribution of the participants, the overall sample sizes to be collected through the CCHS surveys were also statistically and methodologically spread over three sampling frames (para. 3). These sampling frames were composed of three entities named: area frame (covering 49.5% of the participants until 2010 and 40.5% of sample populations thereafter), telephone lists frame (covering 49.5% until 2010 and 58.5% of the sample sizes thereafter), and the "Random Digit Dialing (RDD) sampling frame" (covering about 1% of the total sample sizes; 2011a, para., 7). Therefore, the final sample sizes drawn through the use of these samples confirmed that the sample populations used in the CCHS were the representative of the general Canadian population.

Though the CCHS had been designed to cover about 98% of the general Canadian population, there are also few Canadians (2%–3%) excluded from this survey every year (Statistics Canada, 2013a, para. 8)). As Statistics Canada (2011a) also stated,

> The CCHS data is always collected from persons aged 12 and over living in private dwellings in the 117 health regions covering all provinces and territories. Excluded from the sampling frame are individuals living on Indian Reserves and Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of specific remote regions. (para. 2)

In addition to the 2%–3% Canadians excluded from the survey, there were also other groups of people who were initially considered as part of the African immigrant target population and participated in the CCHS. However, they were not selected per the study inclusion criteria and instead were excluded from this study. I will provide a brief description of the characteristics of the excluded or non selected population as compared to the selected sample population.

Initially, a sample of 65,000 people participated in the CCHS every year from all over Canada (Statistics Canada, 2014a, para. 13). Of these participants, I filtered out the data for only African immigrants in Canada (N = 4,373) by geographical region of the country of origin and by immigrant status. From this pool, I selected the study sample populations per the inclusion criteria of being adult African immigrants and the residents of Ontario.

Based on the inclusion criteria, only 1,526 (about 35%) participants were sampled as the final selected population for this study. This total included unweighted numbers of 123 people with T2DM (about 8%) and 1,403 participants without T2DM (about 92%). (See Figure 1)

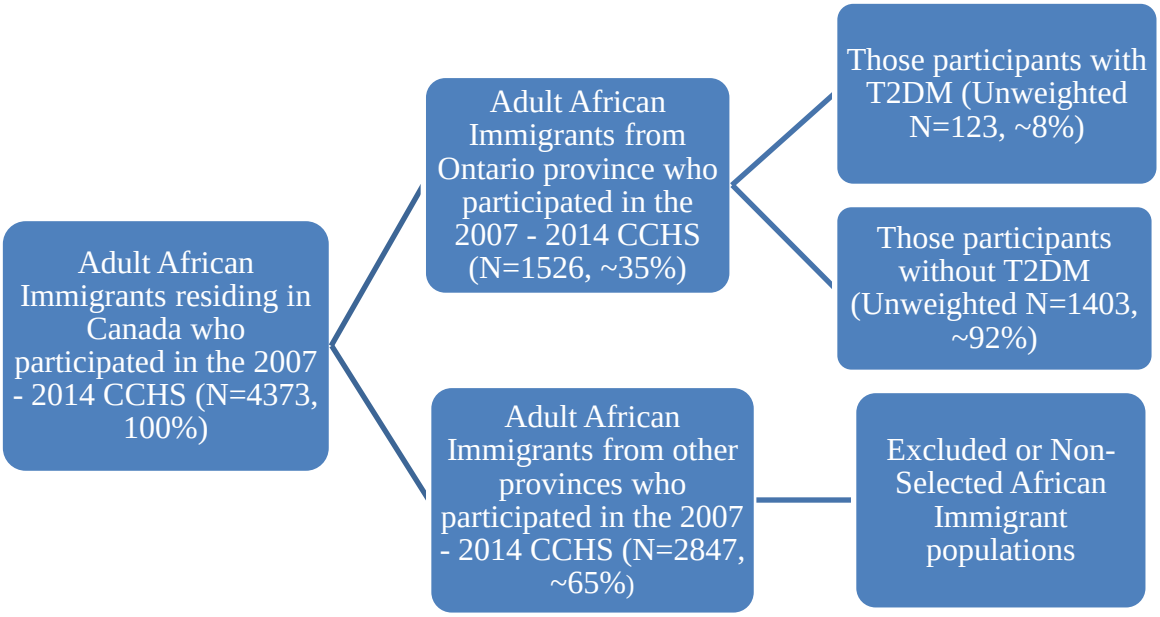

Figure 1. Graphical presentation of the selection of the sample populations and the nonselected African immigrant populations.

To avoid any selection bias through the aforementioned process, I also assessed the characteristics of those excluded 2,847 (about 65% of the total 4,373 possible participants) African immigrants. The non selected populations comprised the unweighted number of 134 participants with T2DM (about 4.7% of 2,847) and 2,713 survey respondents without T2DM (about 95.3% of 2,847). I found the nonselected population group without T2DM to be a little lower in the proportion of population than those without T2DM in the selected group. Though not my focus in this study addressing the prevalence of T2DM among the nonelected sample of African immigrant populations in Ontario, Canada, consideration of the nonelected group of people would benefit future research studies and clarify any additional issues that might arise in consideration of the needs of the larger African immigrant populations in Canada.

Challenges, Discrepancies, and Changes from What was Proposed in Chapter 3

Initially, at the beginning of data collection, there were challenges and barriers related to the accessibility of the 2007 to 2014 CCHS microdata files through a Remote Access Program (RAP) solely approved by Statistics Canada, the data provider. RAP is one of the portals primarily designed to provide access for those researchers who mostly couldn't get approval for access to the Research Data Centers (RDCs) and also the available Public Use Microdata Files (PUMF), other sources of CCHS data open to the public, didn't provide them with sufficient information required by their research projects.

Though it had been offered free of charge, it was restricted and merely approved for those who were demonstrating a prevailed need for the CCHS microdata. The researchers who get the approval of remote access by Statistics Canada also provided with synthetic data, and prior sending to the appropriate unit, they had to test by themselves for the functionality of their syntax programs created using either Statistical Analysis System (SAS) or Statistical Package for the Social Science (SPSS) software. Finally, those functional computer syntax programs should be sent by email to the remote access unit to run it in a secure server whereby the CCHS microdata prevailed and then to obtain the vetted outputs as a return to proceed with the data analysis. This process had been the standing procedure for researchers who wanted to use the RAP as their main portal to access the CCHS microdata.

However, due to SPSS version related errors and other unresolved technical problems, the use of the remote access program for the current research had remained very challenging, and it was time-consuming. Finally, the director general of Statistics

Canada granted permission to the appropriate department to switch the RAP for a direct access program through the use of the RDCs. This permission paved a way to access the CCHS microdata primarily, through the use of South Western Ontario Research Data Center (SWORDC) located at the University of Waterloo; and secondarily, RDC Toronto, located in the University of Toronto. RDCs are research data centers located in most major Canadian Universities throughout the country, and they are intentionally designed as an alternative venue to provide researchers with access to microdata files collected by various Statistics Canada surveys.

Another challenge was regarding the use of additional sources of data besides to the CCHS microdata held by Statistics Canada. Initially, it was stated in Chapter 3 that immigrants' related additional data could also be solicited from other sources as needed. However, because of an unanticipated length of time lost to resolve the barriers and challenges associated with the remote access program, no extra time was left to search for additional health-related data from other sources (e.g., CIHI, Canadian Institutes of Health Information and Canadian Landed Immigrant Database LIDS) rather than CCHS.

An additional challenge was related to the sample sizes of the target populations. As compared to what was stated in Chapter 3, a compiled 2 year (2013 to 2014) CCHS dataset was also added in the analysis in addition to the previously mentioned datasets (2007 through 2013) to satisfy the needs of obtaining enough sample sizes that represent the targeted African immigrant populations in Canada.

In regards to confirming the reliability of the CCHS datasets, the survey questionnaires were prepared by many experts who were currently working in Statistics

Canada skilled and experienced in research and statistical methodologies. In doing so, the survey questionnaires used in the annual CCHS were standardized and used from 2007 to the present date to yield the intended sociodemographic and health-related outcomes. Each year approximately 65,000 sample survey participants took the same questionnaires through the CCHS as hosted by Statistics Canada. The statistically allocated sample sizes and the standard questionnaires employed in these surveys were the same each year yielding a response rate of > 72%, and the reliability of the CCHS datasets and the results obtained from using this microdata could also be an affirmative condition of the reliability of the datasets.

Furthermore, to avoid any cross contamination between those datasets collected from 2007 through 2014, the use of statistically appropriate combining method with SPSS Syntax Commands (e.g., SORT, ADD FILES, & COMPUTE Commands, etc.,) were used to sort the microdata in each CCHS dataset and then combined or merged them accordingly by a unique sample ID. In this procedure, each dataset independently stacked one after the other following the sorting of the datasets by a unique Sample ID to form one combined working data file. This combined final working dataset was taken as the main CCHS microdata used in the current study. Following the combination of the datasets, to ensure that there was no cross-contamination between the microdata datasets, the merged data were also finally tested using frequencies and crosstabs of study variables by reference periods. The visual checkups of the stacked data sets arranged by reference years and the meaningful SPSS outputs obtained from running the descriptive

statistical summary mentioned above were additionally taken as an affirmative proof that there was no any cross-contamination of the datasets.

The additional challenge was related to the population targeted under this research study. As depicted in the previous chapters, it was initially planned in the study to use all African immigrants in Ontario as the primary target populations regardless of their participation in the CCHS. Unfortunately, only those Ontario African immigrants who participated in the 2007-2014 CCHS were taken instead as the central target populations for the current study. Some of the reasons were due to the aforementioned remote access program related constraints, the limitations of the CCHS microdata for being the only source of primary data for this study, and the shortage of time for not being able to use other sources of data as well.

In regards to the issues raised on the use of the lower age limit, the decision was made based on available evidences that, instead of using the lower age limit (>12 years) employed by Statistics Canada for inclusion into the CCHS, the sample was drawn from the aforementioned target African immigrant populations over the age of 15 years and above. The main reason for using age 15 years old as the lower limit instead of the 12 years was that no African immigrants were found even in the age under 15 years old category. This rationale was also supported by the available CCHS microdata used in the current study which was vividly confirming that all the sample populations from Ontario were above the lower age category, which was 15 years and above. Statistics Canada also used age 15 years old and above, as a standard age category in the CCHS to indicate the lower age limit rather than the 18 years old group. Also, CIC frequently use the same

standards as Statistics Canada for age categories in all refugees and immigrants entering Canada as well. Thus, based on the premises mentioned above the final total sample populations from Ontario with the age of 15 years old and above were totaled to be 1526 people.

For clarity, the sample populations were also presented by each CCHS dataset aggregated and organized by Statistics Canada to contain 2-year microdata for enhancing better data management, data analyses, and interpretation. For the present study, the total sample sizes obtained from each dataset by years of collection periods from Ontario province were depicted as follows: 372 participants (2007-2008 dataset), 397 respondents (2009-2010 dataset), 359 persons (2011-2012 dataset) and 398 participants from the 2013-2014 dataset. These individual samples were finally summed up to be a total of 1,526 African immigrant populations who participated in the CCHS from Ontario in the above-indicated survey periods, which was from 2007 through 2014 (Please refer Table 1 for details here below).

Table 1 summarized the total number of weighted African immigrants with and without T2DM in Ontario by reference periods. Based on the indicated reference years, those weighted sample populations with T2DM were also 26 (7.0%, in 2007-2008), 35 (8.8%, in 2009-2010), 23 (6.4%, in 2011-2012), and 28 (7.0%, in 2013-2014) in numbers. In total, the weighted sample populations with self-reported T2DM were 112, which was 7.3% of the 1,526 African immigrants. Of these, the highest numbers of participants with T2DM were shown in the CCHS conducted in the 2009-2010 reference years.

Table 1

The Distributions of the Sample Population: Weighted African Immigrants in Ontario with & without T2DM by Reference Periods.

Reference period * T2DM_SelfReported Cross-tabulation

			T2DM_SelfReported		
			No	Yes	Total
Reference period	200701-200812	Count	346	26	372
		% within Reference period	93.0%	7.0%	100.0%
	200901-201012	Count	362	35	397
		% within Reference period	91.2%	8.8%	100.0%
	201101-201212	Count	336	23	359
		% within Reference period	93.6%	6.4%	100.0%
	201301-201412	Count	370	28	398
		% within Reference period	93.0%	7.0%	100.0%
Total		Count	1414	112	1526
		% within Reference period	92.7%	7.3%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Additionally, the other discrepancy not mentioned in Chapter 3 but observed during data analysis was the issue related to creating the standardized measurement scale of acculturation variable specifically for African immigrant populations. Unfortunately, acculturation variable was not initially included in the CCHS questionnaires, and there were no independent data directly collected from the survey participants with the use of this variable. Hence, creating this variable became another challenge.

