PREVALENCE AND FACTORS ASSOCIATED WITH SELF-REPORTED DIABETES MELLITUS IN GAUTENG PROVINCE IN SOUTH AFRICA

by

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A research report submitted to the School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Masters of Science in Epidemiology (Epidemiology and Biostatistics).

January, 2018

DECLARATION

I [**Jonathan Chiwanda Banda**] declare that this research report is my own work. It is being submitted for the degree of [**Master's in Epidemiology**] at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

11th day of January, 2018 in Johannesburg, RSA

DEDICATION

I dedicate this work to God for the unconditional love to my life. I am very thankful for giving me responsible parents whose relentless support has been a source of inspiration. It could not help at all if I don't thank God for giving me lovely wife 'Temwachi' and beloved son 'Irvine'.

ABSTRACT

Introduction Diabetes mellitus is a global public health challenge because of its increasing prevalence particularly in low and middle income countries. The prevalence of diabetes varies between countries because of differences in environmental factors and genetic susceptibility. The aim of this study was to estimate the prevalence and determine factors associated with self-reported diabetes mellitus in Gauteng province in South Africa.

Methods This was a cross sectional study that used secondary data from a household survey done in 2015 by Gauteng City-Region Observatory. The study had 30,002 participants aged 18 years and above who were selected through multistage sampling technique in which enumeration areas (EAs) as primary sampling unit were drawn using probability proportional to size. Random eligible participants per household were sampled. Prevalence was estimated as a proportion of total diabetes cases from the study sample. Logistic regression was used to analyse the association between diabetes status as an outcome and certain socio-demographic and comorbidity characteristics.

Results The estimated prevalence of self-reported diabetes was 11.23% (95% CI: 10.87-11.59) overall, 12.19% (95% CI: 11.69-12.69) in women and 10.13% (95% CI: 9.63-10.63) in men. Factors significantly associated with diabetes were being migrants who had lived in the province for less than ten years [adjusted Odds Ratio (aOR): 0.57, 95% CI: 0.47-0.69], advanced age (aOR: 1.01, 95% CI: 1.01-1.02), socioeconomic status ($p<0.0001$), Indian race (aOR: 1.52, 95% CI: 1.19-1.94). In addition, a number of comorbidities were associated with diabetes, namely hypertension, heart disease/stroke, HIV/AIDS, tuberculosis, cancer, asthma and mental illness

Conclusion The study findings reported higher prevalence of self-reported diabetes mellitus among adult population in Gauteng province compared to national prevalence (8.4%). Migrants who had stayed less than ten years and participants with low socioeconomic status were protected against diabetes. We recommend scaling up public health interventions that would reduce further growth of the disease particularly targeting higher risk population sub-groups.

Keywords: **Diabetes mellitus, prevalence, Gauteng province.**

ACKNOWLEDGEMENTS

First and foremost, I would like to thank God for His unconditional love to my life. He is the only reason for my living.

Special gratitude goes to my supervisor Dr Jabulani Ncayiyana for his untiring support during the conduct of the study.

My sincere acknowledgement goes to Dr Sufia Dadabhai, Dr Taha Taha, LaPonda Strickland and entire team from Johns Hopkins School of Public health in Maryland, USA for financial supporting towards my studies.

I would like to thank lecturers and staff of Witwatersrand School of public health for the knowledge and support during my training.

I am also indebted to thank Gauteng-City Region Observatory for providing the dataset.

Special gratitude goes to Dr Felix Chilunga, Dr Christopher Chikhosi, Mwiza Singini for their cooperation during the study period.

Appreciation goes to my colleagues and classmates for their moral support.

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AIDS: Acquired Immune Deficiency Syndrome

aOR : Adjusted Odds Ratio

AGE: Advanced glycation end products

CAPI: Computer Aided Personal Interviewing

CD4: Cluster of Differentiation 4

CI: Confidence Interval

DM: Diabetes Mellitus

EA: Enumerator Area

EMME: Eastern Mediterranean and Middle East

GRCO: Gauteng City-Region Observatory

HAART: Highly Active Antiretroviral Therapy

HICs: High Income Countries

HIV: Human Immunodeficiency Virus

IDF: International Diabetes Federation

IUD: Intrauterine fetal Death

K: Kappa

LMICs: Low and Middle Income Countries

NCDs: Non-Communicable Diseases

OR: Odds Ratio

PPS: Probability Proportional to Size

QOL: Quality of Life

SAL: Small Area Layer

SES: Socioeconomic status

SDG: Sustainable Development Goals

TB: Tuberculosis

UJ: University of Johannesburg

WHO: World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 General Introduction

Chapter 1 gives the background, literature review, problem statement and justification for the study, describing the global burden of diabetes, and also how the prevalence of this disease is now increasing in low and middle-income countries. The chapter also summarises the known risk factors for diabetes and justifies the need for this study.

1.2 Background

Diabetes mellitus (DM) is a group of metabolic disorders characterised by insulin deficiency, insulin resistance or a combination of the two leading to chronic hyperglycaemia (1). It is a huge and growing public health challenge across the globe because it affects nearly all countries and it continues to increase in numbers and significance (2). DM affected more than 387 million (8.3%) people worldwide in 2014 and was estimated to rise by 53% reaching 592 million by 2035 (3, 4). Type 2 diabetes is the commonest form accounting for more than 95% of world cases (2, 4-7). Therefore, diabetes in this study largely meant type 2 diabetes mellitus (T2DM). In addition to previous knowledge that diabetes was predominantly the disease affecting the elderly and high income countries (HICs), recent evidence has shown a disproportionately high rise in prevalence among the youth and in low and middle-income countries (LMICs). Such information was proven when analysing global prevalence whereby 80% of diabetes cases were coming from LMICs (3, 8). The largest contribution being from India, China and Brazil because they are considerably larger and more populous countries (2).

According to international diabetes federation (IDF) geographical regions, highest prevalence of the disease was reported in North America (11.5%) followed by eastern Mediterranean and middle east (EMME) (9.7%) (2). African region had lowest prevalence (5.1%) and in addition, it contained world highest percentage of undiagnosed diabetes (62%). (2) At the time of this study, the largest number of affected individuals were in the 40-59 year age group. However, predictions indicated there could be a shift with more cases belonging to 60-79 age groups by 2030 (2). Assuming the status quo, there would be a sustained annual growth of 2.2% of diabetes cases, equalling twice as much as annual growth of total world

population. Therefore, there could be an estimated 54% increase of cases from 2010 to 2030 with the highest increase affecting LMICs (69%) compared to HICs (20%) (2). In HICs, the majority would be in the ages above 60 years while in LMICs, the affected would belong to the age group 40-60 years. Therefore, this would mean higher economic burden due to diabetes in LMICs because the most affected population sub-groups would belong to productive years (<65 years) compared to HICs (2).

DM is a manageable disease but has no definitive cure. Although patients could lead a reasonably normal lifestyle, its late complications result in reduced life expectancy and major health costs (9). These complications include macrovascular diseases leading to an increased prevalence of coronary heart disease, peripheral vascular disease, and stroke and microvascular damage causing retinopathy, nephropathy and neuropathy (4, 9). In pregnancy, poorly controlled diabetes increases the risk of intrauterine foetal death (IUD) (4). In terms of economic burden, people with diabetes incur medical expenditures 3 times higher than healthy counterparts (10). The global economic cost of diabetes mellitus in 2014 was estimated at US$612.2 billion, translating to 11% of total annual global healthcare expenditure (11). It is because of these growing health challenges with economic implications that diabetes has been targeted for action by world leaders in the Sustainable Development Goals (SDG) aimed at reducing premature death by a third by 2030 (4). Diabetes together with cardiovascular diseases, cancers and chronic respiratory diseases, complete a four member group of non-communicable diseases (NCDs) prioritized in the SDG (4).

