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The Association Between Socioeconomic Factors and Geographical Distance from Home to Healthcare Facility, and Diagnosis of Diabetes and Hypertension in Rural Uganda

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Bachelor of Science in Nursing
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2016

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

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Objectives. To investigate the relationship between socioeconomic factors and geographical distance from household to health facilities, and diagnosis of diabetes and hypertension in rural Uganda.

Methods. This study was based on data from a cross sectional study in rural Uganda, and included information on 426 individuals from 87 households. Information on personal characteristics, socioeconomic factors, and diabetes and hypertension diagnosis was collected via questionnaires, self-reports, and observation. Participants underwent Fasting Plasma Glucose (FPG) and glycated hemoglobin (HbA1c) tests to determine diabetes status, and blood pressure measurements to determine hypertension status. Chi square test was used to determine the relationship between socioeconomic factors and diabetes and hypertension status. Multinomial logistic regression was used to model associations between geographical distance from home to health facilities, and diabetes and hypertension status. Results are reported as odd ratios (OR) and 95% confidence intervals (CI).

Results. Employment was statistically significantly related to diabetes diagnosis. Education and employment were statistically significantly related to hypertension diagnosis. Compared to those with diagnosed diabetes or hypertension, OR of being undiagnosed did not increase with increasing distance from home to the nearest health facility. (OR:1.02 [95%CI: (0.78,1.34)] and 1.04 [95%CI: (0.79,1.37)] for undiagnosed diabetes and hypertension, respectively). OR of undiagnosed diabetes and undiagnosed hypertension increased with increasing distance from home to hospital with paid weekly diabetes clinic, although not statistically significant (OR:1.04 [95%CI: (0.98,1.05)] and 1.03 [95%CI: (0.99,1.07)] for undiagnosed diabetes and hypertension, respectively). There was no association between undiagnosed diabetes and distance from home to hospital with free monthly diabetes clinic, and the association between hypertension diagnosis and distance to this hospital was not clear. (OR:0.97 [95%CI: (0. 94,1.01)] and 1.00 [95%CI: (0.97,1.04)] for undiagnosed diabetes and hypertension, respectively).

Conclusion. Socioeconomic factors varied in their relation to diagnosis of diabetes and hypertension. This study focused on diagnosis and on geographical distance, aspects that have not been widely investigated by previous Ugandan studies. Further research on the association between geographical distance from household to health facilities and diagnosis of diabetes and hypertension is needed, to provide evidence-based recommendations for planning access to diabetes and hypertension diagnostics in healthcare facilities.

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CHAPTER ONE: Introduction

Globally, non-communicable diseases (NCDs) are responsible for over 70% of all deaths. Each year, over 85% of deaths from NCDs among people between the ages of 30 and 69 in occur in low and middle-income countries. The major NCDs are diabetes, cardiovascular diseases, chronic respiratory diseases and cancer.[1] The number of people with these diseases is rapidly increasing worldwide, making NCDs a significant public health burden particularly to low-income countries.[2] NCDs are also called chronic diseases as they usually last long, and they are caused by a combination of physiological, behavioral, environmental and genetic factors.[2] This study will focus on diabetes, one of the NCDs, and hypertension, a major risk factor for NCDs.

Diabetes mellitus (DM) is a chronic disease caused by the inability of the pancreas to produce insulin (a hormone that regulates blood sugar or glucose), or the body being unable to effectively use the insulin produced.[3] Over time, high levels of blood glucose can damage body organs, leading to life-threatening and disabling complications such as kidney damage (nephropathy), nerve damage (neuropathy; which may lead to limb amputations), cardiovascular diseases (CVD), and eye disease resulting in retinopathy, vision loss and even blindness.[4] Diabetes, and its complications, is responsible for great economic loss to people with the condition and their families, and to national health systems and economies.[4 5]

Sub Saharan Africa (SSA) currently has the lowest age-adjusted prevalence for diabetes, but by 2045 the prevalence is projected to increase by 143%, from 19 million people to 47 million people living with diabetes, which is the highest projected increase globally. Up to one half of people with diabetes globally may be undiagnosed and only receive a diagnosis when they present to hospital with complications. This is even higher in SSA where 60% of adults aged 20–

79 years who have diabetes are undiagnosed.[4] Diabetes complications can be prevented or delayed with proper diabetes management.

High blood pressure, also called hypertension, is a medical condition in which pressure in blood vessels is persistently raised. It significantly increases the risk of developing cardiovascular disease (CVD), brain, kidney and other diseases. Complications resulting from uncontrolled hypertension include angina (chest pain), heart attack, heart failure, stroke and kidney failure.[6] Just as with diabetes, early diagnosis and treatment of hypertension have significant positive outcomes. With early detection, it is possible to reduce the risk of kidney failure, stroke, heart attack and heart failure.[7]

When hypertension presents together with diabetes, the risk for diabetic complications such as nephropathy and retinopathy is higher than when diabetes occurs alone. The incidence of cardiovascular disease and mortality also increase when hypertension coexists with diabetes. In contrast, the risk of cardiovascular disease is reduced in diabetics with controlled hypertension, compared to diabetics with uncontrolled hypertension.[8]

Purpose Statement

Undiagnosed diabetes and hypertension are a big burden in SSA. Not only does the lack of diagnosis affect individuals negatively by predisposing them to long-term complications, cardiovascular disease and premature death, but it is also a threat to communities and countries' economies. There is significant impact on economies from direct costs such as high healthcare expenditures and indirect costs such as loss from premature mortality and people dropping out of the labor force due disease complications.[4] Therefore, more knowledge about factors and determinants associated with undiagnosed diabetes and hypertension is needed.

This research will investigate factors associated with being diagnosed versus undiagnosed with either disease; something that is particularly important in rural areas of developing countries which may not have adequate healthcare resources. Thus, this study will focus on rural Uganda; aiming at informing research on better access to diagnosis of diabetes and hypertension. This study will investigate the association between undiagnosed diabetes and hypertension, and access to diagnostics at a health facility. Access is investigated as geographical distance and socio-economic status.

Research Objectives

This study will use secondary cross-sectional data from rural south-western Uganda to:

1. Investigate the association between socioeconomic factors and the diagnosis of diabetes and hypertension.
2. Determine the relationship between geographical distance from home to healthcare facilities and having diagnosed diabetes and hypertension, compared with having undiagnosed diabetes and hypertension.

CHAPTER TWO: Literature Review

The goal of this literature review is to present evidence about prevalence of diabetes and hypertension and social and economic factors associated with accessing diagnostic screening, care and management for these conditions in rural low-income communities, with a particular focus on rural Uganda. There will be discussion about options for treatment and management of diabetes and hypertension in Uganda, including public and private health systems and alternative opportunities for care for people with the diseases. Therefore, evidence about the relationship between socioeconomic factors, geographical distance and diagnosis of diabetes and hypertension in rural Uganda will be presented.

Prevalence of Diabetes and Hypertension in Uganda

Data on the prevalence of diabetes and hypertension in Uganda vary considerably. The International Diabetes Federation (IDF) places the prevalence of diabetes in adults in Uganda at 1.6% [9], while according to the World Health Organization (WHO), diabetes prevalence in Uganda is 2.8% (World Health Organization, 2016).[10]

In a nationwide population-based NCD risk-factor survey carried out among Ugandan adults aged 18 to 69 years, the prevalence of diabetes was found to be 1.4% while that of Impaired Fasting Glucose (IFG) was 2%. Further, the study found a lower prevalence of diabetes in rural residents (1%) than in people living in urban areas (2.7%).[11] In another population-based survey in Eastern Uganda, the prevalence of diabetes among Ugandans aged 35 – 60 years old was 7.4%, while the prevalence of pre-diabetes in the same age group was 8.6%.[12] The differences in diabetes prevalence is likely explained by a higher age (35-60 years) in the study population in thin study than in the previous study.