However, based on the directions and recommendations forwarded by researchers from previous studies (Johnson-Agbakwu, Flynn, Asiedu, Hedberg, & Breitkopf, 2016), an attempt was made to create a new acculturation variable with the use of existing variables which were initially employed in the CCHS to collect the required data for the intended research studies. Initially, as stated in Chapter 3, it was proposed that

acculturation could be represented or measured through the use of only one variable, time since immigration variable; however, as explained in previous studies by Deng, Zhang, and Chan (2013), Zheng, et al. (2012), Oza-Frank, Stephenson, and Narayan (2011), and Mainous, Diaz, and Geesey (2008), the acculturation variable was represented by more than one variable, which included time since immigration, country of birth, language proficiency and diet adoption to the host countries.

In doing so, instead of using only one variable as initially planned, three CCHS existing variables were used for creating and coding the new acculturation variable, which was denoted by Acculture_Index variable. As there was no standardized acculturation scale established for African immigrants to the western countries, this newly created variable was anticipated to measure the acculturation level in the above-indicated sample population (Johnson-Agbakwu et al. 2016). Other than African immigrants, such a validated acculturation scale measures had been created for some other cultural/racial ethnic and immigrant populations indeed [e.g. the Psychological acculturation scale and the modified Bi-dimensional Acculturation Scale for Hispanics (Van Rompay et al., 2012, p. 65), the Suinn-Lew Asian Self-Identity Acculturation (SL-ASIA) scale for Asians (Deng, Zhang, & Chan, 2013), & others].

However, recently Johnson-Agbakwu et al. (2016) adopted a Bicultural Involvement Questionnaire (BIQ) to test its reliability among the Somali immigrant women to measure acculturation level in the African immigrants in the United States. The modified BIQ scale was solely designed to measure acculturation in Somali women rather than all African immigrant populations; and also, it was difficult to implement such

a measuring scale with secondary data analyses due to the limitation of using survey data such as the CCHS microdata, which was initially collected for other purposes. Though it was a challenge to apply such acculturation scale in the current sample population, several attempts were carried out to create a new acculturation index variable with the use of the already existing input variables from the CCHS datasets.

Therefore, for the current study, the two language variables (1st official language learned/still understand & the language(s) quite often spoken at home) and another third variable a duration of time (Length/time in Canada since immigration) were used as the input proxies for the creation of the new acculturation index variable. This newly created Acculturation Index variable had finally been classified into three categories to represent the high, moderate, and low acculturation levels of the sample population in this study.

The other deviation from Chapter 3 was the selection of a variable representing the country of origin. The country of origin was initially proposed to be represented by a country of birth variable. However, due to the continuous changes made by Statistics Canada from year to year in the use of the country of birth variable in the CCHS, country of birth grouped by regions was used in this study instead of the country of birth variable.

Besides, the other reasons for the selection of the country of birth by regions were to get a valid representation of the target population, to avoid the sample size limitations, and the availability and completeness of the data for this variable in the CCHS. Thus, as per the inclusion criteria, only those >=15 years old adult immigrants from Africa region were selected to be used as a sample population as a whole instead of choosing them by country of births. In doing so, the country of origin had represented only African

iimmigrants in Ontario who participated in the 2007-2014 CCHS (n=1,526). Of these, 112 weighted participants were self-reported to having T2DM, i.e., the subsample population of interest in this study.

Sample Representativeness and Sample Selection

As aforementioned, a total of 1,526 eligible adult African immigrant populations from Ontario selected as the final sample population in this study. Data obtained through a self-reported T2DM variable were used as the primary source for calculating the prevalence of diabetes among the indicated study population. In this quantitative research, as stated above in previous sections, the representativeness of the selected sample population was carefully considered by taking into account the advantage of the complex probability random sampling techniques employed by Statistics Canada. In doing so, the above-indicated sample populations were randomly selected from the pool African immigrant populations who participated in the 2007-2014 CCHS from all over Canada (N=4,373). Of these, 1526 African immigrant populations were filtered out by Ontario province, and these sample populations were considered as the appropriate final sample size required for this dissertation research.

In regards to its representativeness, as depicted earlier in this document, the current sample populations were drawn from the larger Canadian people through a nationally held multistage random sampling technique validated by Statistics Canada. The survey instrument was in use since its inception in 1991 and evaluated each year accordingly by Statistics Canada experts to minimize errors during the sampling (e.g., nonsampling errors) and designing stages of the survey as well. Also, during the

collection of data and processing after that, quality monitoring measures were carried out at each level as an integral part of the assurance of data quality. Some of the quality monitoring measures implemented during the CCHS consisted of providing training extensively on the survey questionnaires and procedures, engage interviewers who were highly skilled, use of field testing, and testing of the Computer Assisted Interview Applications as well.

A priori sample size, the minimum sample sizes required for detecting any possible association or relationship with this study outcome variable, was determined to be 725 participants. This priori sample size was predetermined with the application of the G*Power software discussed in details in Chapter 3. Finally, the sample sizes selected as per the inclusion criteria of the study were 1,526 African immigrants, and this size anticipated to be powerful enough to detect if an association/relationships exist.

Regarding the use of weighting, the total sample sizes chosen for this study (n=1,526) were weighted by African immigrants in Ontario. Of these, initially, the unweighted counts of 123 African immigrants were self-reported to having T2DM, and 1403 of them were reporting for being non-diabetes. Then, a standard weight was statistically applied to the sample population, and the total African immigrants with T2DM decreased to weighted counts of 112 (7.3 %) participants and the remaining 1414 (92.7%) populations considered non-T2DM or free of the disease. This count confirmed the final weighted samples of African immigrant populations with the disease (T2DM) who were residing in Ontario and participated in CCHS during the above indicated study periods.

In addition to weighting of the sample population, recoding and recategorization of essential variables were also carried out to match with the study sample sizes and to abide by the vetting rules set by Statistics Canada. For example, Income was usually measured using the standard categories employed by Statistics Canada (which was composed of about 12-15 classes) for measuring the total household incomes of the landed immigrants with the ages of 15 years old and over. However, instead of using all the above 12-15 income categories, the total household income variable used in this study was re-coded accordingly to contain only three groups rather than all the above mentioned Statistics Canada income categories. Due to small frequency if used 12-15 income categories, then some of the categories will have smaller numbers than 5 events and will be restricted by vetting rules of the data provider as well.

Results

Descriptive analyses of all variables were presented in logical perspectives to depict the demographic and the health characteristics of the sample population under this study. Inferential statistical tests (bivariate, univariate, and multivariable analyses) were also conducted besides to the descriptive statistical analysis to assess the existence of any association or relationships between the various potential predictors and the response variable. Multivariable analysis, specifically a logistic regression model, for testing the hypotheses and for predictions of the binary outcome variable was employed as the primary multivariable analysis model in this study.

Evaluations of the Statistical Assumptions

As mentioned previously, the study dependent variable of interest was type 2 diabetes denoted as T2DM. In the CCHS, this variable was not independently existed as the other survey variables in the datasets; but instead, it was included as one of the four categories of the types of diabetes variable employed in the survey. Then, this study outcome variable was statistically recoded by Statistics Canada to be filtered out from other types of diabetes with the purpose of enabling the researchers to obtain the actual number of CCHS participants with T2DM. Then, the filtered out dependent variable, T2DM was finally taken and methodologically recategorized as a binary outcome variable used as the primary dependent variable of interest for the current research study.

Following the descriptive summary of potential predictors and based on the decision made to choose the right statistical tests, for the current study, a logistic regression model to the binary outcome of T2DM was selected as the appropriate inferential statistical model, where the goodness of fit of the model was assessed by Hosmer and Lemeshow test. This model assessed whether the outcomes was explained by the predictors, evaluated the hypotheses, and inferred the existence of any relationship between these potential predictors and the study dependent variable T2DM including the covariates for known confounders in the Binary Logistic Regression (BLR) model.

Descriptive Analysis

The baseline descriptive univariate statistics of each predictor and the outcome variable depicting the behavioral health, sociodemographic and sociocultural

characteristics of the sample populations were summarized individually and in whole on various tables here below for further clarity and details.

Table 2 summarized the gender distributions of the sample population with and without T2DM. Of the total percent indicated within the gender, males constituted the highest percentage of 62(8.4%) the participants with self-reported T2DM as compared to the female ones 50(6.4%).

Table 2

The Gender Distributions of the Sample Population: Gender vs. T2DM

Gender by T2DM_SelfReported Cross-tabulation

			T2DM_SelfReported		
			No	Yes	Total
Gender	Male	Count	678	62	740
		% within Gender	91.6%	8.4%	100.0%
	Female	Count	736	50	786
		% within Gender	93.6%	6.4%	100.0%
Total		Count	1414	112	1526
		% within Gender	92.7%	7.3%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 3 summarized the age distributions of the sample population. As depicted on the table below, participants with self-reported T2DM within the respected age categories found to be: <= 45 years old, 24 (2.7%); 46 to 74 years old, 74 (12.7%); and Over 75 years old, 14 (24.1%). Those Over 75 years' old participants had shown the highest percentage of T2DM as compared to the others within the indicated age categories of the sample population.

Table 3

The Age Distributions of the Sample Population: Age vs. T2DM

Age by T2DM_SelfReported Cross tabulation

			T2DM_SelfReported		
			No	Yes	Total
Age	Under 45 years	Count	863	24	887
		% withinAge	97.3%	2.7%	100.0%
	46 – 74 years	Count	507	74	581
		% withinAge	87.3%	12.7%	100.0%
	Over 75 years	Count	44	14	58
		% withinAge	75.9%	24.1%	100.0%
Total		Count	1414	112	1526
		% withinAge	92.7%	7.3%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 4 highlighted the cultural/racial distributions of the sample population who identified themselves as Black and non-Black (Whites) in origin during the indicated survey periods. Of these respondents, those who self-reported to have T2DM comprised of 37 (4.7%) Black survey participants and 75 (10.4%) non-Black (White) individuals. Participants with a non-Black (Whites) cultural/ racial origin reported the highest number of T2DM as compared to the Black African immigrant participants.

Table 4

The Cultural/Racial Distributions of the Sample Population: Cultural/Racial Origin_Black vs. T2DM.

Cultural /Racial_Black by T2DM_SelfReported Cross tabulation

			T2DM_SelfReported		
			No	Yes	Total
CultRacialOrigin_	Yes	Count	752	37	789
Black		% within CultRacialOrigin_Black	95.3%	4.7%	100.0%
	No (Whites)	Count	645	75	720
		% within CultRacialOrigin_Black	89.6%	10.4%	100.0%
Total		Count	1397	112	1509
		% within CultRacialOrigin_Black	92.6%	7.4%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 5 highlighted the total household income (best estimate) distributions of the sample population. Of these, those individuals with self-reported T2DM who reported the best estimate of their total household annual income were comprised of the following categories: Less than $45,000, 59 (10.5%); $45,000 through $90,000, 18 (4.5%) and over $91,000, 35 (6.2%). Participants from the under $45,000 income category had shown the highest self-reported T2DM as compared to the others.

Table 5

The Income Distributions of the Sample Population: Total Household Income (Best Estimate) vs. T2DM

Total Income by T2DM_SelfReported Cross tabulation

			T2DM_SelfReported		
			No	Yes	Total
TotHHInc_BE	Under $45,000	Count	501	59	560
		% within TotHHInc_BE	89.5%	10.5%	100.0%
	$45,000 - $90, 000	Count	385	18	403
		% within TotHHInc_BE	95.5%	4.5%	100.0%
	Over $91, 000	Count	527	35	562
		% within TotHHInc_BE	93.8%	6.2%	100.0%
Total		Count	1413	112	1525
		% within TotHHInc_BE	92.7%	7.3%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 6 highlighted the acculturation characteristics as described by the Acculturation Index categories and the apparent distributions of T2DM in the sample population. Based on this acculturation index variable, those respondents who self-reported to have T2DM were categorized into three levels: Low acculturated (those people with acculturation index equal to 1) 18 (4.9%), moderately acculturated (those people with acculturation index equal to 2) 74 (7.3%), and highly acculturated (those people with acculturation index equal to 3) 14 (15.6%). Participants with a high acculturation index level had shown the highest percentage of self-reported T2DM as compared to the other categories in the group.