1.3 Use Of Self-Reports In Prevalence Studies

Self-reports are commonly used to estimate the prevalence of diabetes. This involves the collection of information on their disease status through the use of questionnaires, interviews or telephone surveys rather than clinical examinations and biomedical analyses (gold standard) (12, 13). Use of self-reports is usually preferred because it is economically feasible, efficient and readily available and has become a useful tool in chronic disease surveys (12). Clients who are aware of their diabetes status are usually open to disclosure and help in promoting public awareness and in addition they are more likely to adhere to treatment and therefore ensure good management and disease control (12, 14). Notably, few reports particularly in Africa had suggested underestimation of prevalence estimates when self-reports were used because of higher proportions of undiagnosed DM (15).

However, most evidence had indicated that use of self-reports in estimating prevalence of diabetes is consistent and yielded similar results when compared with estimates from other data sources (13, 14). For example, the proportion among diabetic cases with cardiovascular risk factors in Netherlands were comparable to data from self-reports (29%), medical records (29%) and clinical measurement (31%) (13). Other studies in US and Spain had similar and consistent findings (16, 17). In addition, kappa (K) values also indicated good agreement for self-reported diabetes (K=0.78) which implied high accuracy (18).

In conclusion, diabetes which was previously considered as the disease for the elderly and HICs is a well recognized epidemic with rapid rise in LMICs and equally affecting the youth. Therefore, there is an urgent need for conducting country and location specific diabetes studies that would generate local data to guide in implementing locally applicable preventive strategies particularly in LMICs (7).

1.4 Aim

The study aim was to estimate prevalence and factors associated with self-reported diabetes mellitus among the adult population in Gauteng province in 2015.

1.5 Objectives

The following were the objectives of the study;

1. To estimate the prevalence of self-reported diabetes mellitus among the adult population in Gauteng province in 2015.
2. To determine the association between self-reported diabetes mellitus and certain socio-demographic and disease characteristics among adult population in Gauteng province in 2015.

1.6 Problem Statement

South Africa is one of the countries undergoing epidemiological and health transition as a result of rapid economic growth.(19) Gauteng province being the hub of such major economy contributes above 34% of national Gross Domestic Product (GDP) and 10% of Africa's GDP respectively (20). As a result, the province experiences high levels of industrialization,

urbanization and increased stress related to economic growth. Due to this socioeconomic profile, the province registers high levels of obesity and physical inactivity (10). There are also increased consumption of low fibre foods (unhealthy diets) and high prevalence of ageing population (21). In other settings elsewhere, these characteristics have been reported to be associated with increased prevalence of diabetes and other NCDs (8). However, to our best knowledge, no studies have been conducted to specifically determine prevalence and factors associated with diabetes using a representative sample from Gauteng province.

1.7 Justification Of The Study

Prevalence and factors associated with diabetes vary between countries and population sub-groups. Therefore, reports from other settings would not be directly applicable to perspective of Gauteng. Therefore, there is a need to generate local diabetes data specific to the province. Such scientific evidence will help in informing health policy on diabetes. It will also help to categorise groups with higher odds of diabetes and therefore influence screening methods towards early diagnosis and management among the population sub-groups at higher risk of the disease. Such a strategy could improve survival among diabetic patients and consequently reduce the economic burden arising from morbidity and mortality (13, 22).

1.8 Literature Review

The prevalence of diabetes varies globally among populations due to differences in environmental factors and genetic susceptibility (23). While there are global estimates which suggest high prevalence of diabetes in LMICs, there are still a number of gaps in the knowledge of the prevalence in certain countries in such settings. (7). Currently, most evidence on the aetiology and factors associated with self-reported diabetes comes from HICs (24). Subsequent sections indicate the variation of DM profiles across different countries worldwide.

1.8.1 Prevalence of diabetes mellitus

There is a remarkable contrast in the prevalence pattern of diabetes between HICs and LMICs. Generally, HICs reported lower prevalence estimates than LMICs (24). Some research outputs from HICs had following findings: a population based study in Naie town of

Japan reported disease prevalence of 9.0% in 2010 (25). Further projections for 2014 indicated national prevalence of 7.6% (11). Regional data for Thessaly in Greece had shown that 10.7% of the population had diabetes in 2008 (23). Such report came at the background of national projected prevalence of 7.0% (11). Similar studies in Korea reported DM prevalence of 7.7% (11). Relatively lower prevalence estimates were also reported in United Kingdom (5.4%),Denmark (8.3%),France (7.2%),Spain (10.6%) and Switzerland (7.2%) in 2014 (11). Few isolated countries from HICs had reported higher prevalence estimates. For example, in USA, 11.4% of the total population had DM in 2014 (11). Canada also reported high prevalence of 11.6% (11).

By contrast, consistently higher DM prevalence estimates had been reported in LMICs. For example, in Palau, a small island in Pacific Ocean, 17.7% of total population had DM in 2013 (26). Reports in Tunisia reported prevalence of 15.1% with urban setting having higher proportion than rural in 2015 (27). Similar studies in Mwanza city in Tanzania reported prevalence of 11.9 % in 2015 (28). Research from Uyo metropolis of Nigeria had revealed that 10.5% of the population had the disease in 2010 (3). Similarly higher estimates were also reported in Saudi Arabia (23.7%), Bahrain (25.7%) and Al Ain, United Arab Emirates (17.7%) in 2010 (27). In addition, reports from Haryana in India, 13.3% of the population had diabetes in 2011 (29). Extreme high prevalence estimate was reported in Mauritius where 23.5% of the population had diabetes in 2014 (11). Reports from South Africa showed an estimated national prevalence of 8.4 % in 2014 (11). Other reports in 2012, showed that the country had an estimated 3.0 % prevalence of diabetes among pregnant women (30). Few provinces in South Africa had reported estimates of the prevalence of diabetes. To our knowledge, in Limpopo, a rural based study reported disease prevalence of 4% in 2014 (31). Another study in Western Cape province indicated that 7.2% of the population had DM in 2010 (32). In addition, among diabetic patients attending primary healthcare in OR Tambo district of Eastern Cape province,83.8% had uncontrolled type 2 diabetes in 2013 (33). There was no specific data for Gauteng. However, basing on the trend of national diabetes estimates and reports from other LMICs, it was presumed that diabetes was on the rise as well.

1.8.2 Factors associated with diabetes mellitus

There have been marked difference as well in the distribution of factors associated with DM between HICs and LMICs. Starting with HICs, reports in US had indicated 5-fold increase in the odds of diabetes among hypertensive individuals whereas those with cardiovascular diseases had 3-fold increase (14). Men and people who had dyslipidaemia, abdominal obesity, black race, low socio-economic status and increased age had higher odds of diabetes (14). In Japan, blue collar occupation and middle household income were found to be significantly associated with high prevalence of DM (25). Another study from Greece demonstrated that smoking was protective against diabetes while individuals with low education status, male gender and alcohol consumption history proved to have higher odds of the disease (23). In addition, it was further demonstrated that unemployment was independently associated with diabetes in five German regions (34). Consistent results were also reported in Korea where diabetes increased with advanced age but inversely associated with socioeconomic status (education and income status) (35). In a nutshell, diabetes was consistently higher among men and those who were materially and socially deprived in HICs.