A Ugandan nationwide NCD risk factor survey found that the prevalence of hypertension was 28.9% in urban areas and 25.8% in rural areas.[13] Another study, from southwestern Uganda, found an age-standardized hypertension prevalence of 14.6%, [14] while a study from a district in western Uganda, found a hypertension prevalence of 30.5%.[15]

Among people with diabetes, the prevalence of hypertension is higher than in the general population of Uganda: in a study conducted in a National Referral Hospital, the prevalence of hypertension among newly diagnosed adult diabetic patients was 61.9%.[16]

Awareness of Disease Status

For this study, we will define awareness of disease status as having a known diagnosis of diabetes and/ or hypertension. The person with the disease must have been informed of their disease status by a health professional. The literature shows that there is low awareness of disease status in Uganda.

A study in Eastern Uganda found that only 19.5% of those having a fasting blood glucose level corresponding to diabetes were aware of having diabetes i.e. were already diagnosed with the disease.[12] Further, in a population-based national survey of adults in Uganda, the majority of those participants found to have hyperglycemia (90.5% of those with impaired fasting glucose and 48.9% of those with diabetes) did not know about that their blood glucose values were abnormal.[11]

In the case of hypertension, awareness of disease status is also low among Ugandans: a multi-disease community-based screening campaign in 2013 which included blood pressure measurements of all adults found that only 38.1% participants with hypertension had prior knowledge of their hypertension status.[14]

A study focusing on hypertension among newly diagnosed diabetics found that 27.7% of people with diabetes who also had hypertension were aware of their hypertension status, and among these, only 44.4% were on treatment for the disease.[16]

Diagnostic Criteria for Diabetes and Hypertension in Uganda

The Uganda Ministry of Health has adopted the diagnostic recommendations by the World Health Organization, and has published them in the 'Uganda Clinical Guidelines 2016'.[17] The diagnostic criteria for diabetes followed in Uganda are:

1. Fasting blood sugar >7.0 mmol/L (126 mg/dl)
2. Two-hour blood sugar after 75 mg of glucose >11.1 mmol/L (200 mg/dl)
3. Glycated hemoglobin 1c (HbA1c) >6.5% (48 mmol/mol)
4. In a patient with classical symptoms of hyperglycemia: Random Blood Sugar >11.1 mmol/L (200 mg/dl)

For hypertension, the Uganda Ministry of Health has also adopted WHO guidelines for diagnosis and treatment. Thus, in the 'Uganda Clinical Guidelines, 2016' publication[17], the diagnostic criteria for hypertension is: persistent high resting blood pressure (>140/90 mmHg) for at least two measurements five minutes apart with patient seated, on at least 2 or 3 occasions 1 week apart. Normal blood pressure is systolic blood pressure (SBP) <120mmHg and diastolic blood pressure (DBP) <80 mmHg; 120/80. Three other categories are given:

1. Pre-hypertension: SBP 120-139 or DBP 80-89
2. Hypertension, stage 1: SBP 140-159 or DBP 90-99
3. Hypertension, stage 2: SBP >160 or DBP >100

Access to Diagnostics for Diabetes and Hypertension in Uganda

Evidence about access to diagnosis of diabetes and hypertension in Uganda is lacking. Instead, we will have to rely on data about access to treatment and care to understand where people may get tested and/or diagnosed with diabetes and hypertension. The Ugandan public health care system is level-based, with district hospitals at the top. These are large referral units serving populations of more than 100,000 people. Next to these are the Health Center IVs which cater to people at the sub-district level, and could serve up to 100,000 people. Health Center IIIs are intermediate facilities at the sub-county level which cater to 25,000 people and Health Center IIs are at the parish level and serve 5,000 people.[18]

Each level of care has different roles. An assessment of Uganda health systems shows that village health team forms Health Center Is (HC I) and have no physical structure. Health Centre IIs (HC II) conduct community outreaches and provide outpatient care for parish members while in Health Centre IIIs (HC III), there is maternity care and basic laboratory diagnosis. Health Centre IVs (HC IV) provide higher level of services like carrying out minor operations, in addition to providing the same services as the lower level health centers. District hospitals have all the services offered at Health Center IVs, as well as consult physicians and specialized clinics for different diseases.[19] Apart from district hospitals and health centers, other options for care in Uganda include private-non-for-profit hospitals, private clinics which are small scale and mainly provide out-patient services, Community Health Workers (CHWs), drug shops, herbalists, neighbors or friends, or other individuals like preachers and pastors.[20]

According to the literature, people with diabetes and hypertension receive most of their care from Health Center IVs and District hospitals. A study on pathways to diabetic care in rural Eastern Uganda and found that the first level of care was hospitals for 50% of participants, private clinics for 21%, health centers for 14%, drug shops for 8.9%, and other types of providers for 6.1%. Participants switched between different levels of care several times before eventually all participants settled on receiving their diabetes care from hospitals.[20]

A study found that participants sought diabetes care at both health center IVs and district hospitals. However, HC IVs may have better diagnosis and treatment outcomes than hospitals, as the study found that HC IV patients had better blood glucose and blood pressure control, and they were less likely to have chronic complications, compared to patients receiving care at hospitals.[18] In contrast, another study found that HC IVs had less capacity to treat and manage diabetes. In this study, only one of the HC IVs visited had a glucose meter and patients were charged highly for blood glucose measurements. Participants reported that they visited health facilities multiple times before being diagnosed with diabetes.[21] This difference in findings could be attributed to differing geographical locations as the first study was in Eastern Uganda[18] while the second one was conducted in Southwestern Uganda.[21] Overall, the studies point to a lack of standardization of diabetes and hypertension care services in health facilities across different regions of the country.

Barriers to Diabetes and Hypertension diagnosis in Uganda

Some common barriers to diagnostic of diabetes and hypertension in the literature include inadequate supply of diagnostic material and financial constraint. A study conducted in rural Uganda found that health facilities had poor availability of diagnostic equipment. They often lacked relevant equipment for diagnosis, including blood pressure machines, blood glucose machines, glucose and urine test strips, and adult weighing machines. In addition, the health facilities had low numbers of nurses and clinicians to perform testing.[18] Another study found that a district hospital in rural Uganda which offered free diabetes testing often experienced periods of glucose test strip shortages, while two hospitals and a HC IV charged for glucose testing. The charges were a barrier for people who could not afford to pay.[21]

Apart from barriers to diagnostics, studies have also looked at barriers to care and management of diabetes and hypertension. One of the common barriers found was transportation difficulties. People reported long distances from their homes to health facilities, [18, 22] and high transportation costs.[20] Another common barrier reported is financial constraint, as studies showed that people found services and medications at health facilities expensive.[18, 21, 22] Poor knowledge of the diseases by health professionals is another barrier, as nurses and clinicians at some health facilities lacked training in standard diabetes care and education material for patients[18],while in other health facilities there was lack of diabetes specialists.[21]

One study also found that low socioeconomic status (SES) was a barrier to accessing treatment, while high SES was associated with better connections to treatment possibilities. Participants with high SES had better controlled HbA1c levels than those with low SES.[21]

Factors associated with Diabetes and Hypertension in Uganda

Several factors associated with having diabetes and hypertension in Uganda are reported in the literature.

A common factor associated with both diabetes and hypertension is body weight. One study found that obesity was significantly associated with diabetes. Furthermore, people with low physical activity levels and low dietary diversity were more likely to have diabetes.[12] Another study found that abdominal obesity was associated with diabetes, while increasing body mass index (BMI) and high cholesterol were associated with increased likelihood of impaired fasting glucose (IFG).[11] Increasing BMI has also been associated with increased likelihood of having hypertension.[14-16]

Sex and age also come up as a significant factor for diabetes and hypertension in the literature. A study found that females and people in the age groups 30-49 years and 50-69 years were more likely to have diabetes.[11] Female gender has also been found to be independently associated with having hypertension.[16] Increasing age, being diagnosed with diabetes in females, and having a family history of hypertension in males, are also associated with increased likelihood of having hypertension.[14]

Studies in Uganda have found that region of residence is associated with diabetes. One study found that rural residents were 60% more likely to have abnormal glucose regulation (AGR) than peri-urban residents.[12] In contrast, another study found a lower prevalence of diabetes in rural residents (1%) than in people living in urban areas (2.7%).[11] This study also looked at region of residence in terms of location within the country. People living in Eastern Uganda were less likely to have Impaired Fasting Glucose (IFG). Central Uganda had highest prevalence of Diabetes Mellitus (DM), while there was highest prevalence of IFG in Western Uganda.[11]

Another factor that is associated with diabetes in Uganda is socioeconomic status (SES). People of higher SES as evidenced by cement and tiled floors were more likely to have diabetes than people of low SES who had earth and cow dung floors.[11]

Other factors that have been found to be associated with hypertension are unemployment,[14] level of education and alcohol use. People with tertiary education were three times more likely to be hypertensive than those with no formal education.[15]

Geographical Distance and Disease

Few studies have investigated the association between distance from home to a health facility and diagnosis of diabetes and/ or hypertension in Uganda. A study about challenges for hypertension and diabetes care in rural Uganda indicates that residents of a county with a district hospital had higher incomes than residents of counties further away from the district hospital, yet the hospital served as the main center of diabetes care for all the counties.[22] This suggests that variation in availability of resources and longer distance to the district hospital may negatively impact the experience of residents from counties further away, when accessing care. It is necessary to conduct more research to verify this. Actual geographical distances from home to health facilities were not calculated in this particular study.