Table 6

The Acculturation Level and Distributions of the Sample Population: Acculturation Index vs. T2DM

			TYPES OF DIABETES_T2DM ONLY		Total
			Yes	No	
ACCULTURE_ INDEX	1.00 (Low)	Count	18	347	365
		% within ACCULTURE_INDEX	4.9%	95.1%	100.0%
	2.00 (Moderate)	Count	74	943	1017
		% within ACCULTURE_INDEX	7.3%	92.7%	100.0%
	3.00 (High)	Count	14	76	90
		% within ACCULTURE_INDEX	15.6%	84.4%	100.0%
Total		Count	106	1366	1472
		% within ACCULTURE_INDEX	7.2%	92.8%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 7 depicted the summary of the Leisure physical activity levels of the sample population as represented by the Physical Activity Index variable. Based on this categorical variable, the distributions of those sample population with self-reported T2DM were also classified as inactive 74 (7.8%) and active 35 (6.3%). Those people who were categorized as Inactive had shown the highest percentage (7.8%) of self-reported T2DM as compared to the other groups.

Table 7

The leisure physical activity levels and distributions of the Sample Population: Behavioral Risk Factors (BRFs) _Leisure PA Index vs. T2DM.

LesiurePA_Index by T2DM_SelfReported Cross tabulation

			T2DM_SelfReported		
			No	Yes	Total
BRF_PA_LesiurePA_Index	Inactive	Count	878	74	952
		% within BRF_PA_LesiurePA_Index	92.2%	7.8%	100.0%
	Active	Count	521	35	556
		% within BRF_PA_LesiurePA_Index	93.7%	6.3%	100.0%
	Missing's	Count	15	3	18
		% within BRF_PA_LesiurePA_Index	83.3%	16.7%	100.0%
Total		Count	1414	112	1526
		% within BRF_PA_LesiurePA_Index	92.7%	7.3%	100.0%

Notes. BRFs- Behavioral Risk Factors; PA-Physical Activity. *Data Source:* Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 8 depicted the summary of the total number of weighted African immigrants with and without T2DM in Ontario by self-reported BMI for obesity. As per this BMI, the distributions of the sample population with self-reported T2DM were also classified as: normal (those with BMI <=24.9), 26(3.9%); overweight (BMI 25.0 - 29.9), 34 (7.2%); and obese (BMI >= 30), 52 (14.2%). Those obese people who were categorized as greater or equal to 30 on BMI scale had shown the highest percentage (14.2%) of self-reported T2DM as compared to the other two categories.

Table 8

The Obesity Level (BMI) and the Distributions of the Sample Population: BRF_Obesity_BMI vs. T2DM.

Self-reported BMI by T2DM_SelfReported Cross tabulation

			T2DM_SelfReported		
			No	Yes	Total
Self-reported BMI	Under 24.9	Count	649	26	675
		% within Self-reported BMI	96.1%	3.9%	100.0%
	25.0 – 29.9	Count	437	34	471
		% within Self-reported BMI	92.8%	7.2%	100.0%
	Over 30	Count	315	52	367
		% within Self-reported BMI	85.8%	14.2%	100.0%
	99.00	Count	13	0	13
		% within Self-reported BMI	100.0%	0.0%	100.0%
Total		Count	1414	112	1526
		% within Self-reported BMI	92.7%	7.3%	100.0%

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 9 depicted the summary of the total number of weighted African Immigrants with & without T2DM in Ontario by diet, daily consumption frequencies of fruit juice. As per this diet parameter, the distributions of the sample population with self-reported T2DM were also classified into two categories: a group with daily consumption frequencies of fruit juice less than 0.3 servings and another group with greater or equal to 0.3 servings per/day. From these diet groups, those individuals who consumed fruit juices less than 0.3 serving/day had shown the highest percentages of T2DM 61 (12.0%). When stratified by gender, those male participants who reported to have a less than 0.3 servings/day in the consumption of fruit juices had shown the highest percentage of self-reported T2DM (15.0%) as compared to the female respondents (11%).

Table 9

The Daily Consumption of Fruit Juice and the Distributions of the Sample Population: BRF_Diet_Consumption_Frujuice vs. T2DM Stratified by Gender.

Variable	Gender	Category	Self-Reported T2DM					
			No	%	Yes	%	Total	% Col Total
FruJuice consumption (servings /day)	Male	< 0.3	160	85%	28	15%	188	27.7%
		>=0.3	458	93%	32	7%	490	72.3%
		Total	618	91%	60	9%	678	100.0%
	Female	< 0.3	276	89%	33	11%	309	38.2%
		>=0.3	475	95%	24	5%	499	61.8%
		Total	751	93%	57	7%	808	100.0%
	Total	< 0.3	436	88%	61	12%	497	33.4%
		>=0.3	933	94%	56	6%	989	66.6%
		Total	1369	92.1%	117	7.9%	1486	100.0%

Note. The above data may vary with variables and indicated only frequencies and percentages (%); *FruJuice- Fruit Juice. Data Source:* Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 10 summarized the country of origin of the weighted African immigrant participants with and without T2DM stratified by gender. Of those African immigrants with T2DM 112 (7.3%), males constituted the highest number of participants and had also shown the highest prevalence of T2DM 62 (8.4%) as compared to the female African immigrant participants with T2DM 50 (6.4%).

Table 10

The Country of Origin and the Distributions of the Sample Population: Country of Origin (African Immigrants) vs T2DM Stratified by Gender.

Variable	Gender	Categories	Self-Reported T2DM				Total	Column
			No	%	Yes	%	Count	%
Country of Origin_ Africa	Male	W/o T2DM	678	100.0%	0	0.0%	678	91.6%
		With T2DM	0	0.0%	62	100.0%	62	8.4%
		Total	678	91.6%	62	8.4%	740	100.0%
	Female	W/o T2DM	736	100.0%	0	0.0%	736	93.6%
		With T2DM	0	0.0%	50	100.0%	50	6.4%
		Total	736	93.6%	50	6.4%	786	100.0%
	Total	W/o T2DM	1414	100.0%	0	0.0%	1414	92.7%
		With T2DM	0	0.0%	112	100.0%	112	7.3%
		Total	1414	92.7%	112	7.3%	1526	100.0%

Note. The above data may vary with variables and indicated only frequencies and percentages (%); Abbreviations: W/o = without.
Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Table 11 described the distributions summary of the sample populations for all critical variables vs. T2DM as stratified by gender. In doing so, of those male individuals with T2DM, moderately acculturated 44(11.7%), obese (BMI over 30) 2(100%), with the age range of 46 through 74 years old 38(100%), Black (9.1%) individuals with a daily consumption of fruit juice less than 0.3 servings per day 28(15%), and who earned an annual total household income of less than $45,000 59(10.5%) had shown the highest prevalence rate of T2DM as compared to the other categories. On the other hand, those females who were highly acculturated 14 (15.6%), obese 50(13.7%), with the age of over

75 years old 14(24.1%), who also self-identified their cultural racial origin as white 50(12.3%), along with a daily consumption frequencies (servings) of fruit juice less than 0.3 servings per/day 33 (11.0%)**,** and who were earning an annual total household income of $45,000 - $90,000 15(6.7%) had also shown the highest self-reported T2DM as compared to the other group (s) within their categories.

Though there were explicit variations in the outcomes of some variables between both genders, in general, the summarized study results obviously indicated that those individuals who were highly acculturated 14 (15.6%), self-reported to be obese 52 (14.2%), with the age of over 75 years old 14 (24.1%), self-identified themselves as a White cultural racial origin 75(10.4%), having with a fruit juice consumption frequencies of less than 0.3 servings/day 61(12%), and those who were earning an annual total household income of less than $45,000 59(10.5%) had shown the highest percentage of T2DM as compared to the other categories within their variables (Please see Table 11 here below for details of the summary results).

Table 11

The Baseline Descriptive Summary of the Sample Populations for all Key Study Variables vs T2DM Stratified by Gender.

			Self-Reported T2DM					
Variable	Gender	Category	No	%	Yes	%	Total	% Col Total
Accul_Index	Male	Low	347	95.1	18	4.9	365	49.3%
		Moderate	331	88.3	44	11.7	375	50.7%
		Total	678	91.6	62	8.4	740	100.0%
	Female	Moderate	612	95.3	30	4.7	642	81.7%
		High	76	84.4	14	15.6	90	11.5%
		Total	736	93.6	50	6.4	786	100.0%
	Total	Low	347	95.1	18	4.9	365	24.8%
		Moderate	943	92.7	74	7.3	1017	69.1%
		High	76	84.4	14	15.6	90	6.1%
		Total	1366	92.8	106	7.2	1472	100.0%
BMI Self-report	Male	< 24.9	649	96.1%	26	3.9%	675	91.2%
		25.0 – 29.9	29	46.0%	34	54.0%	63	8.5%
		Over 30	0	0.0%	2	100.0%	2	0.3%
		Total	678	91.6%	62	8.4%	740	100.0%
	Female	25.0 – 29.9	408	100.0%	0	0.0%	408	51.9%
		Over 30	315	86.3%	50	13.7%	365	46.4%
		Total	736	93.6%	50	6.4%	786	100.00%
	Total	< 24.9	649	96.1%	26	3.9%	675	44.6%
		25.0 – 29.9	437	92.8%	34	7.2%	471	31.1%
		Over 30	315	85.8%	52	14.2%	367	24.3%
		Total	1401	92.6%	112	7.4%	1513	100.0%
Age	Male	< 45 yrs.	678	96.6	24	3.4	702	94.9%
		46 – 74 yrs.	0	0	38	100	38	5.1%
		Total	678	91.6	62	8.4	740	100.0%
	Female	< 45 yrs.	185	100	0	0	185	23.5%
		46 – 74 yrs.	507	93.4%	36	6.6%	543	69.1%
		> 75 yrs.	44	75.9	14	24.1	58	7.4%

…… (table continues).

Variable	Gender	Category	Self-Reported T2DM No	%	Yes	%	Total	% Col Total
		Total	736	93.6	50	6.4	786	100.0%
	Total	< 45 yrs.	863	97.3	24	2.7	887	58.1%
		46 – 74 yrs.	507	87.3	74	12.7	581	38.1%
		> 75 yrs.	44	75.9	14	24.1	58	3.8%
		Total	1414	92.7	112	7.3	1526	100.0%
FruJuice	Male	< 0.3	160	85%	28	15%	188	27.7%
consumption		>=0.3	458	93%	32	7%	490	72.3%
(servings/day)		Total	618	91%	60	9%	678	100.0%
	Female	< 0.3	276	89%	33	11%	309	38.2%
		>=0.3	475	95%	24	5%	499	61.8%
		Total	751	93%	57	7%	808	100.0%
	Total	< 0.3	436	88%	61	12%	497	33.4%
		>=0.3	933	94%	56	6%	989	66.6%
		Total	1369	92.1%	117	7.9%	1486	100.0%
Black	Male	Yes	368	90.9%	37	9.1%	405	51.1%
Cul/Racial		No (Whites)	363	93.7%	25	6.4%	388	48.9%
		Total	731	92.2%	62	7.8%	793	100.0%
	Female	Yes	421	100%	0	0	421	50.8%
		No (Whites)	357	87.7%	50	12.3%	407	49.2%
		Total	778	94.0%	50	6.0%	828	100.0%
	Total	Yes	752	95.3%	37	4.7%	789	52.3%
		No (Whites)	645	89.6%	75	10.4%	720	47.7%
		Total	1397	92.6%	112	7.4%	1509	100.0%
Income	Male	< $45 K	501	89.5	59	10.5	560	75.7%
Tot Hhold		$45K - $90K	177	98.3	3	1.7	180	24.3%
		Total	678	91.6	62	8.4	740	100.0%
	Female	$45K - $90K	208	93.3	15	6.7	223	28.4%
		Over $91K	527	93.8	35	6.2	562	71.6%

…… (table continues).

Variable	Gender	Category	Self-Reported T2DM				Total	% Col Total
			No	%	Yes	%		
		Total	735	93.6	50	6.4	785	100.0%
	Total	< $45 K	501	89.5	59	10.5	560	36.7%
		$45K - $90K	385	95.5	18	4.5	403	26.4%
		Over $91K	527	93.8	35	6.2	562	36.9%
		Total	1413	92.7	112	7.3	1525	100.0%
Country of Origin_Africa	Male	W/o T2DM	678	100.0%	0	0.0%	678	91.6%
		With T2DM	0	0.0%	62	100.0%	62	8.4%
		Total	678	91.6%	62	8.4%	740	100.0%
	Female	W/o T2DM	736	100.0%	0	0.0%	736	93.6%
		With T2DM	0	0.0%	50	100.0%	50	6.4%
		Total	736	93.6%	50	6.4%	786	100.0%
	Total	W/o T2DM	1414	100.0%	0	0.0%	1414	92.7%
		With T2DM	0	0.0%	112	100.0%	112	7.3%
		Total	1414	92.7%	112	7.3%	1526	100.0%

Note. The above data may vary with variables and indicated only frequencies and percentages (%); *Abbreviations:* W/o = without. *Data Source*: Statistics Canada. (2007-2014, 2007-2014a*). CCHS 2007—2014* (master files). Statistics Canada (producer).