Different patterns of factors associated with diabetes have been reported in LMICs. For example, in Nigeria, diabetes was positively associated with high education status and more prevalent in females (3). In that report, individuals with advanced age, poor dietary habits, obese, physically inactive, positive family history of diabetes, medical history of hypertension and cardiovascular diseases had higher odds of diabetes (3). While data from Tanzania had reported that history of smoking and alcohol intake were highly significant factors in addition to female gender, hypertension and advanced age (28). A study carried out in Palau had reported that individuals with diabetes were generally older, more likely to be betel nut chewers, obese, hypertensive and having abnormally high lipid profiles than those without the disease (26). Further evidence from Tunisia has also shown that high economic level was strongly associated with the disease (27). Other notable findings were also reported in a community based study in India where diabetes was not associated with education level and socioeconomic status (29). Another study from China has demonstrated that higher socioeconomic status (higher income and non-manual occupation) was associated with higher odds of diabetes whereas smoking was not a significant factor (36). Further evidence from a community-based study carried out in five provinces of Zambia reported that individuals with DM were more likely to be in advanced age and obese (32). In a nutshell, cumulative evidence had indicated relatively higher prevalence of diabetes in LMICs than HICs with

more females affected than males. In addition, high socioeconomic status was positively associated with high prevalence of the disease in LMICs.

Some sparse data across the globe has also shown association between diabetes and certain chronic diseases. For example, in Italy, HIV/AIDS had 2-fold increase in the odds of diabetes. In that study, prevalence was higher among HIV infected (4.1%) than healthy individuals (2.1%) (37). It was also demonstrated that prevalence increased with increasing exposure to HAART and low CD4 count (37). Similar association pattern was reproduced in Morocco where high viral load, longer use of HAART, longer duration of HIV infection were significantly associated with the disease (38). Another study from US/Mexico border indicated higher prevalence of tuberculosis among DM cases (17.8%) in Mexico and 27.8% in Texas. Such findings far exceeded those from general population where prevalence was 9.5% and 7.9% respectively .In that study, individuals who were male, older ages and HIV positive had higher odds of diabetes (39). A similar study from Tanzania has indicated that diabetes was associated with 4-fold increase in the risk of active TB (40). In addition, a systematic review of 13 studies has indicated 3-fold increase in TB prevalence among diabetic patients (41). Data from China has also demonstrated strong association between diabetes and some cancers namely colon, rectal, prostate and bladder (42). Further evidence from Denmark has demonstrated that diabetes was associated with 10-fold increase in the risk of all types of cancers (42). Data on specific cancers from Pakistan has shown 5-fold increase in the odds of breast cancer among diabetic individuals (43).

In Singapore, asthma was found to be associated with 3-fold increase in the odds of diabetes. In that study, association was stronger among females, adults and obese population (44). Further research findings from nurses' health study reported that asthma was associated with 5-fold risk of diabetes (44). In addition, cumulative evidence showed that diabetes had been associated with various forms of psychiatric disorders. For example in Bangladesh, prevalence of depression among diabetic cases was 45.5% (45). In Canada, diabetes was more prevalent among schizophrenic individuals than normal controls especially in young males (1.72-fold) (46). In addition, a study in Taiwan also reported higher odds of diabetes among schizophrenic patients.

1.8.3 Factors associated with diabetes mellitus in South Africa

In South Africa, there was also limited evidence on the factors associated with DM. To our knowledge, few studies had reported specific data connected to certain provinces and location For example in Limpopo province, individuals who had diabetes were more likely to have advanced age, low education status and male gender (31). Another research output from Western Cape province showed that individuals with DM were more likely to be females and those with high socioeconomic status. In that study, people with higher education levels were protective against diabetes (32).

In conclusion, lack of adequate data on DM hinders implementation of intervention strategies towards prevention and control. Therefore, the study would provide useful material to guide policy making at different levels of DM management and care.

CHAPTER TWO: MATERIALS AND METHODOLOGY

1.9 Introduction

Chapter 2 describes the methodology used in the study. Both the original QoL household survey from which the data were obtained and the current secondary analysis are described. The description of data management and approach to data analysis as well as ethics approval are also included.

1.10 Primary Study

Primary data were collected using household survey methods by Gauteng City-Region Observatory (GRCO) using a structured questionnaire administered by trained field workers in 2015. These surveys are normally done every two years since 2009 to measure socio-economic and political circumstances experienced by the residents. GRCO was established by partnership of University of Johannesburg (UJ), Witwatersrand University and Gauteng provincial government.

Computer Aided Personal Interviewing (CAPI) technique was employed to capture data using electronic tablets that had installed "SurveyToGosoftware". The software was responsible for supporting question branching, recording, exporting data into excel and SPSS and had offline facility of data collection The questionnaire had 12 sections including health with 224 closed and 4 open ended questions. There were a total of 228 questions. They were all translated into Afrikaans, Sesotho, isiZulu and isiXhosa local languages.

The 2015 survey had 30,002 participants who were sampled using stratified multistage technique using implicit stratification. Therefore, the population of sampling units within those strata were sorted by main place then sub-place and dwelling enumerator areas (EAs). The predetermined number of EAs were drawn using probability proportional to size (PPs). PPs sampling is a method in which the probability of selection for a sampling unit is directly proportional to a measure of size. In this survey, a total number of adult population (18 years and above) was regarded as the measure of size. As such, dwelling EAs were considered as primary sampling units while households were secondary sampling units. A total of 5860 EAs were drawn across all 508 wards in the province. Wards in this context were defined as geopolitical subdivisions of municipalities for electoral purposes while regarded as strata in

this report. Vacant, industrial and recreational EAs were excluded in the survey design. In instances where wards had fewer EAs than required by sample design, some EAs were drawn more than once. In order to find collect visiting points, three-colour maps were provided for each EA. EA sampling frame was constructed using small area layer (SAL), main and sub-place data superimposed on 2011 population census' EA boundaries. That information was further combined with updated data on imagery, aerial photography and dwelling unit counts to form basis of EA sampling frame. Five visiting points were selected per EA (26). These visiting points were selected with equal probability and one individual age 18 and above was randomly selected per visiting point per EA. An additional 5 visiting points were selected per EA as oversampling points. These ones were used when original point resulted in a substitute because of refusal to participate, vacant homes, or when nobody was at home after three independent visits (26). An automated kish grid was used to randomly select the household and single respondent for interview.

1.11 Present Study

1.11.1 Study design

This was a cross-sectional study that used data from GRCO quality of life (QOL) survey.

1.11.2 Study site

The study was conducted in Gauteng province. This is the smallest province in South Africa covering an area of 18178 km^2 (1.4% of national total surface area). It is bordered by Free State province to the south, North West province to the northwest, Limpopo province to the north and Mpumalanga province to the northeast and southeast. Despite being the smallest province, it is the most populous with 13.5 million people (24% of national population). It is by far the most densely populated with 680 persons per km^2 against the national population density of 42 (16). It has ten municipalities out of which three are major metropolitan municipalities namely cities of Johannesburg, Ekurhuleni and Tshwane. In addition, there are two district municipalities of Sedibeng and West Rand which are further subdivided into seven local municipalities. For example, Sedibeng district has three municipalities namely Emfuleni, Lesedi and Midvaal. West Rand district has four municipalities namely Merafong city, Mogale city, Randfontein and Westonaria (31). The province has a total of 37 public

hospitals and 373 primary healthcare facilities which serve over 71% of the total population. Figure 1.1 below shows political map of Gauteng province.