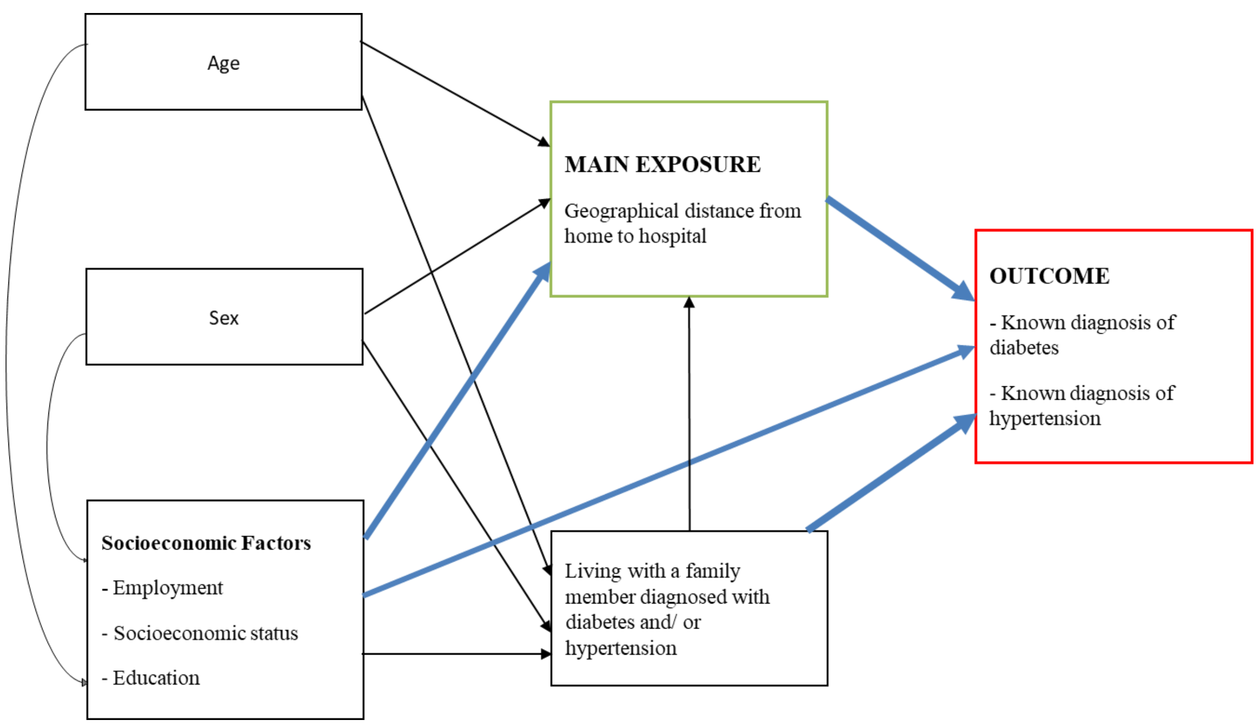
Studies from Uganda on other diseases have also investigated the relationship with geographical distance from home to health care facilities. One study on access to malaria treatment in rural Uganda found that one of the factors associated with utilization of malaria treatment services among children under five was proximity to a community health worker. Distances of less than 3 Km (1.86 miles) were strongly associated with use of Community Health Worker (CHW) services, which was associated with better outcomes for sick children, compared to distances of longer than 3 Km from home to a CHW.[23] Another study found that increasing distance to health facility led to increased delay in seeking treatment for tuberculosis; for each minute of driving time to the clinic, there was a 0.25 days' delay to care.[24]

Although these studies were not on diabetes or hypertension, the findings suggest that longer geographical distance from home to healthcare facilities may be negatively associated with access to diagnosis of diabetes and hypertension in rural Uganda

Conceptual Framework

The objective of this master thesis is to investigate the association between socioeconomic factors and geographical distance from home to a healthcare facility, and having been diagnosed compared to being undiagnosed with diabetes and hypertension in rural Uganda. The conceptual framework for this study is based on factors which the literature review showed to be associated with having diagnosis of diabetes and/ or hypertension.

Figure 1. Study Conceptual framework



The outcome of interest is having a known versus unknown diagnosis of diabetes and/ or having a known versus unknown diagnosis of hypertension. The main exposure is geographical distance from participant's home to a health care facility. In the literature we saw research suggesting associations between disease diagnosis and treatment, and distance from home to healthcare facility. As written, time to seeking TB treatment was reduced with shorter geographical distance, [24] and shorter distance and use of community health worker (CHW) services was associated with better health outcomes for children with malaria.[23] Thus, we will investigate whether such a connection exists between geographical distance and having a known diagnosis of diabetes and/ or hypertension; whether living close to a health facility increases the likelihood of having been diagnosed.

We will examine the association between socioeconomic factors such as employment, socioeconomic status (SES) and education; and the main exposure geographical distance from home to a healthcare facility. In one study, the fact that people living in a county with a district hospital had higher socioeconomic status than people in counties without a district hospital was discussed.[22] This suggests that there may be a relationship between distance from home to facility and socioeconomic factors. Thus, this study will examine the association between socioeconomic factors and geographical distance from people's homes to nearest healthcare facility and to health facilities with known diagnostics and care for diabetes and hypertension. We will also examine if there is a direct association between socioeconomic factors and disease status, that is, having diagnosed or undiagnosed diabetes and/ or hypertension.

Covariates like age, sex and living with a diagnosed household member may be associated with whether a participant is diagnosed or undiagnosed with diabetes and/ or hypertension. As described in the review of the literature above, several studies on diabetes and hypertension in Uganda have shown associations between age and sex, and having diabetes and/ or hypertension. In addition, one study found that there was an association between living in the same household as someone diagnosed with diabetes and diabetes risk factors.[25]

We will investigate the relationship between socioeconomic factors and disease status. We will also investigate and the association between socioeconomic factors and the main exposure geographical distance from home to a health facility, and the outcome of having a known diagnosis of diabetes and/ or hypertension versus having undiagnosed diabetes and/ or hypertension.

CHAPTER THREE: Methods

Data

Secondary data for this study were obtained from a cross-sectional study investigating the influence of sharing household with a person with diabetes on cardio-metabolic risk factors. This study was carried out in Kasese District, Western Uganda, for the PhD project by Nielsen *"Living with type 2 diabetes in rural Uganda – Exploring the household as an intersection for diabetes management, risks and behaviors"* at the Faculty of Health and Medical Science, University of Copenhagen, in collaboration with Kagando Hospital. Participants answered questions and underwent physical examinations between December 2012 to April 2013.