Inferential Statistics

Multivariable Analyses

Multivariable analyses were conducted to analyze the data, & to reach to evidence-based inferences, as well as to address the research question of interest. Self-reported T2DM was the outcome variable having with two nominal categories, a yes or no response, examined under this study. A binary logistic regression model was chosen as the appropriate multivariable parametric test to investigate the stated hypotheses, to predict any relationship or associations of the potential predictors with the outcome

variable, and to identify the relationship of the dependent variable that was explained by the key independent variables & the study covariates.

Of the total weighted sample populations (n=1,526), only 1,336 individuals were selected and entered into the binary logistic regression model for analysis and the rest remained to be some missings and outliers (n=1,90). The Hosmer and Lemeshow goodness of fit test was also attested that the selected model was a good model fit as evidenced by the nonsignificant *p*-value of 0.163.

In addition to this, the reported Nagelkerke RSquare (the pseudo R^2) showed 82.0% prediction test result, which also indicated that the selected LR model was the right model and able to show the variability of the outcome variable as explained by the predictors that entered into the model. Thus, to assess those research questions and test the stated hypotheses, a binary logistic regression model was found to be a good fit to be employed, and the results reported as follows:

In Step 1. All combined study variables the demographic (income, country of origin, gender, age, and ethnicity), sociocultural (acculturation), and the BRFs (obesity and diet/dietary habits) were entered into the logistic regression model to test their relationship or associations with the dependent variable, T2DM.

As mentioned previously, the physical activity variable, one of the behavioral risk factors in this study, was removed from the model. The rationale for its removal was for being nonsignificant in the logistic regression results, having issues of multicollinearity, and having high missing data points played an additional crucial role for the Leisure Physical Activity Index variable to be dropped and not to enter it into the model along

with the other study variables. In this step one, no adjustment for known covariates made at this time, and the full (unadjusted) logistic regression model used as depicted under RQ1 mentioned here below:

Research Question #1. Is there an association between income, acculturation, country of origin, BRFs (obesity, physical activity, and diet/dietary habits), age, gender, ethnicity, and t2dm? this first rq investigated and tested the null hypothesis, using the full unadjusted model, whether the demographic (income, country of origin, gender, age, and ethnicity), sociocultural (acculturation), and the BRFs (obesity and diet/dietary habits) were the key predictors or independent factors for predicting T2DM. In this initial RQ, Ho1 stated that no statistically significant relationship or associations existed between the study variables and no predictions made between the aforementioned independent risk factors and T2DM.

However, as summarized in Table 12, the odds of T2DM were higher in those people with the age group of 75 thru highest (*OR*= 7.766, 95% *C.I:* 3.29, 18.33, $p<0.001$) and with the middle age group of 45 thru 74 (*OR*= 3.879, 95% *C.I:* 2.31, 6.513, $p<0.001$) as compared to the 15 thru 44 lower age group ones. In addition, the odds of T2DM were higher in those participants with high acculturation index (*OR*=3.135, 95% *C.I:* 1.377, 7.136, $p=0.012$) and with moderately acculturated individuals (OR= 2.285, 95% C.I: 1.231, 4.241, $p= 0.01$) as compared to those people with low acculturation index (reference group). Also, the odds of T2DM were higher in those survey participants with lowest thru $44999.00 (*OR*=2.839, 95% C.I: 1.554, 5.187, $p<0.001$) and with the $95000 thru highest total annual household income group (*OR*=1.385, 95% C.I: 0.736, 2.608,

p<0.001) as compared to the middle income group ones (reference group). The odds of T2DM were also higher in those participants with a BMI scale of 30 thru HIGHEST, obese group (*OR*= 4.547, 95% *C.I:* 2.627, 7.871, *p*<0.001) and with a BMI scale of 25.0 thru 29.95, the overweight group (*OR*= 1.633, 95% *C.I:* 0.927, 2.878, *p*<0.001)) as compared to the lower BMI scale of under 24.9 (the reference group). In all the above-indicated variables, the odds of T2DM were found to be higher, and all the results were found to be statistically significant that supported the alternative hypothesis as set out in the RQ1.

On the other hand, the odds of T2DM were lower in those female participants (*OR*=0.892, 95% *C.I:* 0.573, 1.388, *p*<=0.613) as compared to male (the reference group) African immigrants participated in the CCHS. The odds of T2DM were also lower in those participants who identified themselves from a Black cultural/racial origin (*OR*= 0.686, 95% *C.I:* 0.43, 1.10, *p*= 0.120), as compared to those White (non-Black) group of individuals (the reference group) as well. Unfortunately, the BLR results obtained from computing both variables, i.e., gender vs. T2DM and Black cultural/racial origin vs. T2DM, were found to be statistically nonsignificant that supported the initially depicted null hypothesis.

The odds of T2DM were also found to be lower (protective) in those individuals who consume 0.3 or more servings of fruit juice per day (*OR*= 0.605, 95% *C.I:* 0.386, 0.948, *p*= 0.03) as compared to those individuals who consumed less than 0.3 servings of fruit juice per day. The result was statistically significant in rejecting the null hypothesis.

In Step 2. The covariates, BRFs (obesity and diet/dietary habits) and some of the demographic factors such as gender, age, & ethnicity were entered into the BLR model, while the other demographic factors such as income, country of origin, and the sociocultural factor (acculturation) adjusted for known confounders. As mentioned in Step 1 above, leisure physical activity index variable was also removed from step 2 model as well.

Research question 2. Is there an association between the Covariates [behavioral risk factors (obesity, physical activity, & diet/dietary habits), age, gender, ethnicity], and T2DM after adjusting for income, acculturation, & country of origin? This RQ examined and tested the null hypothesis using the partial LR model whether the known Covariates were independent risk factors for T2DM while adjusting for income, acculturation, & country of origin variables. The null hypothesis stated that there were no statistically significant associations or relationships between the known covariates and T2DM and no predictions made between those risk factors and the outcome variable even after adjusting for income, acculturation, & country of origin.

In Step 3. The demographic risk factors such as income, country of origin, and the sociocultural factor (acculturation) were entered into the binary logistic regression model while the other the covariates BRFs(obesity and diet/dietary habits) and some of the demographic factors such as gender, age, and ethnicity adjusted for known confounders. As aforementioned in Step 1 above, leisure physical activity index variable was not entered in this model too.

Research question 3. Is there an association between income, acculturation, and country of origin after adjusting for BRFs (obesity, physical activity, and diet/dietary habits), age, gender, ethnicity, and T2DM? This final RQ had also examined whether the key independent variables income, acculturation, and country of origin associated with the outcome variable and whether they were statistically significant predictors of T2DM after adjusting for known covariates indicated above. The null hypothesis stated that the key independent variables were not statistically significant predictors for T2DM and did not associate with the outcome variable even after adjusting for the known Covariates.

In regards to all the BLR model results following the examining of the RQ2, RQ3 and the apparent testings' of the initially stated null hypotheses, no remarkable variations were found and remained the same as with the results of RQ1. The test outcomes from the multivariable analysis remained unchanged even if the covariates and the key IVs were interchangeably adjusted for known confounders and couldn't observe any prominent variations in the results of all the three RQs. So, the RQ2 and the RQ3 results were not discussed here to avoid redundancy and misinterpretations.

For the final test outcomes and analyses results obtained from running the BLR models pertain to RQ2 and RQ3, please refer the detailed analyses explained in RQ1 and also refer the total results submitted on Table 12 here below.

Table 12

Multivariable Analysis Summary Statistics (BLR) of Risk Factors Predicting T2DM

Variables in the Model

Odds Ratio Estimates					
Effect	DF	P-value	OR	95% Wald Confidence Limits	
DHH_SEX Female vs Male	1	0.6125	0.892	0.573	1.388
ACCULTURE_INDEX High vs Low	1	0.0121	3.135	1.377	7.136
ACCULTURE_INDEX Moderate vs Low	1	0.0121	2.285	1.231	4.241
HWTDBMICAT 25.0 thru 29.95 vs Lowest thru 24.98	1	<.0001	1.633	0.927	2.878
HWTDBMICAT 30 thru HIGHEST vs Lowest thru 24.98	1	<.0001	4.547	2.627	7.871
SDC_43D_CAT Black vs Non-Black	1	0.1158	0.686	0.429	1.097
INC_3_CAT 95,000 thru Highest vs 45,000 thru 94,999	1	0.0006	1.385	0.736	2.608
INC_3_CAT Lowest thru 44,999 vs 45,000 thru 94,999	1	0.0006	2.839	1.554	5.187
DHH_AGE_CAT 45 thru 74 vs 15 thru 44	1	<.0001	3.879	2.31	6.513
DHH_AGE_CAT 75 thru Highest vs 15 thru 44	1	<.0001	7.766	3.29	18.332
FVCDJUICAT 0.3 or more servings per day vs less than 0.3 servings per day	1	0.0283	0.605	0.386	0.948

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

Univariate Analysis

Table 13 also summarized the univariate analysis, the univariate logistic regression test results, of the study risk factors predicting T2DM. As presented in the test results below, except gender and Leisure Physical Activity Index variables, all the other

study variables had shown statistically significant associations with the prevalence of T2DM. Inconsistent with the test results of the multivariable analysis presented in Table 12, the odds of having a higher percentage of T2DM were observed in most study variables as evidenced in the Univariate analysis test results as well. These relationships or associations were also statistically significant and rejecting the null hypothesis as evidenced by the test statistics shown in among those individuals who were: highly acculturated *(OR*=3.75, 95% *C.I*: 1.792, 7.848, *p*=0.002*)* , obese (BMI >=30) *(OR*=5.854, 95% *C.I:* 3.528, 9.715, *p*<0.001*)*, having a total household annual income of less than $45,000 *(OR*=1.759, 95% *C.I:* 1.138, 2.721, *p*=0.001*)*, adults or seniors with an age of >=75 years old *(OR*=11.216, 95% *C.I:* 5.436, 23.143, *p*<0.001*).*

Though, the odds of having T2DM was also higher in those individuals who reported that they were inactive in leisure physical activities *(OR*=1.253, 95% *C.I:* 0.826, 1.903, *p*=0.289) as compared to those active and moderately active individuals, the test result was unfortunately found to be statistically nonsignificant and failed to reject the null hypothesis. Contrarily, in this univariate analysis, the odds of having T2DM were found to be lower in among females, which might have shown a protective effect, as compared to males *(OR*=0.736, 95% *C.I:* 0.5, 1.085, *p*<0.121*)*; however, this result was also statistically nonsignificant and failed to reject the null hypothesis too.

On the other hand, the odds of having T2DM were lower and statistically significant in those Black individuals as compared to the Whites *(OR*=0.425, 95% *C.I:* 0.283, 0.639, *p*<0.001*)* and in those participants who were consuming fruit juice >= 0.3 servings per day *(OR*=0.623, 95% *C.I:* 0.467, 0.831, *p*<0.001*)* as compared to their

counterparts who consumed < 0.3 servings per day. In doing so, the above-indicated test results confirmed to be statistically significant; so, that the null hypothesis was rejected in this regard as well (Please refer Table 13 for further details here below).

Table 13

Univariate Analysis Summary statistics (BLR) of Risk Factors predicting T2DM

Odds Ratio Estimates

Effect	P-value	OR	95% CI Lower	95% CI Upper
ACCULTURE_INDEX High vs Low	0.00186	3.75	1.792	7.848
ACCULTURE_INDEX Moderate vs Low	0.00186	1.554	0.911	2.651
DHH_SEX Female vs Male	0.12146	0.736	0.5	1.085
HWTDBMICAT 25.0 thru 29.95 vs Lowest thru 24.9	<0.0001	2.004	1.186	3.387
HWTDBMICAT 30 thru HIGHEST vs Lowest thru 24.9	<0.0001	5.854	3.528	9.715
PACDPAI Inactive vs Active/Moderate Active	0.28906	1.253	0.826	1.903
SDC_43D_CAT Black vs Non-Black	0.00004	0.425	0.283	0.639
INC_3_CAT 45000 thru 94999 vs 95000 thru Highest	0.00136	0.715	0.4	1.278
INC_3_CAT Lowest thru 44999 vs 95000 thru Highest	0.00136	1.759	1.138	2.721
DHH_AGE_CAT 45 thru 74 vs 15 thru 44	<0.0001	5.255	3.273	8.437
DHH_AGE_CAT 75 thru Highest vs 15 thru 44	<0.0001	11.216	5.436	23.143
FVCDJUI >=0.3 servings/day vs < 0.3 servings/day	0.0013	0.623	0.467	0.831

Data Source: Statistics Canada. (2007-2014, 2007-2014a). CCHS 2007—2014 (master files). Statistics Canada (producer).