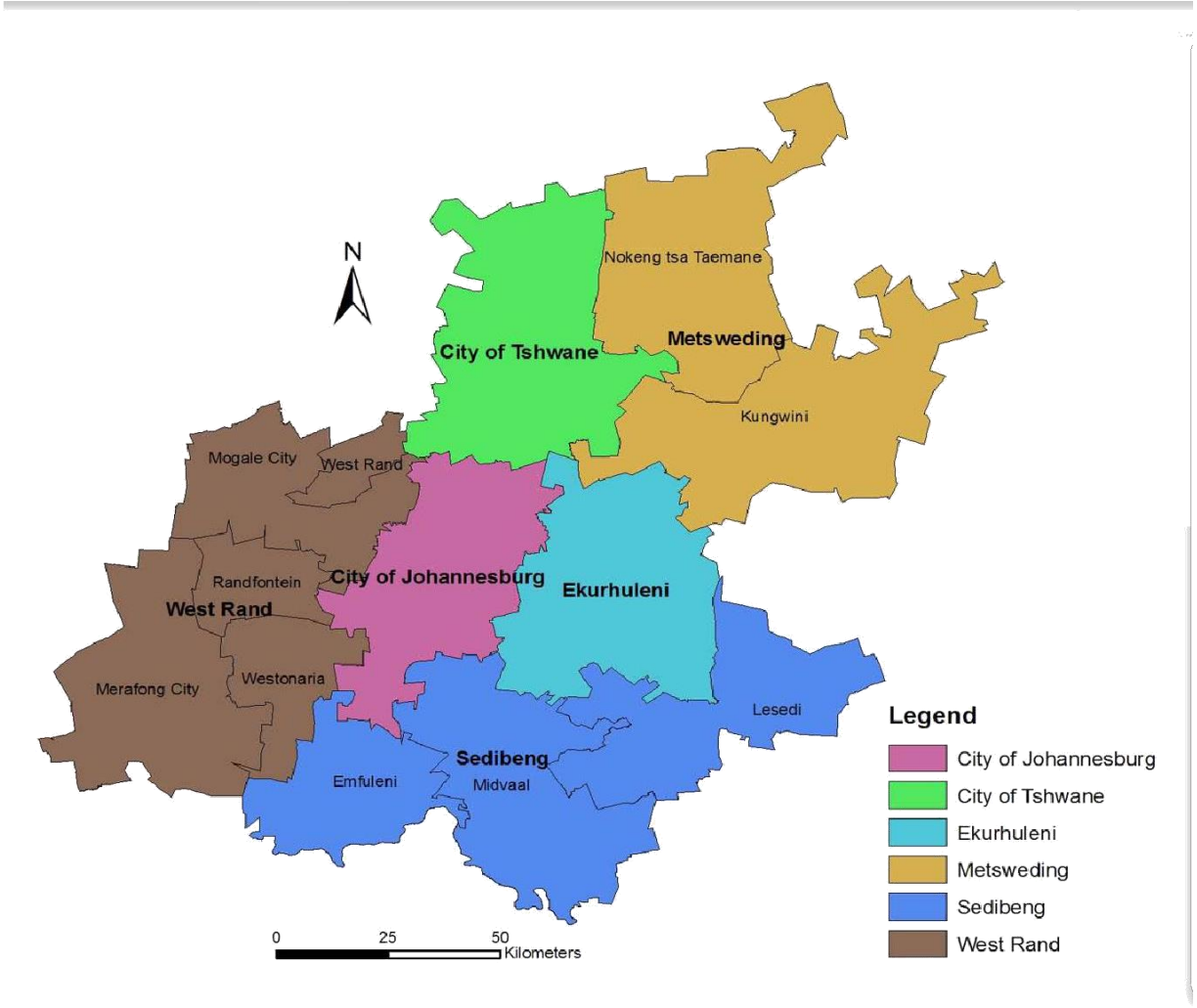

Figure 0.1: Political map of Gauteng province

Source: Gauteng Economic Opportunity Atlas. Available from: http://www.gautengonline.gov.za/Publications%20and%20Reports/Gauteng_Economic_Opportunity_Atlas.

1.11.3 Study population and sampling method

The study population was composed of adult citizens who were at least 18 years and above residing in Gauteng province. Written informed consent was obtained from all participants. No sampling method was used in the current study however primary study used PPS sampling technique.

1.11.4 Study period and data collection

The study was conducted from 01st June 2016 to 17th July 2017. Dataset was secured on 20th December, 2016 from GRCO by the study supervisor.

1.11.5 Study variables

The following were the categories of both exposure and outcome variables.

1.11.5.1 Independent variables

The following were considered as independent variables socio-demographic characteristics and history of disease comorbidities. The full details are as follows;

1. Socio-demographic characteristics; age, sex, race, metropolis of residence, employment status, education status, migration status and socioeconomic status.
2. Medical history of hypertension, heart disease/stroke, asthma, tuberculosis, HIV/AIDS, cancer or mental illness.

1.11.5.2 Outcome variables

Diabetes status (diabetes or no diabetes) was the primary outcome of interest. Diabetic cases were recorded as participants who were already diagnosed by physicians or used anti-diabetic drugs at the time of conduct of the primary survey. However, participants were not asked whether they had either type one or two diabetes.

1.11.6 Data management and analysis

STATA version 14 software was used for data analysis.The analysis followed survey methods adjusting for EAs. Checking for inconsistencies was done. There was no missing data. After data cleaning, 21 variables were retained. All variables were label defined and value labels were also done. The following variables (diabetes, hypertension, heart disease or stroke, HIV/AIDS, tuberculosis, cancer, asthma and mental illness) were maintained in their original format as recorded from primary survey. Table 2.1 shows how these variables were coded in primary survey and how they have been modified in the current study.

Table 0.1: List of variables renamed and modified

NUMBER	VARIABLE	QOL VARIABLE CODING	CURRENT STUDY VARIABLE CODING
1	Sex	Categorical (male/female)	Categorical (male/female)
2	Age	Continuous	Ordinal (18-24,25-34,35-44,45-59,60-79,≥80)
3	Race	Categorical (black, coloured, Indian, white, unspecified)	Categorical (black, coloured, Indian, white, unspecified)
4	Education status	Categorical (no ,primary, secondary ,tertiary, unspecified)	Categorical (no, primary, secondary, tertiary, unspecified)
5	Employment status	Categorical (employed, unemployed, unspecified)	Categorical (employed, unemployed, unspecified)
6	Metropolis of residence	Nominal	Nominal (urban, peri-urban)
7	Migration status	Nominal (Born in Gauteng, external migrants, internal migrants	Ordinal (Born in Gauteng, migrants lived <10 years, migrants lived ≥ 10 years
8	Socioeconomic status (SES)	Not coded	Ordinal (highest ,higher, high, middle, low)
9	Diabetes	Categorical (yes/no)	Categorical (yes/no)
10	Hypertension	Categorical (yes/no)	Categorical (yes/no)

11	Heart disease/stroke	Categorical (yes/no)	Categorical (yes/no)
12	HIV/AIDS	Categorical (yes/no)	Categorical (yes/no)
13	Tuberculosis	Categorical (yes/no)	Categorical (yes/no)
14	Cancer	Categorical (yes/no)	Categorical (yes/no)
15	Asthma	Categorical (yes/no)	Categorical (yes/no)
16	Mental illness	Categorical (yes/no)	Categorical (yes/no)

Five variables namely; type of residence, house ownership, energy source; water source and type of toilet (flush toilet) were grouped together because they were all indicators of socioeconomic status. They were all ordinal and therefore reduced to single variable "socioeconomic status (SES)" using factor analysis. They were tested for direction of influence and all had positive correlation. In factor analysis, first level explained largest proportion of total variance. So assets that were more unequally distributed across the sample had higher weights. Those weights were used for each asset to generate factor scores. So the higher the score indicated the higher the wealth status and vice versa. Finally based on quintiles, the scores were converted into five ordered categories from highest (1^{st} quintile) to lowest (5^{th} quintile). Therefore, the new variable SES was categorised into those five categories namely highest, higher, high, middle and low.