Study Setting

Kasese district, located in Western Uganda, is bordered by Democratic Republic of Congo (DRC) to the West. It currently has a total population of 702, 209 people, with 51.7% females and 48.3% males. 75.5% of the people live in rural areas and 24.5% live in urban areas.[26] Around the time of data collection, the population was 694,897.[27] The majority of the people of Kasese are young, with over 60% of the population being age 20 years or younger, and only 3.7% aged 60 years and older. The main language spoken in the district is Lukonzo. Illiteracy among people age 18 and older is 32.1%, and 70.7% of households depend on subsistence farming as their main source of livelihood.[27]

Kasese District has 105 health units, including 3 hospitals and 5 Health Center IVs. The rest are Health Center IIIs and Health Center IIs. The three hospitals in the district are: Bwera District Hospital, the public district hospital; and two private-not-for-profit hospitals: Kilembe Mines Hospital and Kagando Hospital.[28] In the district, 18.8% of households live 5 Km or further away from the nearest health facility, either public or private, and 26.5% of households live 5 Km or further away from the nearest public health facility.[27]

Study Population

A total of 437 individuals from 90 households participated in the study. Half of the households had a member who was diagnosed with diabetes, and half were non-diabetic households. Participants with diagnosed diabetes were patients of Kagando hospital, a private-not-for-profit hospital in the district. They had to have been diagnosed with diabetes for a minimum of two years, attended at least two diabetic clinics at the hospital, and have been $\geq$ 40 years of age at the time of their diagnosis. Their households had to be made up of at least three individuals who were 13 years or older and had lived in the household for a minimum of three months prior to the study, with at least two generations being part of the household. The exclusion criteria were: having a member who was diagnosed with type 1 diabetes, HIV/AIDS, severe mental illness, active tuberculosis, drug addiction or alcoholism. Random sampling was used to select non-diabetic households. These households had to fulfil the same criteria as diabetic households, as well as have no member diagnosed with diabetes.[29]

Ethics

This master’s thesis included human subjects and their personal health information, thus Institutional Review Board (IRB) approval was required. The study protocol was submitted to Emory’s IRB and expedited approval was granted on April 17, 2020 (STUDY00000265).

Data used for this study was de-identified. The author of this thesis was not present during the actual data collection. However, the thesis was carried out under the supervision of Dr. Nielsen, the researcher in charge of data collection for the original study. The original study was approved by The Uganda National Council of Science and Technology (ADM 154/212/01), Makerere University School of Medicine Research & Ethics Committee (REC REF 2012-183), Kagando Hospital, and St. Raphael of St. Francis Hospital Nsambya. Cultural leaders in the study area and leaders at the district level granted verbal permission.

Participants received information on the study both orally and through information leaflets written in Lukonjo and English, and had the chance to ask questions for clarification. Researchers explained to the participants that participation was voluntary, they could withdraw from the study at any time, only minor inconvenience would be associated with study examinations, and information confidentiality would be maintained. The participants provided both oral and written consent. Those who could not write signed with a thumb print. Caretakers provided consent for participants who were under 18 years of age.[29]

Variables

Study variables are divided into five main categories: participant characteristics, socioeconomic factors, diabetes status, hypertension status, and geographical distance. These are described below.

Participant Characteristics

Information on participant characteristics was obtained from a "Demography and health assessment questionnaire" which was administered to the participants by field assistants. Two variables will be used to describe participant characteristics in this study: sex and age. Sex will be treated as a categorical variable with two nominal categories: male and female. Age will also be categorical, but with three ordinal categories: $\leq$ 20 years, 21-50 years, and > 50 years old.

These categories were selected to provide adequate number of participants in each category for the purpose of data analysis, and to allow for comparisons between different age groups.

Socioeconomic Factors

There were three key variables that dealt with socioeconomic factors: education status, employment status, and socioeconomic status (SES). Information on education, employment and SES was obtained from questionnaires. The Socio-economic status questionnaire comprised of 22 questions which dealt with marital status, employment, land ownership, livestock ownership, and other sources of income. Only the head of the household completed this questionnaire. In addition, field assistants recorded the materials used for the floor, roof and walls of the main house on each compound.[29] SES was then categorized into three levels based on all this information: low SES coded as 1, middle SES coded as 2, and high SES coded as 3.

Education status was divided into three categories based on the highest level of education attained: participants who had never been in school, those who had attended primary school, and those who had attended secondary O level or higher levels of education. Employment was also divided into three categories: jobs with a paid salary including wage employees and people receiving a pension; self-employed workers and farmers/ peasants; and people with no income, including unpaid family workers and students/ pupils.

Diabetes Status Variables

For diabetes status, information on whether participants had been diagnosed with type 2 diabetes (T2D) was obtained from hospital records. For those with a known diagnosis, the year diagnosed with T2D was self-reported. Participants also self-reported on whether any member of the household had been previously diagnosed with diabetes.

Two tests were conducted to detect diabetes status in each participant: fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c). To obtain the FPG, blood glucose tests were conducted, using capillary blood from a finger prick, in the morning after an overnight fast. Fasting status was confirmed by questionnaire. FPG was divided into two categories: <7 mmol/L and ≥ 7 mmol/L, based on diabetes diagnosis criteria outlined in the 'Uganda Clinical Guidelines 2016', which is adopted from WHO diabetes guidelines. An Accu-check Aviva glucose meter (Roche Diagnostics) was used to measure the FPG.[29]

According to the World Health Organization, glycated hemoglobin (HbA1c) reflects the average fasting blood glucose over the prior 8 to 12 weeks. HbA1c can be measured at any time of the day and requires no fasting.[30] An Afinion AS100 Analyzer (Axis Shield PoC, Oslo, Norway) was used to test HbA1c using capillary blood from a finger prick.[29] The HbA1c was divided into two categories: $< 6.5\%$ and $\geq 6.5\%$, based on diabetes diagnosis criteria outlined in the 'Uganda Clinical Guidelines 2016', which is adopted from WHO diabetes guidelines.[17]

Three main categories of diabetes status were derived based on all the information and test measurements obtained: 1) No Diabetes, 2) Diagnosed Diabetes and 3) Undiagnosed Diabetes. 1) No Diabetes: people who were not diagnosed with diabetes, had FBG < 7 mmol/L and had HbA1c $< 6.5\%$. 2) Diagnosed Diabetes: participants who had been previously diagnosed with diabetes. 3) Undiagnosed Diabetes: participants who were not previously diagnosed with diabetes, but had a FBG ≥ 7 and/ or HbA1c $\geq 6.5\%$.

Hypertension Status Variables

Participants self-reported other diseases, apart from diabetes, which they had been diagnosed with. Hypertension was one of these diseases. They also self-reported on whether any member of the household had been previously diagnosed with hypertension.

To determine hypertension status, each participant had their blood pressure measured 3 times, at least 5 minutes apart. A sphygmomanometer was used to measure the blood pressure. Based on the three measurements, average systolic blood pressure (SBP) and average diastolic blood pressure (DBP) were recorded. SBP was divided into two categories: <140 mmHg and ≥ 140 mmHg, while DBP was divided into two categories: < 90 mmHg and ≥ 90 mmHg. These categories were based on blood pressure classification of first stage hypertension being SBP $\geq$ 140 mmHg or DBP $\geq$ 90 mmHg, as outlined in the 'Uganda Clinical Guidelines 2016', which is adopted from WHO hypertension guidelines.[17]

Three main categories for hypertension status were derived: 1) No Hypertension, 2) Diagnosed Hypertension and 3) Undiagnosed Hypertension. 1) No Hypertension: participants who were not diagnosed with hypertension, had SBP < 140 mmHg and DBP < 90 mmHg. 2) Diagnosed Hypertension: participants who had been previously diagnosed with hypertension. 3) Undiagnosed Hypertension: participants who were not previously diagnosed with hypertension, but had SBP > 140 mmHg and/ or DBP > 90 mmHg.

Geographic Distance Variables

At the study visit in each household, a GPS unit was used to obtain the geographical coordinates using a Garmin eTrex10 GPS unit. The coordinates for thirteen healthcare facilities were also obtained. The coordinates were managed by an external partner using ArcGIS and distances were calculated in meters (M). Of the thirteen health facilities, two were health care center 2s (HC2): Kamasasa and Kiburara; eight were health care center 3s (HC3): Karambi, Katwa, Kinymasake, Kyalhumba, Kyondo, Myamirami, Nyabirongo and Nyabugando; one was a health care center 4 (HC4): Kasese town HC4; and two were hospitals: Bwera General Hospital, a district hospital, and Kagando Hospital, a private-not-for-profit hospital. All distances were measured in Meters (M), but converted to Kilometers (Km) for the purposes of this study.