Bivariate Analyses

As summarized in Table 14, bivariate analyses using Spearman Correlation (for continuous variables) and chi-square test (for categorical variables) were conducted

between T2DM, as a categorical dependent variable, and all other key study variables, including the covariates, to investigate the existence of any bivariate relationships among the study risk factors. The bivariate correlation analysis examined the associations between T2DM versus the numerical variables (age, and income variables) whereas the Chi-Square test assessed the associations between T2DM versus the categorical variables (Gender, CultRacialOrigin_Black, Acculture_Index, BRF_Diet_Fruit Juice, BRF_PA_LesiurePA_Index, and BRF_Obesity_BMI variables). For reasons of simplicity, the Pearson chi-square test results were also compiled and presented along with descriptive univariate statistics on Table 14. In addition to this, as depicted with the multivariable analyses in the sections above, the bivariate analyses had also examined the study RQs and the test hypotheses accordingly:

Research Question 1. This first RQ investigated whether income, acculturation, country of origin, BRFs(obesity, physical activity, and diet/dietary habits), age, gender, ethnicity were independent risk factors for T2DM.

In doing so, primarily a bivariate Spearman correlation analysis investigated whether the numerical variables income and age were independently associated with T2DM. From this statistical analyses (See Table 14), actually, the results indicated that Age, $r_s = 0.219$, $p < 0.01$, and Total Household Income (best estimate), $r_s = 0.076$, $p < 0.01$ did show statistically significant associations with T2DM.

Also, following the bivariate spearman's correlation analysis of the 1st RQ, a Chi-square test was also conducted to test if the categorical study variables mentioned above were associated with T2DM. As summarized here below on Table 14, the results from a

Pearson Chi-Square (X^2) test were presented in details: Fruit Juice consumption, $X^2(1, N=1,526) = 3.012$, $p=0.028$, BMI, $X^2(3, N=1,526) = 38.385$, $p<0.01$, ethnicity as represented by the CultRacialOrigin_Black variable, $X^2(1, N=1,526) = 17.971$, $p<0.01$, Acculture_Index, X^2 $(2, N=1,526) = 12.222$, $p<0.01$ were also found to be statistically significantly associated with T2DM. From this Chi-Square test of associations, only Gender variable, X^2 $(1, N=1,526) = 2.280$, $p=0.131$ was found to be statistically non-significant and failed to reject the null hypothesis.

Coincidentally, in all the RQs and test hypotheses, the bivariate analyses results were also consistent with the multivariable analyses of the binary logistic regression model findings. For example, as per the Pearson Chi-square test results for the categorical variables indicated, those individuals with non-Black cultural racial origin, highly acculturated, who self-reported to have a high BMI score and consumed a less than 0.3 servings of fruit juice per day were significantly statistically associated with T2DM as compared to the other categories in their groups. These results were supporting the alternative hypothesis as initially stated and they were inconsistent with the multivariable analysis test results too. On the other hand, the results from those individuals with self-reported leisure physical activities indicated that it was marginally associated with T2DM as indicated by the Chi-square test result for a LeisurePA_Index variable, $X2(2, N=1526) = 6.352$, $p=0.042$. However, the bivariate analysis test result from the association of leisure physical activity with T2DM and the result obtained from Chi-square statistic test actually confirmed that it was not inconsistent with the

nonsignificant test results of the multivariable analysis for the variable leisure physical activity *(OR*=0.83, 95% *C.I:* 0.52, 1.32, *p*=0.422*)* that supported the null hypotheses.

In addition to this, the Spearman correlation was also conducted to test if the following continuous variables (age and total household income) and T2DM were correlated. These test results indicated that both Age *(r_s = 0.219, $p < 0.01$),* and Total Household Income (best estimate; r_s= -0.071, $p<0.01$*)* were found to be statistically significantly associated with T2DM. This result was in support of the alternate hypotheses (H_{A1}) of the research question indicated above, and it was in support of the results obtained from the multivariable analysis as well.

Table 14

Bivariate Spearman's Correlation and the Chi-square Association Test Results between T2DM and Study Variables

Ser. No.	Variables Name	Correlation Spearman r (r_s)	Sig. p-value	Chi-Test Pearson r	df	Sig.
1	Age	0.219	0.01			
2	Total Hhold Income	0. 076	0.01			
3	Fruit Juice			3.012a	1	0.0283
4	Gender			2.280a	1	0.131
5	BMI self -reported			38.385e	3	0.000
6	PA_Leisure PA Index			6.352b	2	0.042
7	Cultural/racial group _Black			17.971d	1	0.000
8	Acculturation_Index			12.222c	2	0.002

Data Source: Statistics Canada. (2007-2014, 2007-2014a). *CCHS 2007—2014* (master files). Statistics Canada (producer).

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 54.31
b. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 1.41.
c. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.48.
d. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 53.44.
e. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 1.03.

In conclusion, with the bivariate analyses, an attempt was made to assess if any possible associations or correlations existed between the study variables and the prevalence of T2DM through testing all the hypotheses identified in the previous chapters. Because all the test results of the hypotheses under the three RQs were found to be similar in the bivariate analyses, only the hypotheses test results under RQ1, which were common to all the three RQs, presented in details here.

Summary

The final study outcomes obtained from the univariate, bivariate, and multivariable statistical analyses were largely and in most part supporting the initially set H_{a1} confirming that most of the study predictors were statistically significantly associated with the prevalence of T2DM. However, few variables, as depicted earlier, representing physical activity indices (PACDLTI, - Leisure and Transport Physical activity index and PACDPAI - Leisure Physical activity index) were removed from the multivariable analyses. Primarily, due to the limitations on the degree of freedoms to be used in the current research study as compared to the sample sizes of the population of interest. Secondarily, the results from the BLR model were statistically nonsignificant (p>0.05) as compared to all other study variables as well.

Descriptive univariate statistics also employed besides the inferential statistical tests described above to examine any associations or relationships existed between the predictors and the outcome variables under the current research study that targeted the African immigrant populations residing in Ontario, Canada.

The total household income, acculturation, and country of origin and the known covariates were entered into the binary logistic regression model interchangeably as independent risk factors and as covariates for assessing or examining the relationships and predicting the prevalence of T2DM. Secondary data analysis was conducted using the 2007-2014 CCHS microdata held and administered by Statistics Canada. The details of the statistical test results were presented accordingly in the tabular forms and illustrated in their appropriate places for viewing as well.

Detailed discussions, its relevance, and contributions to the current knowledge, scientific interpretations of the results, and the conclusion will be made accordingly in the next section, i.e., in Chapter 5. Finally, the social change implications of this dissertation research and the final recommendations to be addressed for future researches in similar areas of study will also be presented and discussed in depth.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

T2DM remains one of the growing challenges in the public health field around the globe. The International Diabetes Federation (IDF; 2017) estimated that about 425 million individuals are affected by diabetes around the globe. This morbidity is expected to rise to 642 million in the coming 20 years (IDF, 2017). T2DM constitutes 90% of the total cases of diabetes and has been one of the known chronic illnesses and disease conditions influenced by several environmental, physiological, biological, behavioral, psychosocial, sociocultural, and socioeconomically and genetically intertwined potential health risk factors (Agyemang et al., 2016; Anderson et al., 2016; Creatore et al., 2010; Dinca-Panaitescu et al., 2011; Hill et al., 2013; Lin et al., 2013; Shaw, Sicree, and Zimmet, 2010; Sherifali, 2012).

Previous research has indicated that immigrants from **sub-Sa**haran Africa were highly susceptible as compared to immigrants from other global regions and face higher diabetes risks explicitly related to T2DM than the general populations residing in the developed and industrialized Western countries such as the United States and Canada (Agyemang et al., 2016; Creatore et al., 2010; Hicks, Rodriguez, and Lopez, 2012; Sherifali, 2012). For example, African immigrants experienced two times the increase in T2DM risks as compared to the general Canadian population (Creatore et al., 2010; Shaw et al., 2010; Sherifali, 2012).

The purpose of this cross-sectional research study was to assess the existence of possible associations between the level of income, acculturation, country of origin, and

T2DM. I also evaluated the possible relationship of the covariates (i.e., the BRFs [obesity, PA, and diet/dietary behavior]; age; gender; and ethnicity) and T2DM using 2007–2014 CCHS microdata. CCHS is an annual cross-sectional survey designed and conducted by Statistics Canada to collect nationally representative data from sample populations residing in 10 Canadian provinces and three territories related to determinants of health, utilization of healthcare and health services, and assessing the status of the health of Canadians (Statistics Canada, 2011, para., 1).

In this study, I investigated these relationships or associations through targeting a sample of African immigrant populations in Ontario who participated in the 2007–2014 CCHS. A quantitative methodology with the use of a probability sampling procedure was employed accordingly to select the required sample sizes and attain the above stated purpose. I sampled a total of 1,526 African immigrants as the final study populations from the province of Ontario, Canada. Of these, 112 weighted samples were identified as individuals with self-reported T2DM, which were the subsample population of interest in this study. Secondary data analysis was carried out using these sample populations, and the study results were tabulated and presented in detail inChapter 4 to answer the research questions guiding the study.

Based on the results, I found the estimated prevalence rate of T2DM in African immigrant populations in Ontario during the study period to be 7.3%. This rate was similar to the national average of diabetes (6.7%) reported in 2014 (Statistics Canada, 2015). The prevalence rate of diabetes in Canada has remained on an increasing trend nationally. As described in the 2015 diabetes statistics report in Canada, this rising trend

has been evidenced by the extrapolated estimate of the prevalence rate of diabetes, which has been expected to rise as high as to 9.3% in the coming decades (CDA, 2018).

Discussion and Interpretation of the Findings

Analysis of Study Findings as Compared to the Literature Review

As I discussed in the results section in Chapter 4, the existence of possible relationships or associations between the independent variables, the covariates, and T2DM were investigated with the purpose of answering the following research questions:

RQ1: What is the association/relationship between income, acculturation, country of origin, the covariates and T2DM in ethnically diverse African immigrant populations residing in Ontario Canada? This research question was the unadjusted model, which was comprised of all the independent variables and the covariates entered into the binary logistic regression as a unified model and evaluated with the dependent variable.

RQ2: What is the association/relationship between income, acculturation, country of origin, and T2DM after adjusting for covariates in ethnically diverse African immigrant populations residing in Ontario Canada? The second research question also depicted a modified model. After controlling for the independent variables, I used the second research question to assess whether there exist any possible relationship or associations between the covariates and T2DM. When elaborated on more, the logistic regression model evaluated and predicted the existence of any possible associations or relationships between the covariates (BRFs [i.e., obesity, physical activity, and

diet/dietary habits]) and the sociodemographic factors (i.e., age, gender, and ethnicity) with T2DM.

RQ3: What is the association/relationship between the covariates and T2DM after adjusting for income, acculturation, and country of origin in ethnically diverse African immigrant populations residing in Ontario Canada? The third research question also depicted the adjusted model. I used it to evaluate whether any possible relationship existed between the independent variables and T2DM (i.e., assess the possible associations between the sociodemographic factors [i.e., income and country of origin] and the sociocultural factor [i.e., acculturation] with T2DM).

Through the use of these RQs in this research study, except for gender (i.e., being a female) and ethnicity (i.e., being from a Black cultural/racial origin) variables, the final, conclusive results that I obtained from all the other study variables entered into the adjusted and unadjusted multivariable analyses models dominantly confirmed the odds of higher risk of diabetes between the level of income (i.e., those participants with low annual total house hold income less than $45,000) and T2DM (*OR* = 2.839, 95% *CI:* 1.554, 5.187, $p < 0.001$); acculturation (i.e., those with high acculturation index) and T2DM (*OR* = 3.135, 95% *C.I:* 1.377, 7.136, $p = 0.012$); and the covariates (i.e., obese individuals with BMI >= 30 kg/m^2) and T2DM (*OR* = 4.547, 95% *CI*: 2.627, 7.871, $p < 0.001$) and age and T2DM in those aged 75 years old and over (*OR* = 7.766, 95% C.I: 3.29, 18.33, $p < 0.001$). On the other hand, the odds of lower risk of T2DM were observed in diet/dietary habits and T2DM in participants who were consuming fruit juice >= 0.3 servings per day (*OR* = 0.605, 95% *C.I:* 0.386, 0.948, $p = 0.03$); gender and

T2DM in female participants (*OR* = 0.892, 95% *C.I:* 0.573, 1.388, $p < 0.612$) , and ethnicity and T2DM in those participants identified themselves as Black cultural/racial origin (*OR* = 0.686, 95% *C.I:* 0.43, 1.10, $p = 0.120$)].