Municipality was renamed to "metropolis" and was collapsed to contain two options namely "urban" comprising of three major cities and "peri-urban" comprising the rest of local municipalities. Migration status was generated and categorised into three namely; born in Gauteng, immigrants who have stayed less than ten years and immigrants who have stayed longer than ten years. The reason for classifying immigrants based on such duration was based on rate of progression from pre-diabetes to diabetes. Scientific evidence has shown that 30% of the cases in pre-diabetic stage would convert to overt diabetes within 11 years (4, 47).

1.11.7 Analysis for objective 1

The prevalence of self-reported diabetes was calculated as a proportion of total diabetes cases from the study sample.The prevalence was also calculated across certain socio-demographic characteristics (sex,age group and comorbidity categories) using tabout command in STATA.

The 95% confidence interval was calculated from using single proportion method ($p \pm Z\sqrt{(p(1-p) \div n)}$) where p=diabetes prevalence,Z=1.96 and n=sample size.Sub-population prevalence of diabetes and confidence intervals for respective variables were calculated following the same formula.Table 3.2 of the results shows prevalence of diabetes mellitus.

1.11.8 Analysis for objective 2

Univariate model of binary logistic regression was fitted to find odds ratios (ORs),90% confidence intervals (CIs) and p-values for all explanatory variables against the main outcome (diabetes status).Values of $p<0.1$ were considered to indicate statistical significance for univariate models. All significant explanatory variables were all fitted into multivariate logistic regression model using forward selection to determine factors significantly associated with diabetes at $p<0.05$. Single p-values for all exposure variables were derived using testparm command in STATA.Checking for interaction was done focusing on variables with natural tendency to have multiplicative effect on the development of diabetes.Interaction terms analysed were SES versus education status, SES versus race and SES versus municipality of residence.Table 3.3 of the results show both univariate and multivariate analysis.

1.11.9 Ethical consideration

Ethics approval for the study was obtained from Witwatersrand University human research ethics committee bearing a certificate number 1611124. See appendix 2.During the analysis, records were kept anonymous by disguising all identifying names of participants in the dataset.

CHAPTER THREE: RESULTS

1.12 Introduction

This section presents results of analysis based on study objectives. Firstly, a descriptive analysis of the study participants is presented in table 3.1. Prevalence estimates are presented in table 3.2 for objective one. Table 3.3 provides unadjusted and adjusted odds ratios for factors associated with self-reported diabetes mellitus.

1.13 Socio-Demographic And Comorbidity Characteristics Of Study Participants

The study had more women (54%) than men. Most of the participants were from black race (81%). In the age category, highest number of participants (28%%) was within 25-34 age group. At least 56% of the participants had attained tertiary education and 49% of them were employed. Larger proportions (64%) were at least above high socio-economic status. Majority (64%) of the participants were born in Gauteng. The remaining participants (36%) were immigrants. Most people were living in urban set-up (81%) compared to peri-urban. In terms of comorbidity, the most common comorbidity was hypertension, which affected (16%) of the study population overall and affected 42.2% of the respondents with diabetes. had followed by asthma (6 %). The least comorbidity was observed in mental illness (1%). The other comorbidities were HIV/AIDS (4%), heart disease or stroke (4%), cancer (3%) and tuberculosis (3%). Table 3.1 below shows detailed descriptive analysis classified based on certain socio-demographic characteristics and pre-existing disease status.

Table 0.1: Socio-demographic and disease comorbidity characteristics of study participants

Characteristics	**Diabetes (%)**	**No diabetes (%)**	**Total (%)**
	N =3370 (11.23)	N =26,632 (88.77)	30,0002 (100)
Sex			
Male	1,414 (41.96)	12,539 (47.08)	13,953 (46.51)
Female	1,956 (58.04)	14,093 (52.92)	16,049 (53.49)
Age group (years)			
18-24	432 (12.82)	4,242 (15.93)	4,674 (15.58)
25-34	558 (16.56)	7,740 (29.06)	8,298 (27.66)
35-44	525 (15.58)	6,367 (23.91)	6,892 (22.97)
45-59	882 (26.17)	5,575 (20.93)	6,457 (21.52)

60-79	864 (25.64)	2,447 (9.19)	3,311 (11.04)
≥80	109 (3.23)	261 (0.98)	370 (1.23)
Educational level			
No education	122 (3.62)	549 (2.06)	671 (2.24)
Primary	509 (15.11)	2,608 (9.79)	3,117 (10.39)
Secondary	998 (29.61)	7,975(29.95)	8,973 (29.90)
Tertiary	1,684 (49.97)	14,967(56.20)	16,651 (55.50)
Unspecified	57 (1.69)	533 (2.00)	590 (1.97)
Employment status			
Employed	1,291(38.31)	13,280 (49.86)	14,571(48.57)
Unemployed	709 (21.04)	7,439 (27.93)	8,148(27.15)
unspecified	1,370 (40.65)	5,913 (22.21)	7,283 (24.28)
Socioeconomic status			
Highest	840 (24.93)	5,332 (20.02)	6,172 (20.57)
Higher	840 (24.93)	5,365 (20.14)	6,205 (20.68)
High	774 (22.97)	5,927 (22.26)	6,701 (22.34)
Middle	506 (15.00)	4,440 (16.67)	4,946 (16.49)
Low	410 (12.17)	5,568 (20.91)	5,978 (19.92)
Migration status (duration in years)			
Born in Gauteng	2,420 (71.81)	16,761 (62.94)	19,181 (63.93)
Migrants <10 years duration	149 (4.42)	3,799 (14.26)	3,948 (13.16)
Migrants ≥10 years duration	801(23.77)	6,072 (22.80)	6,873 (22.91)
Race			
Black	2,499 (74.15)	21,666 (81.35)	24,165 (80.54)
Coloured	138 (4.09)	1,006 (3.78)	1,144 (3.81)
Indian/Asian	104 (3.09)	529 (1.99)	633 (2.11)
White	622 (18.46)	3,316 (12.45)	3,938 (13.13)
Unspecified	7 (0.21)	115 (0.43)	122 (0.41)
Metropolis			
urban	2,627(77.95)	21,702 (81.49)	24,329(81.09)
Peri-urban	743 (22.05)	4,930(18.51)	5,673 (18.91)
Disease status			
No disease	0	26,632 (100)	26,632 (88.77)
Diabetes only	1,378 (40.89)	0	1,378 (4.56)
One comorbidity	1,368 (40.59)	0	1,368 (4.56)
Multiple comorbidities	624 (18.52)	0	624 (2.08)
Comorbidity			
Hypertension	1,422 (42.20)	3,298 (12.38)	4,720(15.73)
Heart disease/stroke	367 (10.89)	754 (2.83)	1,121 (3.74)
Tuberculosis	192 (5.70)	563 (2.11)	755 (2.52)

HIV/AIDS	223 (6.62)	1,073 (4.03)	1,296 (4.32)
Cancer	226 (6.71)	554 (2.08)	780 (2.60)
Asthma	379 (11.25)	1,299 (4.88)	1,678 (5.59)
Mental illness	98 (2.91)	281 (1.06)	379 (1.26)

1.14 Prevalence Of Diabetes Across Certain Socio-Demographic And Comorbidity Characteristics

There were 3,370 participants with diabetes in the study sample representing a prevalence of 11.23% (95% CI: 10.87-11.59). By sex, prevalence was higher among females (12%, 95% CI: 11.82 -12.56) compared to males (10%, 95% CI: 9.79 -10.47). The age above 80 years had highest prevalence of diabetes across all comparable age groups (29%).