Three main distances were used for this study: 1) distance from homes to the nearest health facility, 2) distance from homes to Kagando Hospital which offers weekly diabetes clinic for a fee, and 3) distance from homes to Bwera General Hospital which offers a monthly diabetes clinic free of charge.

Statistical Analyses

Descriptive data of age, socioeconomical factors, diabetes status and hypertension status are presented as frequencies stratified by sex. Geographical distances (Km) from home to healthcare facilities are presented as mean (sd).

Chi-squared tests were conducted to determine the relationship between study variables and disease status. For diabetes status, the variables sex, age, education level, employment status, socioeconomic status, sharing household with a member diagnosed with diabetes, and known hypertension diagnosis were tested for statistically significant associations. In the case of hypertension status, tests for significant associations were conducted for the variables sex, age, education level, employment status, socioeconomic status, sharing household with a member diagnosed with hypertension, and known diabetes diagnosis. P values for each test was recorded in tables.

Multinomial logistic regression was then conducted to model associations between diabetes status and distances from homes to health facilities, and likewise associations between hypertension status and distances from homes health facilities. Crude models were first conducted with diabetes status as outcome variable and geographical distance as exposure variable. Models were run with three different geographical distances: 1) distance from home to the nearest healthcare facility, 2) distance from home to a hospital which offers weekly diabetes clinic for a fee, and 3) distance from home to a hospital which offers monthly diabetes clinic without charges. Three additional models were then conducted, adjusting for some of the variables based on associations from the chi-squared tests. For the first model age and sex were adjusted (model 1); next age, sex and socioeconomic status were adjusted (model II). For model III on diabetes status, age, sex, socioeconomic status, education, and sharing household with someone diagnosed with diabetes were adjusted. The same models were run with hypertension as the outcome variable and geographical distances to healthcare facilities as exposure variables, with the exception of model III. Age, sex, socioeconomic status, education, and sharing household with someone diagnosed with hypertension were adjusted in model III of hypertension status.

Odd ratios (ORs) were calculated and reported for each model with 95% Confidence Interval (CI). In the diabetes models, Diagnosed Diabetes was the base outcome with OR reported for No Diabetes and Undiagnosed Diabetes, while in the hypertension models, Diagnosed Hypertension was the base outcome with OR reported for No Hypertension and Undiagnosed Hypertension. Given the 437 participants came from 90 households, household ID was used as a random effect to account for within household clustering.

All data were analyzed using StataSE16, Copyright © 2019 StataCorp LLC.

CHAPTER FOUR: Results

Characteristics of Study Participants

Table 1 shows the characteristics of the study population. Out of the original 437 participants, 11 lacked information on geographical distance from home to healthcare facilities, and were not included the analyses. A total of 426 participants were included in the analyses, 57% of whom were females. Participants were almost evenly spread out across the three age categories: 33.8% of participants were ≤ 20 years old, 34.5% were 21 – 50 years and 31.9% were > 50 years of age. Among females, the largest age category was 21 – 50 years (38.7 %) while < 20 years was the largest age category for males (37.7%).

Of the participants, 18.8% had never attended school, 58.2% had reached Primary School education level, and 23% had attended secondary school O'level or higher levels of education. The majority of the participants, 65.5%, were self-employed or were farmers/ peasants, and less than 5% received regular wages, either through paid employment or through pension. Socioeconomic status (SES) was categorized as tertiles, thus there were almost equal number of participants in each socioeconomic status (SES) category: 31.7% low, 34.7% middle, and 33.6% high SES. Almost half of the participants (48.1%) lived in a household with a person diagnosed with diabetes, while 35.9% shared a house with a person diagnosed with hypertension.

Twice as many males (15.9%) as females (6.6%) had a prior diagnosis of diabetes.15.5% of participants had abnormal fasting blood glucose level ≥ 7.0 mmol/L, and 9.2% had abnormal glycated hemoglobin (HbA1c) level ≥ 6.5%.

In the case of hypertension, 32 participants (7.5%) had a prior diagnosis. 7.7% of the males and 7.4% of the females had a prior diagnosis of hypertension. 29.4% of participants had high systolic blood pressure ≥ 140 mmHg, while 18.5% had high diastolic blood pressure ≥ 90 mmHg.

Table 1. Characteristics of Study Population

Characteristics	Sex n (%)		
	Male 183(43.0%)	**Female 243 (57.0%)**	**Total 426 (100%)**
Age			
≤ 20	69 (37.7%)	74 (30.5%)	143 (33.6%)
21 – 50	53 (29.0%)	94 (38.7%)	147 (34.5%)
> 50	61 (33.3%)	75 (30.9%)	136 (31.9%)
Education Level			
Never in school	16 (8.7%)	64 (26.3%)	80 (18.8%)
Primary School	116 (63.4%)	132 (54.3%)	248 (58.2%)
Secondary O'level & higher	51 (27.9%)	47 (19.3%)	98 (23.0%)
Employment Status[1]			
Paid wage & Pension	13 (7.1%)	5 (2.1%)	18 (4.3%)
Self & Farmer/peasant	105 (57.4%)	168 (70.0%)	273 (64.5%)
Unpaid & Student/pupil	65 (35.5%)	67 (27.9%)	132 (31.2%)
Socioeconomic Status (SES)			
Low	62 (33.9%)	73 (30.0%)	135 (31.7%)
Middle	63 (34.4%)	85 (35.0%)	148 (34.7%)
High	58 (31.7%)	85 (35.0%)	143 (33.6%)
Share household with person diagnosed with Diabetes			
Yes	82 (44.8%)	123 (50.6%)	205 (48.1%)
No	101 (55.2%)	120 (49.4%)	221 (51.9%)
Share household with person diagnosed with Hypertension			
Yes	60 (32.8%)	93 (38.3%)	153 (35.9%)
No	123 (67.2%)	150 (61.7%)	273 (64.1%)
Know Type II Diabetes Diagnosis			
Yes	29 (15.9%)	16 (6.6%)	45 (10.6%)
No	154 (84.2%)	227 (93.4%)	381 (89.4%)
Fasting Blood Glucose (fbg) (mmol/L)			
< 7.0	151 (82.5%)	209 (86.0%)	360 (84.5%)
≥ 7.0	32 (17.5%)	34 (14.0%)	66 (15.5%)
Glycated hemoglobin (HbA1c)			
< 6.5	162 (88.5%)	225 (92.6%)	387 (90.9%)
≥ 6.5	21 (11.5%)	18 (7.4%)	39 (9.2%)
Know Hypertension Diagnosis			
Yes	14 (7.7%)	18 (7.4%)	32 (7.5%)
No	169 (92.4%)	225 (92.6%)	394 (92.5%)
Systolic Blood Pressure[2]			

< 140 mmHg	127 (69.8%)	171 (71.3%)	298 (70.6%)
≥ 140 mmHg	55 (30.2%)	69 (28.8%)	124 (29.4%)
Diastolic Blood Pressure[2]			
< 90 mmHg	144 (79.1%)	200 (83.3%)	344 (81.5%)
≥ 90 mmHg	38 (20.9%)	40 (16.8%)	78 (18.5%)

[1]3 missing values (3 female)

[2]Four missing values (1 male, 3 female)

Characteristics of Study Participants by Diabetes Status

The characteristics of the study population by diabetes status are described in Table 2a. There were 45 participants (10.6%) with previously diagnosed diabetes, 34 (8.0%) with undiagnosed diabetes and 347 (81.4%) with no diabetes.

The number of women and men having no diabetes, diagnosed diabetes or undiagnosed diabetes was significantly different (p value 0.008). Among males, 15.9% had a known diabetes diagnosis and 7.1% had undiagnosed diabetes, while 6.6% of females were previously diagnosed with diabetes and 8.6% had undiagnosed diabetes. Variations in number of participants in the age categories were also significantly different (p value < 0.001): 37 out of the 45 participants with diagnosed diabetes were in the > 50 years age category and 17 out of 34 participants with undiagnosed diabetes were in the 21 – 50 years category. 4.2% of participants aged < 20 years old had undiagnosed diabetes, and none of them had a prior diagnosis.