Overall, I found a 7.3% prevalence rate of T2DM in this study among ethnically diverse African immigrant sample populations residing in Ontario who participated in the 2007–2014 CCHS in Canada. In all of the above indicated statistical test results, the null hypotheses were conclusively rejected with statistical significance in support of the alternative hypothesis. Besides the multivariable analysis results (i.e., the results from binary logistic regression), the findings from the bivariate analysis also confirmed that there had been statistically significant associations or relationships between the study variables and T2DM. In the following subsections, I will provide detailed descriptions of the study findings as compared to those of the literature reviews.

Country of Origin vs T2DM

Several prior studies indicated that the burden of diabetes (both diagnosed and undiagnosed) has been increasing worldwide in general, and the prevalence of T2DM in particular (Agyemang et al., 2016; Anderson et al., 2016; Beagley, Guariguata, Weil, and Motala, 2014; Guariguata, Whiting, Weil, and Unwin, 2011; Spanakis and Golden, 2013). The risk of being disproportionately affected by T2DM has also been increasing and is highly associated with the country of origin of individuals immigrated from non-European countries to the Western world (e.g., the risks of T2DM in those Asian American, Latin American, Caribbean American, African, sub-Saharan African immigrants, and in a few other immigrant groups as well (Abate, Chandalia, and et al.,

2007 Adhikari and Sanou, 2012; Bennet et al., 2011; Herman and Zimmet, 2012; Rotermann, 2011; Shaw, Sicree, and Zimmet, 2010; Spanakis and Golden, 2013). Not only self-reported or diagnosed T2DM, but the prevalence of undiagnosed T2DM was also found to be rising throughout the world, especially in those developing countries with low- and middle-income levels, from where the sample study populations initially originated (see Beagley et al., 2014; Guariguata et al., 2011).

Creatore et al. (2010) and Agyemang et al. (2016) reported that the risk of having T2DM varied according to the country of origin of immigrants. For example, the chances of having T2DM were more than three times greater in South Asian immigrants and also doubled in those immigrants from sub-Saharan Africa, Latin America, and the Caribbean as compared to those Western European and North American immigrants, even after adjusting for the known covariates or confounding factors such as gender, age, income, immigrant status, and time since arrival variables too. Prior research also indicated that the incidence of diabetes risks were higher in immigrants who were born in other countries as compared to those native residents of the United States (e.g., Latinas who were born in Mexico showed a higher risk of diabetes than those Latinas who were born in the United States; Afable-Munsuz et al., 2013; Oza-Frank et al., 2013).

The long-standing notion and accepted paradigms of the healthy immigrant effects (i.e., immigrants were much healthier than those groups of populations or individuals born in the Western countries at the time of arrival to their host countries) also encompassed the target population of this study. However, this paradigm did not persist for long following their immigration to the new host countries. The health of

immigrants deteriorates through time, and they become more likely to develop various chronic diseases like T2DM, CVD, and other illnesses (Afable-Munsuz et al., 2013; Bruce Newbold, 2005; Kobayashi, and Prus, 2012).

Based on their country of origin, immigrants may also be faced with various health-related challenges, including disparities to access health care services (Creatore et al., 2010; De Maio, 2010; Shah, Vittinghoff, Kandula, Srivastava, and Kanaya, 2015). In recent studies, other researchers also described that the higher prevalence of T2DM and health disparities in diabetes and other chronic diseases were evident among immigrants from developing countries including those from Middle East and African immigrants (Bennet, Agardh, and Lindblad, 2013; Bennet et al., 2011; Grant and Retnakaran, 2012; Hicks et al., 2012; Prus, Tfaily, and Lin, 2010; Shah et al., 2015; Spanakis and Golden, 2013; Valore Project et al., 2013).

Inconsistent with the findings from all the aforementioned previous research studies, the results of this study confirmed that the prevalence of T2DM was significantly associated with the country of origin of immigrants as compared to those Canadians or people with European origin. This result was supported by the evidence that the prevalence rate of T2DM among the African immigrants in Ontario who participated in the 2007–2014 CCHS was 7.3%. This rate was similar to the estimated national prevalence rate of diabetes (6.7%) in Canada reported in 2014 (Statistics Canada, 2015). As the current findings and the evidence from the previous research studies confirmed, the country of origin is one of the dominant predictors or independent influencing factors of T2DM and should be considered and given special attention when designing various

public health programs and public health policies. The consideration of country of origin is warranted whenever intervention measures are needed to be launched in the future targeting African immigrants and all the other group of vulnerable populations who are immigrating to the province of Ontario in particular and Canada in general.

Acculturation vs T2DM

Acculturation has been explained as a dynamic and complex process comprising of several dimensions or proxies by which newcomers (refugees or immigrants) quite often experienced several changes. These changes consisted of psychological , sociocultural, and environmental changes and adopt the values, attitudes, behaviors, and the cultures of the people in the host countries where the immigrants arrive or prefer to live as the new country of residences (Anderson et al., 2016; Johnson-Agbakwu et al., 2016; Mainous, Diaz, and Geesey, 2008; O'Brien et al., 2014; Rodriguez et al., 2012).

At present, there is no universally accepted measurement scale or an agreed upon a one-fit-for-all global measurement acculturation scale of all immigrants to the western countries. However, as mentioned in several prior research studies, time since immigration or the duration of time of residence in host countries, language proficiency (quite often spoken language at home), country of birth, cultures, diet acculturation (diet/dietary habits, diet preferences), citizenship/nativity predictors have frequently been utilized as the most proxy variables for representing, defining, and creating acculturation measurement scale. Then, based on their cultural/racial identities of immigrants, various acculturation measurement scale used for measuring the level of acculturation in among multiple immigrants to western countries (Anderson et al., 2016; Hicks et al., 2012;

Johnson-Agbakwu et al., 2016; Mainous et al., 2008; O'Brien et al., 2014; Rodriguez et al., 2012).

A new acculturation variable was created for the present study, because no other prior valid acculturation measurement scale was available that to be explicitly used for African immigrants residing in Canada. The creation of the acculturation measurement scale was possible through the combinations of the available proxy variables, i.e., the language proficiency variables and the time since immigration/the length of stay in Ontario variables, which were used in the 2007-2014 CCHS microdata sets to collect the required data from the sample target Canadian participants. The combination of those proxy variables for the creation of acculturation measurement scale was also supported by the prior studies as well (Alkerwi et al., 2012; Anderson et al., 2016; O'Brien et al., 2014).

Following this process, as also indicated in the current study data, acculturation was measured with the use of the newly created acculturation variable that was denoted by AI. Based on this newly created acculturation index variable, those respondents who self-reported to have T2DM were categorized into three distinct levels: Low acculturated (those people with acculturation index equal to 1), moderately acculturated (those people with acculturation index equal to 2) and highly acculturated (those people with acculturation index equal to 3). The following proxy categories employed as a reference, as used in the CCHS questionnaires, to elucidate the rational premises used to creating the acculturation index for African Immigrants residing in Ontario. These categories were:

Language proficiency variables. Indicated the language (1st official language learned/still understand and spoken language at home) variables used to create the acculturation index and the apparent acculturation levels to measure the association of acculturation and T2DM.

Languages	Acculturation	
Spoken at home/ still learn & understand	Index	Level
English Only	3	High
French Only	3	High
English and French	2	Moderate
English, French and others	2	Moderate
Neither English nor French	1	Low /No acculturation
ALL Other Languages	1	Low /No acculturation

Length of time since immigrated Variable. Indicated the length of time since the participants immigrated to Canada and had been the resident of Ontario. Also, it included the percentage of African immigrants with self-reported T2DM who had been participated in the CCHS during the indicated study periods.

Length of Time since immigrated to Ontario (in years)	Self-reported T2DM (%)
Less than 10 years	4.8
10 through 20 years	7.2
Greater than 20 years	13.8

In regards to reporting on the investigation of the association or relationships of Acculturation with T2DM, and its contribution as an independent risk factor to T2DM, the findings from the current study confirmed that there had been a statistically significant association between acculturation and the prevalence of T2DM in among ethnically diverse African immigrants in Ontario (p=0.002*)*.

In addition, those survey participants with a high acculturation index did have shown a higher odds of T2DM in multivariable logistic regression analyses (*OR*=3.135, 95% C.I: 1.377, 7.136, $p = 0.012$) and in univariate analysis too (*OR*=3.75, 95% C.I: 1.792, 7.848, $p<0.001$). Of note, in descriptive analysis, those African immigrant participants with a high acculturation index had also shown the highest percentage of self-reported T2DM (15.6%) as compared to the other categories in the acculturation group (moderately acculturated group 7.3% and low acculturation group 4.9%). In line with the above results, the evidences from the descriptive analysis also confirmed that, those moderately acculturated males (11.7%) and highly acculturated females (15.6%) were also at higher risk for having T2DM as compared to those low acculturated (4.9%) individuals when we examined the overall distributions between both genders.

In support of the findings from the prior research studies, the present study results were also found to be in favor of the evidence reported on the associations or relationships of acculturation with T2DM. In the previous research studies, they depicted that acculturation remains to be one of the independent predictors associated with higher prevalence of T2DM in among most culturally/racially diverse groups of immigrant populations studied so far (Afable-Munsuz, Mayeda, Pérez-Stable, and Haan, 2013; Anderson et al., 2016; Garcia, Gold, Wang, Yang, Mao, and Schwartz, 2014; Kandula et al., 2008 Oza-Frank, Chan, Liu, Burke, and Kanaya, 2013; Rotermann, 2011)

Moreover, the current study findings also supported the previous results in depicting that, the time since immigration as a proxy variable of acculturation had been associated with increased risks of T2DM. For example, those foreign-born immigrants

and who were long-term residents of Canada and the United States more likely to report an increased prevalence of T2DM. Not only the above immigrants, but those who identified themselves as individuals with culturally/racially from non-European origins were also quite often reporting a high prevalence of T2DM as compared to Whites and those group of populations who had been born in Canada and in other industrialized or developed countries as well (Anderson, 2016; Ford, Narayan, and Mehta, 2016; Hicks et al., 2012; Oza-Frank , Stephenson, and Narayan, 2011; Oza-Frank et al., 2013; Rotermann, 2011; Venkatesh et al., 2013; Zheng, 2012).

The current study results also supported the findings from the previous literatures indicating that those immigrants with limited languages proficiencies (English and/or French), one of the proxy variable used for acculturation index variable in this study, had also reported that they had experienced a poor self-rated health or chronic illness including T2DM, CVD, obesity, hypertension, and others alike (Al-Dahir, Brakta, Khalil, and Benrahla, 2013; Lommel and Chen, 2016; O'Brien, 2014; Okafor, Carter-Pokras, Picot, et al., 2013; Zheng, 2012).

In contrary to the above findings, there had been a previous research study reporting a different result as well. In this result, they indicated that country of birth and language acculturation had not been associated with the risk of diabetes in among Mexican American population born in Mexico and who lived in the United States as opposed to those highly acculturated US-born Mexican American populations who had shown a high prevalence of diabetes (Afable-Munsuz et al., 2013; Anderson et al., 2016; Garcia et al., 2012). They also depicted that this condition might be related to the

complex nature of acculturation that could not be explained by one or two proxy variables or due to other mediating factors affecting the relationship. Further studies with the various contributions of the proxies or the consideration of additional studies with the disaggregation of the Hispanic immigrant populations by ethnicity or by place of birth might be needed to elucidate this relationship among such Hispanic immigrant populations.

Furthermore, though culture was not included as a proxy of acculturation in this study, previous literature reported that culture had been considered as one of the proxies for acculturation measurement scale. They stated that consideration of immigrant cultures or encouraging the cultural practices associated with immigrant languages, diet acculturation, and diet preferences, would help to mitigate the prevalence of diabetes as observed in many immigrant populations to industrialized and developed countries (Cha et al., 2012; Deng, Zhang, and Chan, 2013; Garcia et al., 2014; Venkatesh, and Weatherspoon, 2018; Zheng, 2012).