Table 0.2 : Prevalence of self-reported diabetes mellitus by age, sex and comorbidities

	Diabetes	**Population**	**Prevalence**	**95% Confidence Interval**
Overall	N =3,370	N=30,002	**11.23**	(10.87 -11.59)
Sex				
Male	1,414	13,953	**10.13**	(9.63-10.63)
Female	1,956	16,049	**12.19**	(11.69 -12.69)
Age				
18-24	432	4,674	**9.24**	(8.91 -9.57)
25-34	558	8,298	**6.72**	(6.44 -7.00)
35-44	525	6,892	**7.62**	(7.32 -7.92)
45-59	882	6,457	**13.66**	(13.27 -14.05)
60-79	864	3,311	**26.09**	(25.60-26.59)
≥ 80	109	370	**29.46**	(28.94-29.98)
Comorbidity				
Hypertension	1,422	4,720	**30.13**	(28.82-31.44)

Heart disease/stroke	367	1,121	**32.74**	(29.99-35.49)
Tuberculosis	192	755	**25.43**	(22.32-28.54)
Cancer	226	780	**28.97**	(25.79-32.08)
HIV/AIDS	223	1,296	**17.21**	(15.15-19.27)
Asthma	379	1,678	**22.59**	(20.59-24.59)
Mental illness	98	379	**25.86**	(21.55-30.17)

In terms of comorbidities, people with heart disease or stroke had highest percentage of diabetes (33%) followed by hypertension (30%). The least prevalence was observed among HIV/AIDS individuals (17%). Other comorbidities include cancer (29%), mental illness (26%), TB (25%) and asthma (23%). Table 3.2 shows the prevalence of diabetes mellitus by gender, across different age groups and disease comorbidity.

1.15 Factors Associated With Self-Reported Diabetes Mellitus

1.15.1 Univariate analysis

All socio-demographic characteristics (age, sex, education status, employment status, municipality, socioeconomic status, migration status of residence and race) and history of certain pre-existing disease conditions used in the univariate analysis had significant association with self-reported diabetes mellitus. The results were as follows:

Women were more likely to have diabetes than men (OR: 1.23-90% CI: 1.15- 1.32). The odds of diabetes increases with age. Immigrants who have stayed less than ten years were more protected against diabetes (OR:0.27,90% CI:023-0.32) whereas those lived more than ten years had similar odds as citizens of the province. In terms of education status, secondary and tertiary education levels were protective against diabetes. Individuals with lower socioeconomic status were more protected against diabetes. Living in the peri-urban was associated with higher odds of diabetes (OR: 1.24, 90% CI: 1.12-1.38). While in regard to ethnicity, Indians/Asians had highest odds of diabetes (OR: 1.70, 90% CI: 1.35-2.15) followed by whites (OR: 1.63, 90% CI: 1.47-1.80)

In relation to some pre-existing disease conditions, the results showed that people with hypertension had 5-fold increase in the odds of diabetes compared to normotensive individuals. While people with heart disease or stroke were more likely to have diabetes compared to health counterparts (OR: 4.19, 90% CI: 3.65-4.82). Similarly, people living with HIV/AIDS had higher odds of diabetes than those without HIV/AIDS (OR: 1.69, 90% CI: 1.44-1.98). In addition, tuberculosis (TB), asthma and mental illness were also associated with higher odds of DM.

1.15.2 Multivariate analysis

After controlling for other covariates, the results had indicated that there was no significant sex-specific difference in the odds of diabetes. Diabetes increased with increase in age (aOR(adjusted odds ratio) :1.02 95% CI: 1.02-1.03). Lower socioeconomic status was more protective against diabetes. In respect to race of origin, Indians had highest odds of diabetes (aOR: 1.52, 95% CI:1.19-1.94).

In terms of history of pre-existing disease conditions, the results had demonstrated that hypertension was significantly associated with higher odds of diabetes (aOR: 3.88, 95% CI: 3.54-4.24). Having heart disease and/or stroke was significantly associated with higher odds of diabetes than health counterparts (aOR: 2.31, 95% CI: 1.98-2.70). There was weak significant association between individuals living with HIV/AIDS and the odds of diabetes after controlling for other factors (aOR: 1.28, 95% CI: 1.07-1.53). Similarly, individuals with tuberculosis were also significantly associated with higher odds of diabetes than their healthy counterparts (aOR: 2.12, 95% CI: 1.73-2.59). In addition, cancer patients were more likely to have comorbidity with diabetes than their healthy counterparts (aOR: 2.26, 95% CI: 1.87-2.72). Asthma was also associated with the mildly higher odds of diabetes as well (aOR: 1.82, 95% CI: 1.58-2.10). Finally, participants with mental illness were more likely to have comorbidity with diabetes than their healthy counterparts (aOR: 1.76, 95% CI: 1.34-2.30).

Table 0.3: Logistic regression analysis of factors associated with self-reported diabetes mellitus

Factors	Unadjusted OR (90% CI)	p-value	Adjusted OR (95% CI)	p-value
Sex		**<0.001**		0.6670
Male	1.00		1.00	
Female	1.23 (1.15 - 1.32)		1.01 (0.94-1.10)	
Age	1.03 (1.03-1.04)	**<0.001**	1.02 (1.02-1.03)	**0.0001**
Migration status		**<0.001**		**<0.0001**
Born in Gauteng	1.00	**<0.001**	1.00	
Migrants s<10 years duration	0.27 (0.23-0.32)		0.57(0.47-0.69)	
Migrants ≥10 years duration	0.91(0.84-1.00)		1.00	
Education status		**<0.001**		**0.1976**
No education	1.14 (0.92-1.42)		1.03 (0.81-1.31)	
Primary	1.00		1.00	
Secondary	0.64 (0.57-0.72)		0.87 (0.76-1.00)	
Tertiary	0.58 (0.52-0.64)		0.88 (0.77-1.01)	
Unspecified	0.55 (0.41-0.73)		0.68 (0.50-0.92)	
Employment status		**<0.001**		**0.0001**
Yes	1.00		1.00	
No	0.98 (0.89- 1.08)		1.01(0.91-1.12)	
Unspecified	2.38 (2.19- 2.59)		1.39 (1.26-1.54)	
Socioeconomic status	0.71 (0.68-0.75)	**<0.001**	0.79 (0.75-0.83)	**<0.0001**
Metropolis		**<0.001**		0.4979
Urban	1.00		1.00	
Peri - urban	1.24 (1.12 -1.38)		1.04 (0.93 -1.15)	
Race		**<0.0001**		**<0.0001**
Black	1.00		1.00	
Co loured	1.19 (0.98-1.44)		0.99 (0.81-1.20)	
Indian/Asian	1.70 (1.35-2.15)		1.52 (1.19-1.94)	
White	1.63 (1.47-1.80)		1.20 (1.07-1.35)	
Unspecified	0.53 (0.23-1.21)		0.80 (0.36-1.84)	
Comorbidity				