There was a statistically significant difference in the numbers of participants in the employment categories (p value < 0.001). A third (33.3%) of participants with regular income through paid wage or pension had diagnosed diabetes while 11.1% (2 participants) had undiagnosed diabetes. 13.9% of self-employed or farmers/ peasants had diagnosed diabetes and 9.6% had undiagnosed diabetes. 38 out of the 45 participants with diagnosed diabetes, and 25 out of the 34 with undiagnosed diabetes, were self-employed and farmers/ peasants. 94.5% of participants with no income (unpaid family worker and student/ pupil category) had no diabetes. There was 1 participant in this category who had diagnosed diabetes and 6 had undiagnosed diabetes.

Among participants who lived in the same household as someone who had been previously diagnosed with diabetes, 5.9% had undiagnosed diabetes, while 9.9% of participants who did not live with a previously diagnosed participant had undiagnosed diabetes. These differences were statistically significant (p value < 0.001).

Difference in numbers of participants with a known hypertension diagnosis was statistically significant (p value < 0.001). 32 participants had both undiagnosed diabetes and undiagnosed hypertension, while 20 participants had both diagnosed diabetes and diagnosed hypertension. There were 2 participants (6.3%) with diagnosed hypertension who had undiagnosed diabetes. Among participants who had undiagnosed hypertension, 25 (6.4%) had been previously diagnosed with diabetes.

Differences in education level and diabetes status, and in socioeconomic status (SES) and diabetes status, were not statistically significant (p values 0.134 and 0.056 respectively).

Table 2a. Characteristics of Study Population by Diabetes Status (diabetic if fbg $\geq$ 7 or HbA1c $\geq$ 6.5)

Characteristics	Diabetes Status			Chi2 test p-value
	No Diabetes 347 (81.4%)	**DM/ Yes Diagnosis 45 (10.6%)**	**DM/ No Diagnosis 34 (8.0%)**	
Sex				
Male	141 (77.1%)	29 (15.9%)	13 (7.1%)	**0.008**
Female	206 (84.8%)	16 (6.6%)	21 (8.6%)	
Age				
$\leq$ 20	137 (95.8%)	0 (0.0%)	6 (4.2%)	
21 – 50	122 (83.0%)	8 (5.4%)	17 (11.6%)	**< 0.001**
> 50	88 (64.7%)	37 (27.2%)	11 (8.1%)	
Education Level				
Never in school	58 (72.5%)	14 (17.5%)	8 (10.0%)	
Primary School	205 (82.7%)	22 (8.9%)	21 (8.5%)	**0.134**
Secondary O'level & higher	84 (85.7%)	9 (9.2%)	5 (5.1%)	
Employment Status[1]				
Paid wage & Pension	10 (55.6%)	6 (33.3%)	2 (11.1%)	
Self & Farmer/peasant	210 (76.9%)	38 (13.9%)	25 (9.2%)	**< 0.001**
Unpaid & Student/pupil	125 (94.7%)	1 (0.8%)	6 (4.6%)	
Socioeconomic Status (SES)				
Low	110 (81.5%)	10 (7.4%)	15 (11.1%)	
Middle	126 (85.1%)	12 (8.1%)	10 (6.8%)	**0.056**
High	111 (77.6%)	23 (10.6%)	9 (6.3%)	
Share household with person diagnosed with Diabetes				
Yes	148 (72.2%)	45 (21.95%)	12 (5.9%)	**< 0.001**
No	199 (90.1%)	0 (0%)	22 (9.9%)	
Known Hypertension diagnosis				
Yes	10 (31.3%)	20 (62.5%)	2 (6.3%)	**< 0.001**
No	337 (85.5%)	25 (6.4%)	32 (8.1%)	

[1]3 missing values

Characteristics of Study Participants by Hypertension Status

Characteristics of the study population by hypertension status are presented in Table 2b. There were 32 participants (7.51%) with a known diagnosis of hypertension, 104 (24.41%) with undiagnosed hypertension and 290 (68.08%) with no hypertension.

Results indicate a significant difference in numbers of participants in the different age categories (p value < 0.001). 50% of participants > 50 years had undiagnosed hypertension, 21.3% had diagnosed hypertension and 28.7% did not have hypertension. No participant ≤ 20 years old had a known diagnosis of hypertension. There was also a significant difference in numbers of participants in the education categories (p value < 0.001). Participants with secondary school and higher levels of education were least in both the known hypertension diagnosis and undiagnosed hypertension categories (4 out of 32 participants with diagnosed hypertension and 13 out of 104 participants with undiagnosed hypertension).

A third (33.0%) of participants who were self-employed and farmers/ peasants had undiagnosed hypertension, while 16.7% of participants with regular income (paid wage & pension category) had undiagnosed hypertension. Over 90% of participants with no income (unpaid & student/ pupil category) did not have hypertension. These differences in the employment categories were statistically significant (p value < 0.001).

There was a significant relationship between sharing a house with a person diagnosed with hypertension and hypertension status (p value < 0.001):16.3% of participants who lived in the same household as a person with a known hypertension diagnosis were undiagnosed while almost 29.8% of those who did not share a household with someone with a known diagnosis had undiagnosed hypertension.

The relationship between known diabetes and hypertension status was also statistically significant (p value < 0.001). 20% of participants with a known diabetes diagnosis did not have hypertension. 44.4% of these participants with a known diabetes diagnosis also had diagnosed hypertension, and about 35.6% had undiagnosed hypertension. There were 3.15% of participants without a prior diabetes diagnosis who had diagnosed hypertension and 23.1% had undiagnosed hypertension.

Differences in sex and hypertension status, and socioeconomic status (SES) and hypertension status, were not statistically significant with hypertension status (p values 0.929 and 0.239 respectively).

Table 2b. Distribution of Characteristics of Study Population by hypertension status (hypertensive if systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg)

Characteristics	**Hypertension Status**			**Chi2 test p-value**
	No Diabetes 290 (68.1%)	**HTN/ Yes Diagnosis 32 (7.5%)**	**HTN/ No Diagnosis 104 (24.4%)**	
Sex				
Male	126 (68.9%)	14 (7.7%)	43 (23.5%)	**0.929**
Female	164 (67.5%)	18 (7.4%)	61 (25.1%)	
Age				
≤ 20	137 (95.8%)	0 (0.0%)	6 (4.2%)	
21 – 50	114 (77.6%)	3 (2.0%)	30 (20.4%)	**< 0.001**
> 50	39 (28.7%)	29 (21.3%)	68 (50%)	
Education Level				
Never in school	31 (38.8%)	9 (11.3%)	40 (50.0%)	
Primary School	178 (71.8%)	19 (7.7%)	51 (20.6%)	**< 0.001**
Secondary O'level & higher	81 (82.7%)	4 (4.1%)	13 (13.3%)	
Employment Status[1]				
Paid wage & Pension	13 (72.2%)	2 (11.1%)	3 (16.7%)	
Self & Farmer/peasant	154 (56.4%)	29 (10.6%)	90 (33.0%)	**< 0.001**
Unpaid & Student/pupil	121 (91.7%)	1 (0.8%)	10 (7.6%)	
Socioeconomic Status (SES)				
Low	92 (68.2%)	10 (7.4%)	33 (24.4%)	
Middle	103 (69.6%)	6 (4.1%)	39 (26.4%)	**0.239**
High	95 (66.4%)	16 (11.2%)	32 (22.4%)	
Share household with person diagnosed with Hypertension				
Yes	96 (62.8%)	32 (20.9%)	25 (16.3%)	**< 0.001**
No	194 (71.1%)	0 (0.0%)	79 (28.9%)	
Known Diabetes diagnosis				
Yes	9 (20.0%)	20 (44.4%)	16 (35.6%)	**< 0.001**
No	281 (73.8%)	12 (3.2%)	88 (23.1%)	

[1]3 missing values

Geographical Distances from Home to Healthcare Facilities

Table 3 shows distances from participants' homes to healthcare facilities. Participants lived an average of 2.22 Km ± 1.48 Km from their nearest health facility. Distance to the hospital with a free monthly diabetes clinic was largest and had the most variation (mean 24.94 Km ± 12.63Km). The mean distance from home to hospital with a paid weekly diabetes clinic was 14.36 Km ± 12.03 Km.