Also, in contrary to the current study findings, which were indicating a positive association of acculturation vs. T2DM in moderately acculturated males and highly acculturated females from the sample African immigrant populations, there had also been another different result reported from one prior research study conducted that was investigating the Arab American people. As per the published findings that there had been a negative correlation between the acculturation variables and risk of diabetes in Arab males and the acculturation variables and diabetes risk in American females (Al-Dahir et al., 2013). This deviation from the current and the reported previous research

results might be attributed due to a methodological problem in designing of the study or the use of valid Acculturation measurement scale, if available, or in the absence of an Acculturation Scale specific for the Arab American populations. Also, this opposing result might be due to some genetic variations and cultural racial or ethnic differences between the Arab Americans and all other immigrant populations residing in the United States. This finding might need another confirmatory research study to furtherly investigate these differences and to clarify the conflicting report observed in the above-indicated literature as opposed to the most previous literature supporting the positive relationships between both factors, acculturation, and T2DM.

Thus, as I observed from the current study findings and supported by the results of most previous studies mentioned above, the associations or relationships of acculturation and T2DM was found to be statistically significant that rejected the null hypothesis stated in the study RQ1. Hence, as acculturation influenced the prevalence of T2DM in many several ways through its enablers or proxies, considerations of those controlling factors may help to mitigate the increased risks of T2DM in among the study African immigrant populations in Ontario and all other immigrants residing in Canada as well.

Income vs T2DM

This study also contributes to the growing literature on the crucial importance of the level of income, as one of the markers of SES that influences the prevalence of T2DM. With this in mind, in the current study, the relationships or the associations of the

level of income and T2DM was assessed in among ethnically diverse African immigrants in Ontario through secondary data analysis of the 2007-2014 CCHS microdata.

The confirmatory results obtained from the univariate analysis (*OR* = 1.759, 95% CI: 1.138, 2.721, $p<0.001$) and multivariable analyses (*OR* = 2.839, 95% CI: 1.554, 5.187, $p<0.001$) indicated that the odds of the risk of T2DM were higher in those low-income individuals having with a total household annual income of less than $45,000 as compared to those middle and high-income individuals. In support of the test results indicated above, the bivariate analysis (Spearmans correlation for total household income (best estimate; $r_s = 0.076$, $p < 0.01$) also confirmed the presence of potential relationships between these variables as well. The current study additionally confirmed from the univariate analysis that the odds of being at risk of having T2DM in those lower income individuals (*OR*=1.759, 95% CI: 1.138, 2.721, $p<0.001$*)* had also been as 2.5X as those individuals with the highest income levels (*OR* = 0.715, 95% CI: 0.4, 1.278, $p<0.001$). In general, the above-indicated test results proved that the stated relationship was found to be statistically significant at $p<0.01$ and rejected the initially depicted null hypothesis.

This study finding was also inconsistent and was supportive of the results reported by most previous research studies which were depicting that, as one of the social determinants of health and as a marker of SES, the level of income had shown inverse relationships or associations with an increased in the prevalence of T2DM. Though, the strength of the associations varied between both genders and in among various countries, this dynamic associations or relationship of income status and T2DM generally held true

specifically in those group of population with low-income status as compared to the higher income ones who were residing in the developed, middle and low-income countries (Agardh, Allebeck, Hallqvist, Moradi, and Sidorchuk, 2011; Dasgupta, Khan, and Ross, 2010; Dinca-Panaitescu et al., 2011, 2012; Lee et al., 2011; Lysy et al., 2013).

Thus, consistent to the present study, income as a social determinant of health and as an essential risk factor to influence the prevalence of T2DM, it also confirmed to be affecting the social status of those disadvantaged populations with low income gradients like study immigrant populations from developing countries as opposed to the wealthiest group of people. As mentioned above, the current study findings, hence, confirmed the results reported by most of the previous research literature indicating that lower income level inversely associated with an increase in the risk of T2DM. On the other hand, the study result disconfirmed the findings by Hosseinpoor et al. (2012) which reported that T2DM had been the disease of the wealthy people in low and middle-income countries rather than the poor ones. However, due to some limitations of this study, as a cross-sectional study using secondary data analysis of the CCHS, it would be difficult to discern such gaps at this level, and a longitudinal cohort study in low and middle-income countries and high-income wealthy countries may warrant further exploration of this issues as well.

Covariates vs T2DM

1. Behavioral Risk Factors

Obesity vs T2DM. Obesity has become one of the global public health problems contributing to the increase in the prevalence of T2DM since the mid of the 20th

centuries and tripled from what it was in its morbidity in 1975. Recently, in 2016 more than 650 million (13% of global adult populations) people are reported to be obese (WHO, 2018; Hill et al., 2013).

With this global problem in mind, through the present study, the relationships of the BRFs (in this case obesity) and T2DM were assessed through a cross-sectional design by conducting secondary data analysis of the 2007-2014 CCHS microdata. In doing so, the current finding on the presence of possible association or relationships between obesity and T2DM were discussed accordingly here below.

The results from current dissertation research also support the findings reported from several previous research literature indicating the presence of association/relationship between obesity and T2DM. This study findings concretely indicated that those obese study participants (with BMI score over 30), regardless of variations in BMI rating among both genders, were found to show a high prevalence of self-reported T2DM as compared to those individuals having with a BMI score of 25.0 through 29.9 for over-weight and a <= 24.9 BMI score for the normal and underweight African immigrant participants (Agyemang et al., 2016; Hossain, Kawar, and El Nahas, 2007; Mawaw et al., 2017; Ngoubene-Atioky and Williamson-Taylor, 2016; O'Brien et al., 2014; Staimez, Weber, Narayan, and Oza-Frank, 2013;).

Thus, in support of the previous findings, the results obtained from multivariable (*OR* = 4.547, 95% CI: 2.627, 7.871, $p<0.001$) and univariate analyses (*OR*=5.854, 95% C.I: 3.528, 9.715, $p<0.001$), additionally confirmed that, the odds of having higher prevalence of T2DM observed in those obese African immigrant individuals with higher

BMI score as compared to those sample population with the lower BMI score (the reference group). The bivariate analyses, chi-square test, $X^2(3, N = 1527) = 38.385$, $p<0.001$ also lends additional support to the above results by confirming the presence of relationship or associations between obesity and T2DM. Additionally, these relationships or associations were also statistically significant ($p<0.01$) that rejected the null hypothesis, which initially stated that there was no relationship or associations between obesity and the prevalence of T2DM in among the study sample African immigrant populations.***Diet/ Dietary Habits vs T2DM***. For assessing the presence of possible relationships or associations between diet/dietary habits and the prevalence of T2DM, only the daily fruit juice consumption variable was found to be the only fit to be included in this study and all others diet-related variables were excluded. This exclusion was primarily based on either by having high missing data values and outliers or not be able to have complete relevant data related to the immigrants residing in Ontario Province as do so for other Canadian Provinces. Besides, the exclusion of diet-related variables was also carried out due to the limitations on the number of degrees of freedoms I should have to use as opposed to the available sample sizes of the study population of interest. Thus, the current diet-related results came from through the use of the daily fruit juice consumption variable and T2DM.

In doing so, the results obtained from the univariate (*OR*=0.623, 95% C.I: 0.467, 0.831, $p<0.001$), and multivariable analyses (*OR*= 0.605, 95% C.I: 0.386, 0.948, $p= 0.03$) of the present study provides additional value to the previous knowledge in that consumption of fruit juice with the amount of >= 0.3 servings per day provide protective

effect against the risk of T2DM as compared to those who consumed < 0.3 servings per day. The current study finding also lends additional evidence that the Odds of having T2DM was lower in those African immigrant participants who were consuming fruit juice >= 0.3 servings per day (*OR*= 0.605, 95% C.I: 0.386, 0.948, *p*= 0.03) as compared to their counterparts.

In sober fact, the observed inverse relationships or associations between the daily serving frequencies of the consumption of fruit juice and the prevalence of T2DM also found to be statistically significant in both univariate and multivariable analyses ($p<0.05$) and rejected the null hypothesis. As the above results from multivariable analysis confirmed, the bivariate analysis chi-Square test, $X2(1, N=1526) =3.012$, $p=0.028$ also supported this relationship or association with T2DM. In doing so, this result rejected the null hypothesis, which had been depicting that there was no relationships or associations between consuming daily fruit juices and the prevalence of T2DM in among ethnically diverse African immigrants in Ontario.

Though the findings from the previous research studies indicating that the type of diet and diet preferences had been related to or associated with the risk of T2DM, the present study couldn't be able to include some diet-related variables such as the type of diet and diet preferences, to assess its association or relationship with T2DM. These short-comings were due to the unavailability of complete data in the CCHS for participants from Ontario and due to sample size limitations as well. Also, the lack of valid and reliable diet acculturation measure for African immigrants to western countries as being available for other immigrants also hampered the understanding of the

association and the contribution of this diet acculturation measure to the decrease in the risk of T2DM among those susceptible African immigrant populations residing in the western countries (Venkatesh and Weatherspoon, 2018).

With additional diet-related variables and with the creation of diet acculturation measurement scale, a future study might warrant observing any additional relationships or associations between diet/dietary habits and T2DM in this immigrant population. As it was evident in Africans and other immigrant populations, immigrants from South Asian countries frequently exposed to diet and dietary habit changes that might be unhealthy for their new hosted environments. To assess such changes a dietary acculturation measure needed to be employed to pay attention to dietary patterns and cultural based diet preferences, to provide a timely public health interventions, to educate the at-risk population, and to minimize the risks associated with developing chronic illnesses such T2DM, obesity, CVD, etc., in among such immigrant communities (LeCroy, and Stevens, 2017; Okafor, Carter-Pokras, and Zhan, 2014; Venkatesh et al., 2017).

2. **Age vs T2DM.** In assessing the relationships between the age of the sample population and the prevalence of T2DM, this study revealed that those sample populations with the age of 75 years old and over were at higher risk of T2DM (*OR*=11.216, 95% C.I: 5.436, 23.143, $p<0.001$) as compared to the other categories in the age group.

Besides this, the univariate (*OR*=11.216, 95% *C.I*: 5.436, 23.143, $p<0.001$), and multivariable analyses (*OR*= 7.766, 95% *C.I:* 3.29, 18.33, $p<0.001$) results also confirmed that the odds of having T2DM were higher in those older groups of population

with the age of 75 years and over. These test results were also in conformation with the Bivariate analysis (Spearman correlation, Age, $r_s = 0.219$, $p < 0.01$) as well. Of note, these relationships were found to be statistically significant as evidenced by the p-values ($p<0.01$) of each test result that rejected the null hypothesis which stated that there are no relationships or associations between age and the prevalence of T2DM in among the sample African immigrant populations in Ontario. These results supported the previous findings of research studies that were indicating that older adult populations were found to be at a higher risk for T2DM than the younger and middle age groups (Asaduzzaman et al., 2018; Inoue, M., Inoue, K., and Akimoto, 2012; Yang et al., 2016;).

3. **Gender vs T2DM.** This study result also extends additional knowledge acquired from the previous research findings that were indicating the presence of gender variations and the prevalence of T2DM among the study population. Based on the existed gender variations, one previous research study result depicted that females from low-income status were more likely to be at a higher risk of T2DM than males who were with the same SES, e.g., income status (Ross et al., 2010). Also, Yang et al. (2016) depicted the variations in gender in support of Ross et al. (2010) and reported in their systematic review findings that the prevalence of T2DM was seen higher in males than in females.

However, in contrary to the findings from the previous results reported by Ross et al. (2010) and Yang et al. (2016), in the present study an apparent variation in the prevalence of T2DM was seen between both genders and it was indicated that males did show a higher prevalence of T2DM as compared to females in the study sample population.

Actually, the results from the univariate (*OR*=0.736, 95% C.I: 0.5, 1.085, *p* = 0.121) and multivariable analyses (*OR*=0.892, 95% C.I: 0.573, 1.388, *p*<0.61) confirmed that being a female had conferred a protective effect and a lower odds of being at risk of T2DM than males. However, as evidenced by the study results indicated above, this protective effect was not statistically significantly associated with the prevalence of T2DM and failed to reject the null hypothesis. In line with the above inferential test results, also in the bivariate analysis (chi-square test of associations, X^2 (1, *N*=1526) = 2.280, *p*=0.131), the association between gender and T2DM was also found to be statistically non-significant and failed to reject the null hypothesis.

This current finding was also being supported by a result from a recent research study elucidating that due to a shift in lifestyle (e.g., the sedentary lifestyle observed in males), the prevalence of T2DM had recently been reported more in men rather than in women (Asaduzzaman et al., 2018, Færch, 2014). Thus, men had been found to be more at risk of T2DM than women in current evidence.

4. **Ethnicity vs T2DM'** In this study, a covariate named cultural/racial origin Black'variable was used, which had two categories: Black vs. non-Black (Whites) African immigrants to assess the existence of possible relationship or associations between ethnicity and T2DM.