Hypertension		**<0.0001**		**<0.0001**
No	1.00		1.00	
Yes	5.16 (4.74-5.62)		3.80 (3.47-4.17)	
Heart_ disease_ stroke		**<0.0001**		**<0.0001**
No	1.00		1.00	
Yes	4.19 (3.65-4.81)		2.31 (1.98-2.70)	
HIV/AIDS		**<0.0001**		**0.0072**
No	1.00		1.00	
Yes	1.69 (1.44-1.98)		1.28 (1.07-1.53)	
Tuberculosis		**<0.0001**		**<0.0001**
No	1.00		1.00	
Yes	2.80 (2.35-3.33)		2.12 (1.73-2.59)	
Cancer		**<0.0001**		**<0.0001**
No	1.00		1.00	
Yes	3.38 (2.87-3.99)		2.26 (1.87-2.72)	
Asthma		**<0.0001**		**<0.0001**
No	1.00		1.00	
Yes	2.47 (2.18-2.80)		1.82 (1.58-2.10)	
Mental Illness		**<0.0001**		**<0.0001**
No	1.00		1.00	
Yes	2.81 (2.21-3.57)		1.76 (1.34-2.30)	

Interaction terms	**p-value**
Socioeconomic status and education status	0.85
Socioeconomic status and race	0.45
Socioeconomic status and Metropolis	0.44

All the interaction terms checked in the analysis were not statistically significant. In conclusion, the following factors were significantly associated with diabetes mellitus; age, migration status, socioeconomic status, race, hypertension, heart and/or stroke, HIV/AIDS, tuberculosis, cancer, asthma and mental illness in multivariate analysis. However, sex, education status, employment status and metropolis of residence were not significant. Tables' 3.3.1 and 3.3.2 show a comparison of univariate and multivariate logistic regression results for certain socio-demographic characteristics and pre-existing disease status against the odds diabetes.

CHAPTER FOUR: DISCUSSION

1.16 Introduction

This section provides discussion of results in connection to study objectives and comparison is made to results from the literature. The estimated prevalence is discussed in sub-section 4.2 while factors associated with diabetes are discussed in sub-section 4.3. Study strengths and limitations are presented in sub-section 4.4 while conclusions are given in sub-section 4.5. Finally, recommendations are presented in sub-section 4.6.

1.17 Prevalence Of Diabetes Mellitus

The study reported diabetes prevalence of 11.2 % which is relatively higher compared to national estimate (8.4%) and other provincial estimates of Western Cape (7.2%) and Limpopo (4.0 %) (31, 32, 48). However the results are consistent with reports from other LMICs where prevalence estimates have been persistently higher compared to HICs (3, 26, 28, 48).

The study findings indicating higher prevalence of DM among females (12.2 %) than males (10.1%) are similar to several reports from LMICs which have consistently reported higher prevalence of diabetes among females than males (3, 15, 28, 49). This could be explained by reports indicating that South African women are more insulin resistant and have lower hepatic insulin extraction compared to their male counterparts (50). Further evidence indicates that South African women have a longer life expectancy at birth (65.1 years) compared to men (59.7 years) and this could also explain higher prevalence since odds of diabetes increases with age (51). Higher prevalence of DM also parallels higher obesity levels among women (36%) than men (10%) (49, 52, 53). Differences in such findings may be explained by socio-cultural beliefs in which women perceive obesity as a source of attraction to the opposite sex, and a sign of fertility, success and happiness (50). This concept has also gained popularity especially in these times of HIV/AIDS when weight loss and lipodystrophy are commonly associated with advanced disease and it is a source of stigma (49, 51). Yet obesity has been reported to be associated with higher odds of DM (50).

As expected, the study has also reported higher prevalence of diabetes in higher age groups which is consistent with findings worldwide where an increase in age is significantly associated with increased prevalence of diabetes (1). Ageing is a globally identified risk factor for diabetes regardless of whether it is HICs or LMICs (2, 3, 12, 14, 35, 47).

In addition, higher prevalence of diabetes among individuals with hypertension, heart disease or stroke is well expected considering that they share common risk factors (54-56). Further evidence reveals that most chronic diseases in the long run have negative effect to glucose metabolism either related to their pathophysiology or drug –related effects. Therefore, it is not surprising to note that other chronic illnesses such as asthma, mental illness, various forms of cancer, tuberculosis and HIV/AIDS are associated with higher prevalence of diabetes in this study.

1.18 Factors Associated With Self-Reported Diabetes Mellitus

Age has been shown to be significantly associated with self-reported dibetetes mellitus. The odds of diabetes increased with an increase in age.This trend is expected considering scientific evidence that global peak age of diabetes is 40-60 years of age (2, 57). When one gets older, the cummulative effect of several factors that are prodiabetic becomes more pronounced leading to overt diabetes. It is further suggested that ageing is associated with accumulation of sugar derived substances known as advanced glycation end products (AGE) which increase in proportion to an increase in blood glucose concentration. Such an increase in AGE affects signal transduction pathways and sensitivity of insulin receptors. This eventually contributes to insulin resistance leading to overt diabetes (1). Similar results were demonstrated in south eastern Nigeria and other LMICs where the ages above 40 years have been associated with higher odds of diabetes from baseline (3, 27, 28).

As socioeconomic status (SES) decreases,it becomes more protective against diabetes compared to high SES. This agrees with report from Western Cape province (32). The results are also consistent with other studies from LMICs where low SES has been associated with lower odds of diabetes (15, 27). High energy-burning chores and walking associated with low SES due to economic constraints forces people to lead physically active lifestyles necessary to prevent development of diabetes in long run (49).

The study has shown that education is not siginifacntly associated with diabetes because confidence intervals included one.However as the level of education increases from baseline, it becomes protective against diabetes. Such data has similar trend to findings from other studies where high education level was protective against diabetes (25). The reason why in this study education level is not associated with diabetes could be related to the way in which education was measured (i.e. primary,secondary or tertiary rather than number of years of education) and hence the results are not conclusive.

There is no difference in the odds of diabetes between those who are employed or unemployed because the confidence interval includes one.Interestingly,those who failed to disclose their employment status (unknown employment status) had significantly higher odds of diabetes. However this category is non-existent in the community and hence cannot be targetted for intervention. Contrary to such findings, studies in LMICs have consistently reported positive association between unemployment and high prevalence of diabetes (34, 36). It is believed that chronic stress due to noise and psychosocial factors such as poverty,crime and social disorganization commonly associated with being unemployed set up favours insulin resistance leading to diabetes in long term (34).

The study has also indicated no difference in the odds of diabetes between those living in urban and peri-urban locations. This can be explained by thin line difference in life pattern between the two locations. This is because Gauteng province is made up of integrated cluster of cities,towns and urban nodes that make up a continuum of urbanized cities with similar behavioural and other lifestyle characteristics hence no difference in disease prevalence (20).

Immigrants who have lived less than ten years in the province are protected against diabetes. Most of the immigrants are coming from neighbouring countries where diabetes prevalence is relatively lower than in South Africa (7, 28, 35, 58). It is believed that those migrants that have stayed less than ten years have not fully assimilated to socio-cultural practices that influence diabetes.Therefore having protective effect. As the duration of stay gets longer, the odds of diabetes becomes similar to the indiginous population. Gauteng province is higly urbanized with increased tendencies for junk foods (low fibre diet), physical inactivity and high levels of obesity that favour development of diabetes eventually (52).