Table 3. Summary of Distances from Home to Healthcare Facilities

Geographical Distances	**Kilometers Mean (sd)**	**Kilometers Median (IQR)**
Distance to nearest health facility	2.22 (1.48)	2.12 (2.53)
Distance to hospital with paid weekly diabetes clinic	14.36 (12.03)	9.04 (23.32)
Distance to hospital with free monthly diabetes clinic	24.94 (12.63)	25.22 (11.72)

Models for the Association of Geographical Distance from Homes to Healthcare facilities and Diabetes Status

Table 4a presents the between association geographical distance from home to healthcare facilities and diabetes status. For the nearest Health Facility, the odds of having no diabetes were 4% higher [OR=1.04, 95% CI (0.88, 1.23)] and the odds of having undiagnosed diabetes were 2% higher [OR=1.02, 95% CI (0.78, 1.34)], than having diagnosed diabetes for every 1 Km increase in distance from the households to the health facility. However, these associations were not statistically significant. The odds ratio for undiagnosed diabetes to diagnosed diabetes reduced to 0.91 [OR=0.91, 95% CI (0.75, 1.10)] and the odds ratio for no diabetes to diagnosed diabetes reduced to 0.89 [OR=0.89, 95% CI (0.68, 1.18)] after adjusting for age, sex, socioeconomic status, sharing household with someone diagnosed with diabetes.

For the hospital with a paid weekly diabetes clinic, for every 1 Km increase in distance from the household to the hospital, there was 1.02 higher odds of having undiagnosed diabetes to having diagnosed diabetes [OR=1.02, 95% CI (0.98, 1.05)]. The association was not statistically significant, and was not attenuated by adjustment of age, sex and socioeconomic status. There was no association between having no diabetes and having diagnosed diabetes for geographical distance from the household to hospital with a paid weekly diabetes clinic [OR=1, 95% CI (0.98, 1.02)].

For the hospital which offered a free monthly diabetes clinic, participants were 3% less likely to have undiagnosed diabetes compared to diagnosed diabetes, for every 1 Km increase in distance from home to [OR=0.97, 95% CI (0.94, 1.01)], although the association was not statistically significant. This association remained constant after adjusting for age, sex, socioeconomic status, and sharing household with someone diagnosed with diabetes. There was no association between having no diabetes and having diagnosed diabetes for distance to hospital with free monthly diabetes clinic [OR=1, 95% CI (0.98, 1.02)].

Table 4a. Multinomial Logistic Regression Models of Geographical Distance and Diabetes Status

	Crude Model OR (CI)	**Model 1 AOR (CI)**	**Model 2 AOR (CI)**	**Model 3 AOR (CI)**
Distance to nearest health facility				
Ref: diagnosed diabetes	1	1	1	1
No diabetes	1.04 (0.88, 1.23)	1.04 (0.84, 1.28)	1.04 (0.85, 1.27)	0.91 (0.75, 1.10)
Undiagnosed diabetes	1.02 (0.78, 1.34)	1.03 (0.77, 1.38)	1.04 (0.79, 1.36)	0.89 (0.68, 1.18)
Distance to hospital with paid weekly diabetes clinic				
Ref: diagnosed diabetes	1	1	1	1
No diabetes	1 (0.98, 1.02)	1.01 (0.98, 1.03)	1 (0.98, 1.03)	1.01 (0.99, 1.03)
Undiagnosed diabetes	1.02 (0.98, 1.05)	1.02 (0.98, 1.06)	1.02 (0.98, 1.06)	1.03 (0. .99, 1.06)
Distance to hospital with free monthly diabetes clinic				
Ref: diagnosed diabetes	1	1	1	1
No diabetes	1 (0.98, 1.02)	1 (0.97, 1.02)	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)
Undiagnosed diabetes	0.97 (0. 94, 1.01)	0.97 (0.94, 1.01)	0.97 (0.93, 1.00)	0.97 (0.94, 1.00)

Model 1: Adjusted for age, sex
Model 2: Adjusted for age, sex, socioeconomic status
Model 3: Adjusted for age, sex, socioeconomic status, share household with person diagnosed with diabetes

Models for the Association of Geographical Distance from Homes to Healthcare facilities and Hypertension Status

Table 4b presents the association between geographical distance from home to healthcare facility and hypertension status. For the nearest health facility, the odds of having undiagnosed hypertension was 4% higher than having diagnosed hypertension [OR=1.04, 95% CI (0.79, 1.37)] for every 1 Km increase in distance from household to the health facility. However, this association was not statistically significant. The odds ratio increased to 1.09 after adjusting for age, sex, socioeconomic status, and sharing household with someone diagnosed with hypertension [OR=1.09, 95% CI (0.83, 1.42)], but the association was not statistically significant. The odds ratio for no hypertension to diagnosed hypertension was 1.04 after adjusting for age, sex, socioeconomic status and sharing household with someone diagnosed with hypertension [OR=1.04, 95% CI (0.78, 1.39)].

For the distance from household to the hospital which offered weekly diabetes clinic for a fee, participants were 3% more likely to have undiagnosed hypertension [OR=1.03, 95% CI (0.99, 1.07)], and 2% more likely to have no hypertension [OR=1.02, 95% CI (0.99, 1.05)], compared to having diagnosed hypertension for every 1 Km increase in distance from the household to hospital. However, this association was borderline statistically significant. Additional adjustment for age, sex and socioeconomic status, sharing household with someone diagnosed with hypertension, and having a known diabetes diagnosis did not attenuate the odd ratios.

There was no association between having undiagnosed hypertension to having diagnosed hypertension, for every 1 Km increase in distance to health facility with free monthly diabetes clinic.

Table 4b. Multinomial Logistic Regression Models of Geographical Distance and Hypertension Status

	Crude Model OR (CI)	Model 1 AOR (CI)	Model 2 AOR (CI)	Model 3 AOR (CI)
Distance to nearest health facility				
Ref: diagnosed hypertension	1	1	1	1
No hypertension	1.01 (0.80, 1.27)	1 (0.73, 1.37)	0.99 (0.73, 1.35)	1.04 (0.78, 1.39)
Undiagnosed hypertension	1.04 (0.79, 1.37)	1.05 (0.78, 1.41)	1.04 (0.78, 1.39)	1.09 (0.83, 1.42)
Distance to hospital with paid weekly diabetes clinic				
Ref: diagnosed hypertension	1	1	1	1
No hypertension	1.02 (0.99, 1.05)	1.03 (0.99, 1.07)	1.02 (0.99, 1.06)	1.02 (0.97, 1.06)
Undiagnosed hypertension	1.03 (0.99, 1.07)	1.03 (0.99, 1.07)	1.03 (0.99, 1.07)	1.02 (0.98, 1.07)
Distance to hospital with free monthly diabetes clinic				
Ref: diagnosed hypertension	1	1	1	1
No hypertension	1.01 (0.99, 1.03)	1 (0.97, 1.03)	1 (0.97, 1.03)	0.97 (0.93, 1.00)
Undiagnosed hypertension	1 (0.97, 1.04)	1 (0.97, 1.03)	0.99 (0.96, 1.03)	0.96 (0.93, 1.00)

Model 1: Adjusted for age, sex
Model 2: Adjusted for age, sex, socioeconomic status
Model 3: Adjusted for age, sex, socioeconomic status, share household with person diagnosed with hypertension

CHAPTER FIVE: Discussion

Major Findings

- Age, sex and employment were independently related to diagnosis of diabetes.
- Age, education and employment were independently related to diagnosis of hypertension.
- Living with a household member diagnosed with diabetes reduced the likelihood of having undiagnosed diabetes. Likewise, living with a household member diagnosed with hypertension reduced the likelihood of having undiagnosed hypertension.
- People who had been previously diagnosed with diabetes were less likely to have undiagnosed hypertension than people with undiagnosed diabetes. Likewise, people with a prior diagnosis of hypertension were less likely to have undiagnosed diabetes than people with undiagnosed hypertension.
- People were not more likely to have undiagnosed diabetes with increasing distance from home to the nearest health facility. There was a tendency that people were more likely to have undiagnosed diabetes with increasing distance to the hospital with paid weekly diabetes clinic. No association was seen between undiagnosed diabetes and increasing distance from home to hospital with free monthly diabetes clinic.
- People were not more likely to have undiagnosed hypertension with increasing distance from home to the nearest health facility. People were more likely to have undiagnosed hypertension with increasing distance to the hospital with paid weekly diabetes clinic. No clear association was found between undiagnosed hypertension and distance from home to the hospital with free monthly diabetes clinic.

Socioeconomic Factors and Diabetes Status

We found that the relation between employment and diabetes status, was significant (p–value < 0.001). People with paid wage or pension were more likely to have diagnosed diabetes than the self-employed and farmers/ peasants or those no income such as unpaid family workers or students/ pupils. Using employment as an indicator of socioeconomic status (SES), our results are in line with literature indicating that that SES is associated with diabetes: In one Ugandan study, people of higher SES, as evidenced by cement and tiled floors, were more likely to have diabetes than people of low SES who had earth and cow dung floors.[11]

In our study, socioeconomic status (SES) did not have a statistically significant relationship with diabetes status. SES was reported as a household, rather than an individual characteristic, and households were selected to satisfy a distribution of almost equal numbers of households in each SES cluster; low, middle or high. For analysis, we expanded household SES to apply to each individual in the household. This may have contributed to the lack of statistical significance that we found between SES and diabetes status.

We did not find a statistically significant relationship between diabetes status and education. This is in line with findings from a previous Ugandan study which also found that there was no significant association between diabetes and level of education.[12]

Socioeconomic Factors and Hypertension Status

We found that the relation between hypertension status and education was significant (p–values < 0.001). People who had never been in school were more likely than people with higher levels of education to have undiagnosed hypertension. A previous study in Uganda also found that people with tertiary education were three times more likely to be hypertensive than those with no formal education.[15] The difference in findings between our study and the previous study may be because we did not adjust for age when examining the relationship between hypertension status and education. Uganda adopted compulsory primary education in 1997[31], thus, older people in Uganda tend to have less formal education and younger people more formal education. This was the case in our study. Increasing age has been shown to increase the likelihood of having hypertension.[14, 16] This explains why we found that people with less education (mostly older people) were more likely to have undiagnosed hypertension than those with higher levels of education (mostly younger people).

The relationship between hypertension and employment was also statistically significant (p value < 0.001) Self-employed participants and farmers/ peasants were more likely to have undiagnosed hypertension than with people with paid wage or pension and people with no income. Previous studies in Uganda also found that there was an association between hypertension and employment.[14, 15] One study found that unemployed people were more likely than employed people to be hypertensive[14] Our findings are in line with this previous research, showing that although unemployed people are more likely to be have hypertension[14], they are more likely to be undiagnosed.

We did not find a statistically significant relationship between socioeconomic status (SES) and hypertension status. As discussed in the section above, socioeconomic status (SES) was not an optimal socioeconomic factor for this study.

Geographical Distance from Homes to Healthcare Facilities and Disease Status

The associations between geographical distances from homes to healthcare facilities were not statistically significant in this study. This lack of significance could be attributed to poor availability of diagnostic tools and equipment in health facilities. One Ugandan study found that health facilities often lacked relevant equipment for diagnosis, including blood pressure machines, blood glucose machines, glucose and urine test strips, and adult weighing machines[18], while another found that a district hospital in rural Uganda which offered free diabetes testing often experienced periods of glucose test strip shortages.[21] This may also explain why we found no association between distance to nearest health facility and undiagnosed diabetes or hypertension. In addition, the nearest health facility may often be lower level health centers, which in Uganda often do not have capacity for diagnosing diabetes, and people sought diabetes care mostly from hospitals and health canter IVs (HC IVs).[18, 20, 21]

We found that for distance to the hospital which offered a weekly diabetes clinic for a fee there was increased odds ratio of having undiagnosed diabetes and undiagnosed hypertension. On the other hand, we saw no clear association between diagnosis status and distance from household to the hospital which offered a monthly diabetes clinic free of charge.

The findings that geographical distance is associated with diabetes and hypertension status in the case of the hospital with a paid weekly diabetes clinic suggest that living closer to the hospital increases the possibility that a person 1) seeks care at the hospital when they have symptoms and 2) is diagnosed with diabetes and/ or hypertension.

There was no association found between hypertension diagnosis and distance from home to the hospital with paid monthly diabetes clinic. This lack of associations could be due to the fact that we used geographical distance in Kilometers (Km) without considering travel time to health facilities, but it may be that travel time is more important. On average, people lived farthest away from the hospital with a free monthly diabetes clinic. Some participants may have been living further away but in an area with public/affordable transportation to the health facility, whereas others may have been closer, but in the mountains and would have to walk for a long period of time. In this case, travel time would have been a better factor to examine.

Strengths and Limitations

To our knowledge, this is the first study that has investigated the association between socioeconomic factors and geographical distance from home to a healthcare facility and diagnosis of diabetes and hypertension in rural Uganda. Previous studies investigated factors associated with having diabetes and hypertension but did not include socioeconomic factors and geographical distance in relation to diagnosis.

Another strength of this study is that data on disease status such as FBG, HbA1c and blood pressures, and geographical distances were not self-reported, but systematically measured and recorded by the researchers. This reduced the chance of recall bias and promoted the accuracy of test results.

The main limitation of this study is the small sample size, which meant that for some variables the number of participants in some of the categories may have been low for statistical tests. For example, the employment variable had less than 10% of participants in the paid wage and pension category. Small sample size may also have contributed to the lack of statistical significance in the regression models.

In addition, study participants came from 87 households. Participants from the same household may not have been independent, which is an assumption of regression models. Thus, household ID was used as a random effect to account for within household clustering. This may have reduced the statistical power of the results.

Another limitation to this study is the use of self-report for some study information, which could have been subject to response bias. For example, self-reports on socio-economic factors may be biased.

Conclusion

The objectives of this thesis were to use secondary cross-sectional data from rural south-western Uganda to: 1) investigate the association between socioeconomic factors and the diagnosis of diabetes and hypertension, and 2) to determine the relationship between geographical distance from home to healthcare facilities and having undiagnosed diabetes and hypertension, compared with having diagnosed diabetes and hypertension.

This study found associations between socioeconomic factors and the diagnosis status of diabetes and hypertension. People who were likely to have undiagnosed diabetes were females, younger people, people with no income or those who are self-employed or farmers/ peasants. Those who were likely to have undiagnosed hypertension were younger people and those with less formal education.

This study also showed that sharing a household with someone diagnosed with diabetes reduced the chances of having undiagnosed diabetes, while sharing a household with a person with diagnosed hypertension reduced the chances of having undiagnosed hypertension. Being diagnosed with diabetes meant that one was likely to be diagnosed if they had hypertension.

In this study, the associations between geographical distances from homes to healthcare facilities were not statistically significant.

Public Health Implications

Undiagnosed diabetes and hypertension are a big problem in Sub-Saharan Africa, as both predispose individuals to long-term complications, cardiovascular disease and premature death, which also pose a threat to communities and countries' economies.[4] Diagnosis of diabetes and hypertension is critical in reducing this burden. While it is necessary to target people known to be at risk for diabetes and hypertension such as older people for diagnostic screening, it is also important to think about ways to improve screening and diagnosis among people who the study has found to be at high risk of having undiagnosed disease. In this rural Ugandan population, this would mean younger people particularly those in the 21 – 50 years age group. Other groups to target for diabetes and hypertension diagnostic screening efforts are: females, people with less formal education such as those with only primary education or no education, and people who are self-employed or are farmers/ peasants, or unpaid family workers.

A key area for future public health research is how geographical distance from homes to health facility influences diagnosis of diabetes and hypertension. The present study attempted to investigate this, but more studies are necessary to shape the understanding of the relationship between distance and disease status. Such studies should also investigate travel time, and economic barriers for transportation. This would have an impact on planning for access to diagnostics in healthcare facilities.

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