As evidenced by the study results from univariate (*OR*=0.425, 95% C.I: 0.283, 0.639, *p*<0.001), and multivariable analyses (*OR*= 0.686, 95% C.I: 0.43, 1.10, *p*= 0.120), those who identified themselves as a Black cultural/racial origin did have a lower odds of being at risk for T2DM as compared to the Whites (the non-Black reference group). In

confirmation with the univariate analysis, the bivariate analysis (chi-square test, $X^2(1, N=1526) = 17.971$, $p<0.01$) also proved that there exist an association between Black ethnic group and T2DM. Though both inferential statistical test results conferred a protective effect for the Black African immigrants, unfortunately, the stated relationship or the association was not statistically significant in the multivariable analysis ($p= 0.120$) and failed to reject the null hypothesis.

In contrary to the multivariable analysis, the univariate and bivariate analyses results indicated that the relationship of Blacks cultural/racial group had been found statistically significantly associated with a lower risk of T2DM, which proved the protective effect of being a Black racial-ethnic group that rejected the null hypothesis in favor of the alternative hypothesis. The variation in the multivariable as opposed to the bivariate and univariate analyses might be related to the recategorization of the ethnic groups into two groups within the cultural, racial, ethnic groups used in the CCHS.

In support of the previous research studies, this study also extended its finding to identify the relationship or association of ethnicity and T2DM in among these sample African immigrants in Ontario as do so in other various minority or ethnic groups of immigrants reported in previous literatures as well (Asaduzzaman et al., 2018; Andersen, 2015; Bennet et al., 2014; Jenum et al., 2012; Meeks et al., 2016;; Tzur, et al., 2012). As being said, Blacks and Latinos did also experience the most socioeconomic disadvantage as compared to Asian immigrants and the Whites too (Alang, McCreedy, and McAlpine, 2015; Mohan, Seedat, and Pradeepa, 2013; Yi et al., 2014).

Unfortunately, the current study findings, pertain to the associations or the relationship between Ethnicity and the prevalence of T2DM, presented an adverse outcome to the previous research findings. For example, Ford et al., (2016) and Meeks et al. (2016) also reported that Blacks racial/ethnic population and South Asians/ Indians (Asaduzzaman et al., 2018; Garduño-Diaz and Khokhar, 2012; Gray, 2010; Weber et al., 2012a; Yang et al., 2016) experienced the highest diabetes burdens as compared to other minorities and other ethnic groups (Abate, Chandalia, and et al., 2007; Adhikari and Sanou, 2012).

The variation in the findings of the current study on association of ethnicity and T2DM might be attributable to some limitations related to re-categorization of the ethnic groups into two categories, a black and nonblack cultural/ racial-ethnic (Whites) group, vetting rules, and the sample size issues as related to the maximum number of the degrees of freedom too. In general, concerning to the possible relationships or associations of ethnicity and T2DM, there had also been reported by several researchers mentioned above pertain to the presence of evident variations and diversities associated to the risk of T2DM among the several minority ethnic groups and those of the non-Hispanic whites and European ethnic origins.

Analyzing and interpreting results in the context of SDH Theoretical Framework

In this study, it had been employed SDH theoretical framework, as depicted previously, to guide the current research study. In this regard, income as one of the elements of SDH and as an enabler of the social position or as a determining factor of the

socioeconomic status, it affected or determined the place where someone's social status in the society.

In doing so, it was observed that those with lower income immigrant populations, e.g., African immigrants, Asians, and Latinos, etc., were experienced a higher risk of T2DM, obesity, and CVDs as compared to those with the higher income people as well (Booth et al., 2013). This evidence was also supported by the current study finding, which confirmed that those sample African immigrant populations with a total household annual income of less than $45,000 were found to be at higher odds of being at risk for T2DM. This variation in risks of T2DM was mediated or attributed to the presence of differences in the level of income among the study populations.

Besides this, having income inequalities among individuals or within the population also affects the social status and which indirectly affects more often the health of those people who are from the lower income gradients than the higher income group of individuals too (Booth et al., 2013; Paskov, Gërxhani, and van de Werfhorst, 2017).

Also, those immigrant populations with lower income did have shown to be more obese, experienced a poorer health status, and quite often eat an unhealthy diet which leads to death or unanticipated mortality due to T2DM, CVD, obesity, and other chronic illnesses as well. Obesity, besides to level of income and as one of the SDH, also mediates social status, leads to poor health outcomes, and to unnecessary health problems that lead to death.

Also, as elements of the SDH, cultural/racial ethnicity and acculturation (e.g., country of birth, language proficiency, duration of time since immigration, diet and

culture preferences) all other elements studied in this research played a crucial role in determining the prevalence of T2DM in among African immigrant populations. As confirmed in the current study, those highly acculturated populations did experience a higher odds of being at risk of T2DM.

Also, as indicated in this study, those obese participants, being Black, having limited language ability or proficiency, were experiencing higher odds of T2DM as compared to others. Thus, use of such SDH theoretical framework in this study had been crucial to guide and to assess the relationship of the income, country of origin, acculturation, and T2DM in presence and absence of the covariates as well.

Limitations of the Study

One of the shortcomings observed in the study populations was the presence of heterogeneity or ethnic diversities among African immigrants (Naidoo, 2014) to Ontario Canada. Due to its heterogeneity, data collections and analysis need longer time to get a complete data of these populations by ethnic groups or by country of births. This study could not achieve these conditions due to insufficient data and small sample sizes of African immigrants in Ontario participating in the 2007-2014 CCHS.

Also, due to several changes made in the use of the country of birth variables in the 2007-2014 CCHS, and incomplete data of country of birth variable, self -reported diabetes could not be assessed by using the country of births variable. Instead, to obtaining enough sample sizes and in search of completed data, these immigrant populations were selected as a whole by Africa continent or geographical region and

considered as they originated from Africa as compared to other immigrants from other geographic areas.

The other limitation was the number of African immigrants used in this study. Initially, as per the proposal, the total African immigrants residing in Ontario were targeted to be included in the study. But, due to the unavailability of complete data in the CCHS micro datasets for all African immigrants in Ontario and because it needs longer time to get access to such data from other sources, only those who participated in the CCHS were used in the study as opposed to all the African immigrants residing in Ontario Canada. If time permitted to access those additional data from other sources, the total sample sizes for the population of interest (participants with self-reported T2DM) would be increased somehow. This sample size increase might provide some reluctance on the limitations on the number of degree of freedoms as opposed to the total sample sizes required for this study as well.

The other short-comings were related to the use of secondary data. Its use importantly precluded the flexibility on the use of the secondary data as planned and its limitations from running the appropriate analyses as well. Incompleteness of data, normality related issues (that obliged me to choose nonparametric tests as opposed to the parametric one), some missing data, and outliers were also part of the limitations in this study that forced to drop some important variables that could be used in this study, e.g. Physical Activity Index, other diet-related variables, etc., were dropped out.

Lack of prevailed internationally accepted valid acculturation measurement scale designed for African immigrant populations, as per the case for Asians and Latino

immigrants to the Western countries, also put additional limitations to this study as to where to put the cut-off points of the acculturation measurement scale. Unfortunately, acculturation variable was not initially included in the CCHS questionnaires, and there were no data directly collected from the survey participants with the use of this variable. Hence, creating this variable through the combinations of other proxy variables (languages and time since immigration) became another challenge and might have some limitations in the future in measuring the intended level of acculturation in among these populations as well.

The presence of varied views of researchers on the various components or proxies of acculturation measurement scales that to be used to accurately measure the level of acculturation among multiple immigrants residing in the developed countries had also delayed the creation of valid acculturation measure as well.

This study had also had another limitation mainly related to the weakness and the inherent characteristics of the cross-sectional study design that prevented me to establish a causal relationship among the study variables with the dependent variable, T2DM.

Recommendations

To identify the inherent variations among the heterogeneous African ethnic groups, it will be beneficial to further study the African immigrants in Canada-wide and by country of births rather than by whole African region. Such study will increase the sample sizes and will also help to identify the broader needs of the African immigrant populations residing in Canada. Then, the results obtained from such Canada-wide study

will help to visualize the whole epidemiological picture of the prevalence of T2DM in Africans and all other immigrant populations much better than now.

The creation of reliable and valid Acculturation measurement scale designed for the needs of African immigrants in Canada is desperately needed through a longitudinal survey to properly apply the use of an accurate and dependable Acculturation Scale for African immigrants in Canada. Also, the establishment and identification of the commonly used proxies for creating the universally accepted acculturation measurement scale should also be considered to investigate the possible relationships or associations of acculturation and the prevalence of T2DM.

One of the additional shortcomings of this research was the use of secondary data which were solely based on self-reported CCHS primary microdata, and no other additional data (e.g., diagnosed and undiagnosed T2DM) included from other sources to make it more generalizable. Thus, the use of additional relevant data from different sources would probably enhance the generalizability of the future researches and might also help to avoid recall and information biases as well.

Implications

The current findings paved the way for the creation of acculturation measurement scale that can be used for understanding the acculturation level of the African immigrants to Ontario Canada. The logical combinations of the various proxies of acculturation had helped to create the three level of acculturation scale that was functional which able to discern the association of acculturation with the prevalence of T2DM in the sample immigrant populations.

The Public Health Agency of Canada and the Statistics Canada may consider this Acculturation measurement scale as a precursor input to proceed with the refinement of this tool to implement and revise the public health policy and programs to integrate the cultural needs of the African immigrants in Ontario and the broader immigrant populations in Canada as well.

Furthermore, the prevalence of T2DM, as evidenced by the current study results and also as supported by the 2015 diabetes statistics report in Canada, which was published by CDA in 2018, has been observed on rising trends and rapidly increase annually to reach to the 12.1% (~5.0 million people will have T2DM) prevalence rate, i.e., the projected prevalence rate of T2DM in Canada by 2025

Also, the vulnerable at risk immigrant populations are still immigrating to Canada and specifically the numbers of newcomers to Ontario is increasing in large numbers from time to time. Thus, the public health Canada should pay attention and make itself ready to these prevailed conditions in providing needs-based diabetes prevention and management services and in designing the appropriate public health programs to mitigate the risk of T2DM among these groups of immigrant populations including those from Africa as well.

As shown in details above, the current study findings, as guided by the SDH theoretical model, indicated that the income level, acculturation status, the country of origin, the obesity level, daily fruit consumptions and being African immigrants were significantly associated with the prevalence of T2DM. Thus, to mitigate the prevailed and the future burden of T2DM in ethnically diverse African immigrants, the public health

Canada and the government of Canada and all other related stakeholders should consider provision of cultural-based employment support, increasing the participation of the immigrants in physical activity, healthy eating and healthy living, and in obesity reduction programs. Besides these, provision of health promotion services to increase the awareness and the knowledge of the African immigrant populations on diabetes self-management, diabetes prevention, health care access, and healthy diet and dietary habits, also warrant strengthening the prevention efforts in curbing down the prevalence of T2DM in Ontario and Canada as well.

Conclusion

This research study was a cross-sectional quantitative study designed to assess the association or relationships of income and T2DM, acculturation and T2DM, country of origin and T2DM in the presence and absence of the Covariates through targeting the ethnically diverse African immigrants to Ontario Canada who participated in 2007-2014 CCHS. The association of the country of origin and being immigrant from Africa had also shown a positive gradient with the prevalence of T2DM.

A secondary data analysis of the 2007-2014 CCHS microdata was conducted to assess the possible association or relationships of the study variables and T2DM in African immigrants to Ontario. The results from this study confirmed that: a highly acculturated adult, with the age of >= 75 years old, obese kg/m2, earning a total household income of <$45,000, being a male and who consumed a < 0.3 servings of fruit juice per day had shown a higher prevalence of self–reported T2DM as compared to their apparent categories in their groups. Most of the relationships or the associations were

found to be statistically significant that rejected the null hypotheses and in support of the alternative hypothesis.

The newly created acculturation measurement scale with the use of the proxy variables employed in this research study included the languages and time since immigration variables. These variables were used to create a logically combined one Acculturation Index variable having with three categories: high, moderate, and low acculturation index, which was found to be functional for assessing of the association or the relationships of Acculturation level and the prevalence of T2DM in the sample populations.

SDH was the guiding theoretical framework to conduct this dissertation research study and to reach the outcomes of this research. Based on the current results as pavement and seminal research work, Public Health Agency of Canada, Government of Canada and all other stakeholders expected to revise their policies in addressing the cultural needs of the African immigrant populations in Ontario. Increasing awareness on various public health programs and creation of a reliable and a valid acculturation measurement scale warrant future success to curb the prevalence of T2DM observed in African immigrant populations residing in Ontario and Canada.

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