The study has reported Indians as having higher odds of diabetes than the rest of the racial groups. This is expected considering that Indians lead the world with highest prevalence of diabetes independent of their place of residence. That is why India is nicknamed “diabetes capital of the world” (58, 59). Indians are highly prone to diabetes because of their unique clinical and biomedical characteristics collectively known as “Asian Indian phenotype”. These characteristics include insulin resistance, greater abdominal adiposity (higher waist circumference despite lower body mass index, lower adiponectin and higher high sensitive C - reactive protein levels). These traits are diabetogenic. In addition, Indians are more likely to have genetic polymorphism in PC-1 which is highly associated with increased risk of insulin resistance (1). Further studies have suggested that Indian babies are born smaller but relatively fatter compared to Caucasians referred to as “thin fat Indian babies”. This fat phenotype is persistent in childhood and could be a forerunner of diabetogenic effect in adulthood (59). Other studies also attribute to their abnormal dietary pattern which is predominant in polysaturated fatty acids and low fibre. and physical inactivity that are diabetogenic (59).

The study has also reported positive association between hypertension and diabetes. These results are consistent with reports from other studies (3, 28, 48). The two diseases usually co-exist because they share common risk factors such as obesity, hyperlipidaemia, physical inactivity etc (55). Further evidence indicates that both diseases have common causal pathway through metabolic disturbance that characterize metabolic syndrome and hormonal derangement (56). Similarly having heart disease or stroke has been shown to be associated with higher odds of diabetes from the study findings. This is expected considering that cardiovascular diseases and diabetes share common risk factors (60-62). Further evidence also suggest shared causal pathway in which metabolic syndrome brought by diabetes causes hyperinsulinemia, inflammation and oxidative stress could lead to multiple physiological changes at microscopic level leading to cardiac dysfunction (63).

Participants living with HIV/AIDS were found to have weak association with DM. Despite this weak association, the positivity of the results is consistent with findings from other studies which have reported significant association between the two diseases (37, 38, 64). It is believed that chronic inflammation associated with HIV/AIDS predisposes to insulin resistance (37). In addition, use of highly active antiretroviral therapy (HAART) among the

HIV/AIDS patients is believed to fuel the development of DM. It is believed that HAART influences significant metabolic abnormalities such as obesity, dyslipidaemia, lipodystrophy, diabetes, and hypertension (65).

The study has also shown that having tuberculosis is associated with higher odds of diabetes. Such findings are in agreement with other research outputs from across the world (41, 66-68). It is believed that chronic inflammation associated with TB coupled with impaired cell mediated immunity are associated with higher odds of DM (67). In addition, chronic hyperglycaemia associated with DM may provide a conducive environment for bacterial growth and increased virulence of various microorganisms including TB (67). Furthermore, the study has reported a positive association between cancer and diabetes. This is consistent with reports from other studies (42, 69, 70). It suggested that both diseases share common risk factors such as ageing, sex, obesity, physical inactivity, unhealthy diet, alcohol and smoking (69). Some drugs used for treatment of diabetes have also been implicated in influencing neoplastic transformation. For example, use of sulfonylureas causes hypoglycaemia and promotes weight gain which could be carcinogenic (69). In addition, use of insulin formulations is believed to promote carcinogenic effects through interactions of administered ligand with cells at risk of transformation (69).

The study has also shown a positive association between asthma and diabetes. This is also consistent with reports from other studies (44, 71, 72). It is believed that asthma and type 2 diabetes mellitus also share common risk factors such as obesity (73). Some suggested mechanisms underlying the association between asthma and diabetes include genetic overlap (genetic pleiotropy), lung-related inflammatory cytokines and their effects in promoting insulin resistance (44). It is also believed that tissue hypoxia due to asthma directly affects abnormal glucose metabolism (44). Part of the association between asthma and DM could be explained by chronic use of steroids for treatment of asthma which is associated with weight gain resulting in obesity, peripheral wasting, dyslipidaemia, insulin resistance, glucose intolerance and overt diabetes in the long run (74). The study has also reported a positive association between mental illness and diabetes. These results are expected considering that depression and schizophrenia which are common forms of mental illness have had long history of positive association with diabetes. It is suggested that type 2 diabetes and schizophrenia have shared biological susceptibility (75). Linkage analyses have also identified several loci associated with schizophrenia (chromosome 2p22.1-p13.2 and 6q21-

q24.1) which have also been linked with susceptibility to diabetes (75). In addition, drugs used for treatment of mental illness (anti-depressants and antipsychotics) have noradrenergic activities which potentially cause glucose metabolic disorders through their inhibitory action on H1 and serotonin (5-HT2C) receptors (76).

1.19 Strengths And Limitations

The study had some strengths and limitations. Some of the strengths identified included high level of response rate from participants ensured no missing data for analysis. The study sample was large and representative hence provided more precise estimates as evidenced by narrow confidence intervals. Thirdly, random sampling during primary household survey minimized selection bias. By contrast, the study was limited in following areas: It was cross-sectional study hence could not establish causal effects. The study used a large dataset hence overpowered to yield highly statistically significant variables. Use of self-reports could have introduced measurement error leading to misclassification bias. Therefore, there was chance of over-estimating or diluting true burden of diabetes in the province. Again, use of self-reports could under-estimate disease prevalence especially considering that Africa has a high proportions of undiagnosed DM. In addition, self-reported diabetes did not differentiate between type 1 & 2 which have different aetiologies, clinical presentation and different intervention strategies. Furthermore, the study could not establish the association between diabetes and following variables; obesity, smoking status, alcohol consumption and level of physical activity because there were not measured in the survey. Yet elsewhere the above variables have been reported to be significantly associated with self-reported diabetes mellitus (3, 23, 28). There were no stratum and household identifiers in the survey hence did not form part of variables for analysis.

1.20 Conclusion

The study findings reported higher prevalence of self-reported diabetes mellitus among adult population in Gauteng province compared to national prevalence (8.4%). Individuals with advanced age, Indian race, and a number of comorbidities namely hypertension, heart disease/stroke, HIV/AIDS, tuberculosis, cancer, asthma and mental illness were found to be positively associated with higher odds of diabetes. Migrants who have stayed less than ten

years and participants of lower socioeconomic status were protected against diabetes. In addition, the following variables; sex, education status, employment status and metropolis of residence were not associated with DM.

1.21 Recommendations

Based on the study findings, it is recommended to improve diabetes surveillance system and implement community-based screening particularly focusing on high risk population sub-groups (females, ages above 45 years and Indians). Public awareness of diabetes should be increased. Intensify screening for diabetes among patients presenting to hospital with any chronic illness.

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2 APPENDICES

2.1 Senate Plagiarism Policy

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

I **Jonathan Chiwanda Banda** (Student number: **1294841**) am a student registered for the degree of **Master of Science in Epidemiology** in the academic year **2016/2017**.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and /or without acknowledging the original source) is wrong.

- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.

- I have followed the required conventions in referencing the thoughts and ideas of others.

- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have

failed to acknowledge the source of the ideas or words in my writing.

Signature:  Date: **08/05/17**

2.2 Ethics Clearance Certificate

R14/49 Dr Jonathan Chiwanda Banda

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M1611124

NAME: (Principal Investigator)	Dr Jonathan Chiwanda Banda
DEPARTMENT:	School of Public Health
PROJECT TITLE:	Prevalence and Factors Associated with Self-Reported Diabetes Mellitus in Gauteng Province
DATE CONSIDERED:	25/11/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Jabulani Ncayiyana
APPROVED BY:	Professor P Cleaton-Jones,Chairperson, HREC (Medical)
DATE OF APPROVAL:	30/11/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in November and will therefore be due in the month of November each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date 20/01/17

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES