SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

FACTORS ASSOCIATED WITH GLYCEMIC CONTROL IN PATIENTS WITH TYPE 2 DIABETES IN TAMALE TEACHING HOSPITAL IN THE NORTHERN REGION OF GHANA

BY

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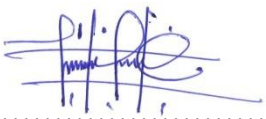
JUNE, 2022

DECLARATION

I, **ABDULLAH MOHAMMED MASOOM** hereby declare that with the exception of the references cited to other people's work which has been duly acknowledged, this work is the result of my own research work done under supervision and has neither in part nor whole been presented elsewhere for the award of another degree.



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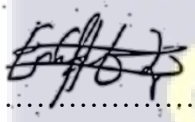

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PROFESSOR ERNEST KENU

(SUPERVISOR)

DEDICATION

To God, my mother, my wife and kids.

ACKNOWLEDGEMENT

I wish to express my profound gratitude to my academic supervisor, Professor Ernest Kenu for his guidance and tutelage throughout the study, you inspired and motivated me to aim higher in the field of academia.

My deepest appreciation also goes to the authorities of Tamale Teaching Hospital, the staff of the diabetes clinic of T.T.H, all the participants of the study, and my research assistants, this research was successful because of your support and cooperation, God richly bless you all.

To my dearest mother, Hajia Amina Amadu, my lovely wife, Alhassan Ramatu Sanyoo, and children, Liyana, Ajwad, Inaaya, Ramadan, and Aslam, I say may Allah bless you for your support throughout my masters programme.

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LIST OF ABBREVIATIONS

ADA	American Diabetes Association
aOR	Adjusted Odds Ratio
BMI	Body Mass Index
BP	Blood Pressure
DM	Diabetes Mellitus
FPG	Fasting Plasma Glucose
HbA1c	Glycated Hemoglobin
IDF	International Diabetes Federation
N/R	Northern Region
OGTT	Oral Glucose Tolerance Test
SSA	Sub-Saharan Africa
TAMA	Tamale Metropolitan Area
TTH	Tamale Teaching Hospital
T2DM	Type 2 Diabetes Mellitus
UN	United Nations
WHO	World Health Organization

ABSTRACT

Introduction: Diabetes Mellitus (DM) continues to be a major public health concern with enormous effects on human health, living standards, the economy, and health care systems. People are at risk of this disease due to lifestyle factors such as alcohol drinking, smoking cigarettes/tobacco, and not exercising regularly during their youth. In Ghana, there is limited evidence of factors such as alcohol drinking, smoking cigarette, and regular exercise associated with glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana.

Objective: The main objective of the study was to determine the proportion of glycemic control and associated factors among patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana.

Method: An analytical cross-sectional study involving patients with type 2 diabetes mellitus was conducted at the Tamale Teaching Hospital in the Northern Region of Ghana. The simple random sampling technique was used to select patients in the diabetes clinic in the Tamale Teaching Hospital in the Northern Region of Ghana. Questionnaires were administered to these patients and data on the proportion of glycemic control and associated factors were collected. The proportion of glycemic control in patients with type 2 diabetes mellitus was assessed by using the frequency and percentages. The association between glycemic control in patients with type 2 diabetes mellitus and the independent variables (socio-demographic and lifestyle related factors) were tested using Pearson's Chi-square test and Fisher's Exact test. The univariate and multivariable logistic regression were performed to determine the association between the glycemic control in patients with type 2 diabetes mellitus and various independent variables at 5% significance level.

Results: The proportion of poor glycemic control in patients with type 2 diabetes was 47.3%(95% CI=42.0% -52.7%). Major risk factors identified to have influenced poor glycemic control in patients with type 2 diabetes were 60 years and above age group (Adjusted Odds Ratio [aOR] $= 4.0, 95\%$ CI $= [1.2 - 13.3]$), family history of diabetes (aOR $= 1.8, 95\%$ CI $= [1.1 - 3.1]$), former alcohol drinkers (aOR $= 2.2, 95\%$ CI $= [1.2, 3.8]$), andformer cigarette/tobacco smokers(aOR $= 1.8, 95\%$ CI $= [1.0 - 3.2]$).

The protective factors identified to have influenced poor glycemic control in patients with Type 2 diabetes were urban residents(aOR $= 0.4, 95\%$ CI $= [0.2, 0.7]$) and regular physical exercise (aOR $= 0.6, 95\%$ CI $= [0.4 - 0.9]$).

Conclusions and Recommendations: This study concludes that type 2 diabetes patients attending the diabetes clinic of the Tamale Teaching Hospital have moderate glycemic control. Major risk factors such as age, family history of diabetes, alcohol consumption, smoking cigarette, and protective factors such as living in urban areas and regular physical exercise were associated with glycemic control in patients with type 2 diabetes. The author recommends that the in charge of the diabetes clinic at the Tamale Teaching Hospital in the Northern Region should appoint some health workers who will routinely check the patients' records to identify patients with HbA1c≥ 7% in order to take the appropriate actions. This monitoring of patients' HbA1c will enhance patient glycemic control and improve better adherence to medication which will result in good quality of life. The author also recommends that health workers such as doctors and nurses at the hospital, during consultation, should continue to advise patients on lifestyle modifications such as reducing alcohol drinking and smoking cigarette/tobacco, and performing more regular exercises. This will increase their general well-being and promote their quality of life.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Diabetes mellitus is a chronic, non-communicable disease caused by either a complete deficiency of insulin or a relative deficiency of insulin resulting from decreased insulin secretion and action (American Diabetes Association [ADA], 2014; stumvoll et al., 2005). It is characterized by a high plasma concentration of sugar levels due to insulin resistance and glucose intolerance by the cells of the body (Grundy, 1999). The three most common types of diabetes mellitus are Type 1 diabetes, Type 2 diabetes, and gestational diabetes.

Globally, an estimated 537 million people between the ages 20 and 79 years were suffering from diabetes in 2021 (International Diabetes Federation [IDF], 2021). Diabetes, accounting for an estimated 1.5 million deaths in 2019 was the ninth leading cause of death worldwide (World Health Organization [WHO], 2021). As reported by the IDF (2021), 24 million African adults between the ages of 20 and 79 years were estimated to have diabetes mellitus. Ghana recorded 329,200 adults between the ages of 20 and 79 years suffering from diabetes and 6,225 diabetes-related deaths in 2021, which is expected to double by the next two decades if proper measures of good glycemic control among Type 2 diabetes patients are not initiated (IDF, 2021).

Uncontrolled diabetes mellitus can result in hyperglycemia or raised blood sugar which seriously damages several body systems such as nerves and blood vessels in persons with diabetes mellitus (WHO, 2021). This further results in microvascular complications comprising diabetic retinopathy, nephropathy, and neuropathy (Zimmet, Alberti, & Shaw,

2001; Valencia & Florez, 2017) and macrovascular complications comprising atherosclerosis, coronary artery disease, and cerebrovascular diseases (Rasheed, Islam, & Mahjabeen, 2015).

Even though diabetic patients benefit from the control of hyperglycaemia (Gupta et al., 2007; Kreisberg, 1998), most of them fail to achieve a sufficient level of glycemic control (Brož et al., 2018; Angamo, Melese, &Ayen, 2013; Bergenstal et al., 2009). Good glycemic control or glycated haemoglobin (HbA1C), which is the regular levels of blood sugar (glucose) in a person with diabetes mellitus, has become an important goal of diabetic care (Kassaian et al., 2012; Haghighatpanah et al., 2018). It prevents the severity of complications and increases cognitive functioning (Shafiee et al., 2012; Kawamura, Umemura, &Hotta, 2012). However, poor glycemic control influences the health-related quality of life of patients (Co et al., 2015; Paschalides et al., 2004).

Globally, about 40 to 60% of patients with diabetes have poor glycemic control (Alzaheb & Altemani, 2018). The proportion of poor glycemic in sub-Saharan Africa is reported to be 74% (Camara et al., 2015). Mobula et al. (2018) found that the proportion of poor glycemic control was 70% among persons with type 2 diabetes in five health facilities in Ghana. Glycemic control in persons with type 2 diabetes differs by sex and age (Dedefo et al., 2020; Mobula et al., 2018). For instance, as persons get older, the mitochondria activity in muscles and brain declines, and fat accumulates in muscles and liver tissues, resulting in insulin resistance and a deficiency in insulin secretion (Lipska et al., 2016).

Assessment of glycemic control and the factors that influence it among patients with type 2 diabetes mellitus has become of much importance because it is vital to understand the impact of the disease and this can allow healthcare providers and patients to focus on areas where

they can lower the risk of diabetic complications and death. Recent studies into glycemic control in patients with type 2 diabetes mellitus in sub-Saharan Africa, including Ghana are limited, hence the need to study the phenomenon and its related factors among patients with type 2 diabetes mellitus in Tamale Teaching Hospital.

1.2 Statement of the Problem

Type 2 diabetes is a global public health problem (Arredondo, Azar, &Recamán, 2018; Hills et al., 2018; Al-Lawati, 2017). Diabetes affected 329,200 adults between the ages 20 and 79 years with 6,225 people dying in 2021 (IDF, 2021). Undiagnosed or poorly controlled type 2 diabetes can result in amputation of the lower limbs, blindness, and kidney failure (Harris, 1998; Hippisley-Cox &Coupland, 2016; Rådholm et al., 2018). It also worsens major infectious diseases, including tuberculosis, HIV/AIDs, and malaria (Goedecke et al., 2017; Dunachie&Chamnan, 2019). People are at risk of experiencing type 2 diabetes due to the kind of lifestyle such as alcohol drinking, smoking cigarettes/tobacco, and eating fatty food (Marjanović et al., 2021; Abdissa&Hirpa, 2022; Mobula et al., 2018; Hailu et al., 2012).

Poor glycemic control in people with type 2 diabetes is a life-threatening illness globally. It has increased co-morbidity burden, decreased life expectancy, and increased mortality rate (McCoy et al., 2020; Liu et al., 2010; El-Kebbi et al., 2001). In Ghana, the proportion of poor glycemic control in persons with type 2 diabetes in five health facilities in Ghana was 70% (Mobula et al., 2018). Several researchers (Marjanović et al., 2021; Abdissa&Hirpa, 2022; Mobula et al., 2018; Hailu et al., 2012; Ohkuma et al., 2015) have shown that family history of diabetes and lifestyle factors such as poor diet habits, lack of exercise, alcohol consumption, and smoking of cigarette play a significant role in the general risk and prognosis of this disease.

Although information about glycemic control in persons with type 2 diabetes is well documented, there is limited information about the risk factors affecting glycemic control in persons with type 2 diabetes in Ghana, especially in the Northern Region of Ghana. This raises questions about "the socio-demographic and lifestyle factors affecting glycemic control?" It is in this light that the research seeks to assess the factors influencing poor glycemic control in persons with type 2 diabetes in the Northern Region of Ghana. This study is designed to create public awareness of the health implications of some lifestyles such as drinking alcohol and poor diet in Ghana. It would also inform future interventions such as measures to be undertaken to improve the quality of treatment and care services as well as promote good glycemic control in persons with type 2 diabetes.

1.3 Conceptual Framework

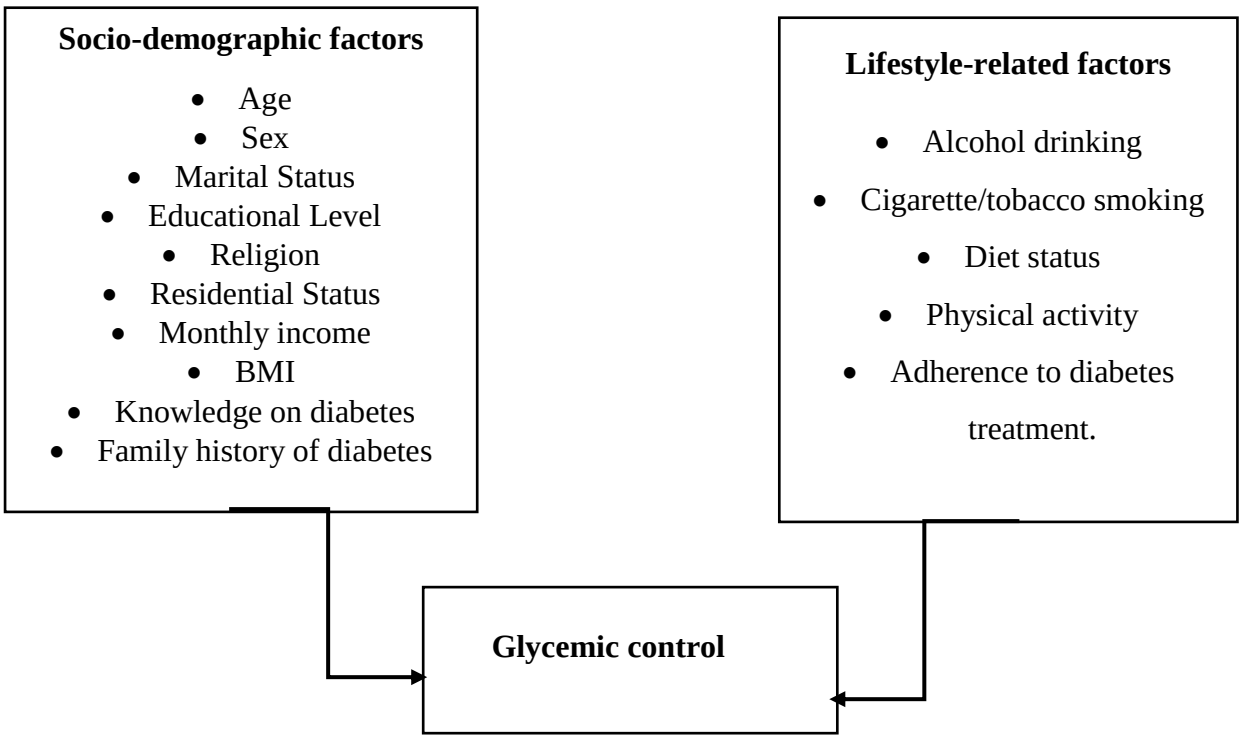

Figure 1.1: Conceptual framework to assess glycemic control in patients with type 2c diabetes and associated factors.

The graphical representation of risk factors such as socio-demographic and lifestyle-related factors influencing glycemic control in patients with type 2 diabetes can be seen in Figure 1.1. The framework comprises socio-demographic characteristics and lifestyle-related factors and their influence on glycemic control in patients with type 2 diabetes. The socio-demographic characteristics are age, sex, educational level, marital status, employment status, religion, residential status, body mass index (BMI), monthly income, knowledge of diabetes, and family history of diabetes.

Studies have shown that socio-demographic factors such as age, sex, educational level, marital status, employment status, knowledge of diabetes, and family history of diabetes have a significant association with glycemic control in patients with type 2 diabetes (Omar et al.,

2018; Dedefo et al., 2020; Angamo, Melese, &Ayen, 2013; Gebermariam et al., 2020; Alzaheb&Altemani, 2018; Abdissa&Hirpa, 2022). For instance, lower educational background is sometimes related to the difficulty in understanding and believes in public health interventions, so those with a low educational background might not be able to read materials on healthy lifestyles such as avoiding smoking cigarettes and drinking alcohol and performing regular physical exercises. People with diabetes who are overweight or obese are more likely to have poor glycemic control.

Also, lifestyle-related factors such as alcohol drinking, cigarette/tobacco smoking, irregular physical activity, poor diet habits, and non-adherence to diabetes treatment are risk factors that influence glycemic control in patients with type 2 diabetes (Marjanović et al., 2021; Abdissa&Hirpa, 2022; Mobula et al., 2018; Hailu et al., 2012; Ohkuma et al., 2015). Diabetic patients who engage in alcohol drinking and cigarette smoking are at higher risk of having poor glycemic control. Smoking directly influences glucose homeostasis by increasing insulin resistance and decreasing insulin secretion.

1.4 Justification of Study

The purpose of the study is to assess the determinants associated with poor glycemic control in persons in persons with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana. Studies have indicated that poor glycemic control in persons with type 2 diabetes mellitus is found in the low-and middle-income countries such as Ghana (IDF, 2017).

Several studies have identified sex, age, educational status, physical activity, alcohol consumption, smoking cigarette, and obesity to influence glycemic control in persons with type 2 Mellitus diabetes (Mobula et al., 2018; Dedefo et al, 2020; Abdissa&Hirpa, 2022;

Almetwazi et al., 2019). This study would help the government and stakeholders in the health sector in formulating measures to decrease the risk of type 2 diabetes-related morbidity and mortality in Sub-Saharan Africa and Ghana to be precise.

The findings will also aid the community, health sector, non-government organizations, and the government as a whole to formulate strategic measures to ensure a decrease in premature mortality of patients suffering from type 2 diabetes to be able to meet the United Nation (UN)'s Sustainable Development Goal target of reducing premature mortality from non-communicable diseases by a third by 2030.

Furthermore, it would assist the Northern Regional Health Directorate in organizing educative and awareness programs on the essence of partaking in the early screening of type 2 diabetes. It would help the health sector to have a clinical assessment and careful monitoring of diabetes since this contributes to the low quality of life of people.

Finally, the results of this study could be used to strengthen future developments for patients suffering from type 2 diabetes and to direct the Ghana Health Service in the Northern Region, other partner organizations in the nation, and the country as a whole.

1.5 Research Questions

The research questions for this study are:

1. What is the proportion of poor glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana?
2. What is the association between socio-demographic characteristics and poor glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana?

3. What is the association between lifestyle-related factors and poor glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana?

1.6 General Objective

The general objective of the study is to determine the proportion of poor glycemic control and associated factors among patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana.

1.6.1 Specific Objectives

The specific objectives of this study are:

1. To determine the proportion of poor glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana.
2. To determine the association between socio-demographic characteristics and poor glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana.
3. To examine the association between lifestyle-related factors and poor glycemic control in patients with type 2 diabetes mellitus attending the Tamale Teaching Hospital in the Northern Region of Ghana.

CHAPTER TWO

LITERATURE REVIEW

2.1 Diabetes Mellitus

Diabetes Mellitus (DM) is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces (Narjis et al., 2021; WHO, 2016). It is a group of metabolic diseases characterized by an elevation in the blood glucose levels resulting from the absolute or relative lack of insulin or the inability of the cells of the body to effectively utilize the insulin (ADA, 2010). The resulting increase in blood glucose levels may lead to acute metabolic complications such as ketoacidosis and long-term chronic micro and macrovascular complications (Hansen, 2018). Classic symptoms include polyuria (excessive urination), polydipsia (excessive thirst), polyphagia (excessive hunger), and weight loss (Deshmukh, Jain, & Nahata, 2015; Mukhtar, Galalain, & Yunusa, 2020).

The onset of diabetes mellitus can occur in childhood also known as type 1 diabetes, in adulthood, also referred to as type 2 diabetes mellitus, or during pregnancy, referred to as gestational diabetes. The current standard criteria for diagnosing diabetes mellitus include elevated fasting plasma glucose (FPG) (126 mg/dL or 7.0 mmoL/L) and/or glucose intolerance with a 2- h plasma glucose level of 200 mg/dL (11.1 mmoL/L) after a standard oral dose of 75 g of glucose (an oral glucose tolerance test or OGTT). Random plasma glucose of 200 mg/dL (11.1 mmoL/L) is also a diagnostic criteria in a patient with symptoms such as thirst, excess urination, and/or weight loss or Glycated hemoglobin (HBA1c) of > 7% (ADA, 2010).

The prevalence of diabetes mellitus increased sharply from 108 million in 1980 to 422 million in 2014, a trend which has been rising more rapidly in the low-and-middle-income countries (WHO, 2016). The International Diabetes Federation report in 2017 indicated that diabetes mellitus is a major cause of kidney failure, heart attacks, lower limb amputation, blindness, and stroke with an estimated death of 1.6 million directly caused by diabetes mellitus. Diabetes, accounting for an estimated 1.5 million deaths in 2019 was the ninth leading cause of death worldwide.

The burden of diabetes mellitus is particularly more serious in sub-SaharanAfrica (SSA) than in the rest of the continent. More than 19 million people currently have diabetes in sub-Saharan Africa, and this will increase to 47 million by 2025, an increase of roughly 143%, the largest increase of any IDF region in the world (IDF, 2017). In parallel with the increasing burden of diabetes in SSA, diabetes care is suboptimal in the region, leading to high diabetes-related rates of microvascular and macrovascular complications in this population (Caballero et al., 2020). Kirigia et al. (2009) estimated the total economic loss to diabetes care by countries of the African region to be US$25 billion. The International Diabetes Federation, in a 2017 report, estimated the total health expenditure due to diabetes at US$ 3.3 billion in Sub-Saharan Africa.

Ghana recorded about 6,262 diabetes-related deaths between 2019 and 2020, which is expected to double by the next two decades if proper measures of good glycemic control among Type 2 diabetes patients are not initiated (IDF, 2017). The mean annual financial cost of managing one diabetic case in Ghana was estimated at GH₵ 540.35 or US$372.65 (Quaye et al., 2015).

2.2 Glycemic Control

The occurrence of complications remains a major concern in the management of Diabetes mellitus. These complications are related to the damaging effects of hyperglycemia (Mamo et al., 2019). To prevent or delay disease progression and reduce the risk of developing diabetes complications, in the management of diabetes mellitus, the most important strategy is to focus on strict glycemic control (Fiseha et al., 2018). A good glycemic control level is the preferred clinical outcome in the effective management of diabetes mellitus, with glycated hemoglobin (HbA1c) of < 7%, fasting plasma glucose of 6mmol/L, or random plasma glucose of 11mmol/L (Nemeh A et al., 2011).

Globally, poor glycemic control in persons with type 2 diabetes was 73.2 % in Yemen (Saghir et al., 2019), 74.9% in Saudi Arabia (Alzaheb&Altemani, 2018), 64.2 in three out-patient hospitals in Beijing, China (Lin et al., 2017), 60.8% in King Abdullah University Hospital in Jordan (Al-Eitan et al., 2016), and 57.1% in Greece (Souliotis et al., 2020).

In the sub-Saharan African region, poor glycemic control in persons with type 2 diabetes was 59.2% in Shanan Gibe Hospital, Southwest Ethiopia (Yigazu&Desse, 2017), 71.4% in Kenya (Otieno et al., 2021), 86.0% in Democratic Republic of Congo (Blum et al., 2020), and 85.0% in Sudan (Noor et al., 2017).

In Ghana, poor glycemic control in persons with type 2 diabetes was 70% in five health facilities in Ghana (Mobula et al., 2018) and 59.4% in the Greater Accra Regional Hospital of Ghana (Djonor et al., 2021).

2.3 Socio-demographic and life-style related factors associated with glycemic control in persons with type 2 diabetes

2.3.1 Sex and glycemic control in persons with type 2 diabetes

Women have poor glycemic control compared to men (Abdissa&Hirpa, 2022; Abdullah et al., 2020; Mobula et al., 2018). According to Abdissa and Hirpa (2022), diabetic women may not attend follow-up therapy as frequently as males, hence being less likely to adhere to their medications.

2.3.2 Age and glycemic control in persons with type 2 diabetes

Age has been identified to have an association with glycemic control. Younger diabetic patients are more likely to have poor glycemic control compared to older diabetic patients (Angamo, Melese, &Ayen, 2013). According to Angamo, Melese, and Ayen (2013), younger diabetes patients may be hesitant regarding disease control, self-care, and adherence to medication recommendations due to busy life schedules or less communication with health care providers.

On the contrary, studies by Abdissa and Hirpa (2022) and Almetwazi et al. (2019) found that older adults suffering from type 2 diabetes are more likely to have poor glycemic control compared to young adults. According to ADA (2014), older adults are at high risk of using multiple medications or having injurious falls, cognitive impairment, persistent pain, and urinary incontinence. Chia, Egan, and Ferrucci (2018) stated that the reason could also be that older adults have had diabetes for longer periods than younger adults since a longer duration of diabetes is linked to poor glycemic control, probably due to progressive β-cell impairment and reduced insulin secretion. Almetwazi et al. (2019) recommend that older adults who have diabetes should be monitored and followed-up to slow the progression of diabetes and enhance their quality of life.

2.3.3 Educational level and glycemic control in persons with type 2 diabetes

Studies have found that patients with a low level of education are at a higher risk of having poor glycemic control compared to those having a high level of education (Yigazu&Desse, 2017). According to Yigazu and Desse (2017), a low level of education may result in a low level of knowledge regarding disease management, bad self-management practices, lower self-efficacy, and lower continuity of care resulting in poor glycemic control. On the other hand, patients with a higher level of education are capable of coping with the disease, managing it, and better controlling the glucose level (Khattab et al., 2010).

2.3.4 Marital Status and glycemic control in persons with type 2 diabetes

Studies have identified that unmarried adults are significantly associated with poor glycemic control (Abdissa&Hirpa, 2022; Omar et al., 2018). According to Abdissa and Hirpa (2022), married patients are expected to have stronger support from their spouses regarding adherence to recommended nutrition, clinical attendance, and prescription medications. However, unmarried patients may experience inadequate family care resulting in poor glycemic control.

2.3.5 Employment Status and glycemic control in persons with type 2 diabetes

Unemployment status is related to poor glycemic control (Dedefo et al., 2020). According to Dedefo et al. (2020), unemployed patients may not be able to afford their prescriptions which may influence their adherence, resulting in poor glycemic control.

2.3.6 BMI and glycemic control in persons with type 2 diabetes

Overweight or obesity has been identified to be a risk factor for poor glycemic control in persons with type 2 diabetes (Ibrahim et al., 2021; Bae et al., 2016). This could be due to

increased fat storage and a high glycemic index from excessive carbohydrate consumption, as well as a higher risk of insulin resistance in obese people (Bae et al., 2016; Harrabi, Al Harbi, & Al Ghamdi, 2014).

2.3.7 Knowledge about diabetes and glycemic control in persons with type 2 diabetes

Poor knowledge about diabetes is associated with poor glycemic control (Dedefo et al., 2020; Angamo, Melese, &Ayen, 2013). According to Dedefo et al. (2020), a lack of diabetes education for patients may cause poor glycemic control in persons with type 2 diabetes. Patients with poor knowledge of diabetes are less likely to adhere to their medication and self-care regimens, resulting in poor glycemic control.

2.3.8 Family history of diabetes and glycemic control in persons with type 2 diabetes

A family history of diabetes mellitus significantly contributes to poor glycemic control (Gebermariam et al., 2020; Alzaheb&Altemani, 2018). According to Gong et al. (2008), diabetes mellitus has hereditary risk factors that can affect the severity and duration of the disease.

2.3.9 Alcohol consumption and glycemic control in persons with type 2 diabetes

Alcohol consumption has been found to be associated with poor glycemic control (Marjanović et al., 2021; Abdissa&Hirpa, 2022). High alcohol consumption, including binge drinking, increases the risk of poor glycemic control among patients with type 2 diabetes (Cullmann et al., 2012).

2.3.10 Smoking of cigarette/tobacco and glycemic control in persons with type 2 diabetes

Smoking cigarettes/tobacco has been associated with poor glycemic control (Ohkuma et al., 2015). According to Petrie, Guzik, and Touyz (2018), smoking hastens and worsens complications from diabetes such as nephropathy, retinopathy, peripheral artery diseases, and cardiovascular diseases.WHO endorses the cessation or avoidance of smoking as part of their lifestyle recommendations because smoking is recognized as a preventable risk factor for type 2 diabetes (WHO, 2016). On the contrary, a study by Wireno et al. (2021) found no significant association between smoking and glycemic control.

2.3.11 Adherence to diabetes medication and glycemic control in persons with type 2 diabetes

Non-adherence to diabetes self-care management of medications was associated with poor glycemic control (Abebe et al., 2022; Basu et al., 2018; Raum et al., 2012). According to Angamo, Melese, and Ayen (2013), insufficient consultation or diabetic teaching time during prescription refiling and poorer educational and health literacy levels could contribute to non-adherence to medication.

2.3.12 Longer duration of diabetes and glycemic control in persons with type 2 diabetes

Several studies have identified a significant association between patients with a longer duration of diabetes and poor glycemic control (Dedefo et al., 2020; Haghighatpanah et al., 2018). Poor glycemic control in patients with a longer duration of diabetes is due to a decline in pancreatic function over time, which leads to reduced levels of released insulin and insulin resistance, which is common in type 2 diabetes, resulting in deteriorating glucose control (Melmed et al., 2011).

2.3.13 Physical exercise and glycemic control in persons with type 2 diabetes

Studies have identified that patients with inadequate physical activities have poor glycemic control (Abdissa&Hirpa, 2022; Mobula et al., 2018). This is due to patients having insufficient knowledge about the importance of physical exercise and fear of hypoglycemia (Abdissa&Hirpa, 2022).

On the other hand, ADA (2004) stated that aerobic exercise has been shown to change lipids and lower blood pressure and is crucial in the management of glycemic and weight control. Physical activity boosts the patient's insulin sensitivity and repairs some damage caused by diabetes-related complications, such as impaired cardiovascular health (Thent, Das, & Henry, 2013).

2.3.14 Residential status and glycemic control in persons with type 2 diabetes

Residential status has been associated with glycemic control in persons with type 2 diabetes (Abebe et al., 2015; Fiseha et al., 2018). Studies by Abebe et al. (2015) and Fiseha et al. (2018) found that poor glycemic control in type 2 patients was higher among rural residents. According to Supiyev et al. (2016), diabetic patients who are rural residents have lower awareness, treatment, and control of diabetes.

2.3.15 Monthly income and glycemic control in persons with type 2 diabetes

Low monthly income is associated with poor glycemic control in persons with type 2 diabetes (Yosef, Nureye&Tekalign, 2021). This could be due to a lack of financial resources to purchase diabetic self-monitoring devices and diabetes-friendly foods that aid glycemic management (Fekadu et al., 2019).

CHAPTER THREE

METHODS

3.1 Study Design

The study used an analytical cross-sectional design in collecting data from patients with type 2 diabetes mellitus attending the diabetes clinic at the Tamale Teaching Hospital in the Northern Region of Ghana. It used a quantitative approach for the data collection and analysis. The primary data was collected from type 2 diabetes patients attending Tamale Teaching Hospital from October 6, 2021, to October 29, 2021, through the administration of questionnaires.

3.2 Study Area

The study was conducted at the diabetes clinic at the Tamale Teaching Hospital located in the Tamale Metropolis of the Northern Region of Ghana. Tamale Metropolitan area is the capital city of the Northern Region of Ghana. It is the third-largest city in Ghana and the fastest growing city in West Africa, with a projected population of 950,124. The city of Tamale is located 600km north of Accra and covers a total land area of 750 square kilometers, Islam is the predominant religion and Dagbani is the language commonly spoken.

It shares common boundaries to the South with Yendi municipality, to the North with Savelugu municipality, to the East with Tolon Municipality, and the West with Gushegu, Naton, and Karaga Districts. Due to its central location, Tamale serves as the hub of administrative and commercial activities in the Northern Region. Tamale Teaching Hospital is the third largest Teaching Hospital in Ghana after the Korle Bu Teaching Hospital and Komfo Anokye Teaching Hospital. It serves as a referral center for the five Northern Regions of Ghana and is situated 2 km southeast of Tamale. The hospital collaborates with the University for Development Studies in Northern Region to offer educational programs in

medicine, nursing, and nutrition. The hospital delivers primary, secondary, and tertiary health services.

Tamale Teaching Hospital has over 35 clinical wards and departments with over 3000 clinical and non-clinical staff. Some of the wards/units in the hospital include Out-patient Department, Accident, and Emergency, Obstetrics and Gynecology, Intensive Care Unit, Surgical Department, Medical Department, HIV/AIDS clinic, and Diabetes Clinic, to mention but a few. The diabetes clinic is held twice every week with a patient attendance of about 300 patients and an average of 6 new patients per week. The Clinic is supervised by a physician endocrinologist.

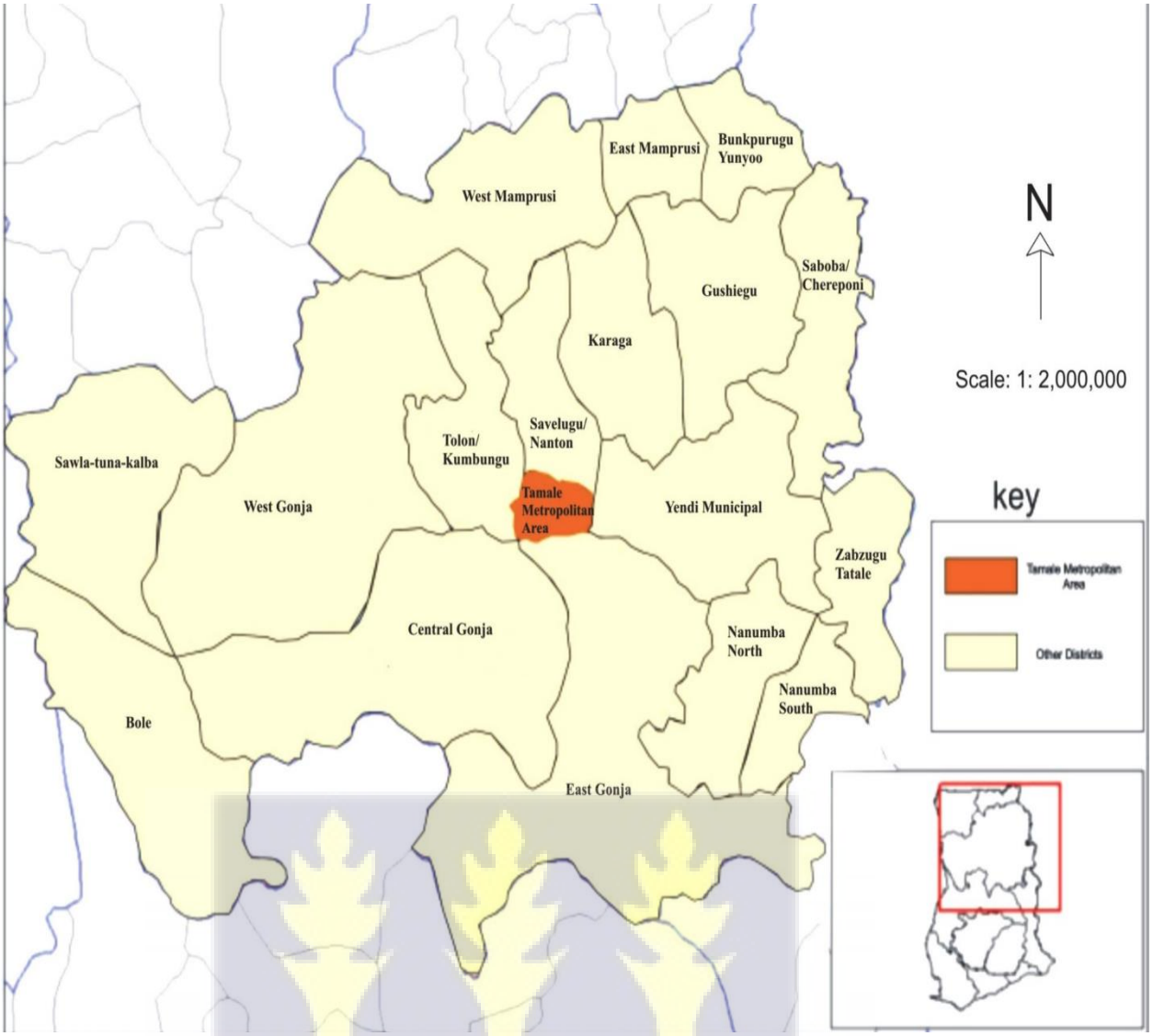

Figure 3.1: Map of Northern Region Showing Tamale Metropolitan Area.

3.3 Study Population

The study population was patients diagnosed with type 2 diabetes mellitus for at least 6 months and attending the diabetes clinic of Tamale Teaching Hospital. From the secondary data, the estimated total number of diabetes patients attending the diabetes clinic in the Tamale Teaching Hospital in the Northern Region of Ghana is 1792 (Tamale Teaching Hospital Report, 2021) which formed the sampling frame for the study.

3.3.1 Inclusion Criteria

The study considered male and female patients diagnosed with type 2 diabetes for at least 6 months. Also, patients who have clinical records in the hospital, who have been attending diabetes clinic for at least 6 months and provided written informed consent to participate in the study, were included.

3.3.2 Exclusion Criteria

The study excluded type 2 diabetics who were severely ill and admitted, pregnant, or lactating mothers.

3.4 Study Variables

The study variables were grouped into dependent and independent variables. The dependent variable for this study is glycemic control in patients with Type 2 diabetes in Tamale Teaching Hospital. The independent variables were the factors influencing glycemic control in patients with Type 2 diabetes. Only two set of factors were assessed as independent variables: socio-demographic characteristics and lifestyle-related factors

Table 3.1: Summary of variables used in the study

Variable Type	Operationalization	Scale of Measurement
Dependent Variable		
Glycemic control (Glycated Hemoglobin)	Poor (Hba1c ≥7%), Good (Hba1c ≤ 7%)	Binary
Independent Variables	**(Socio-demographic characteristics)**	
Age	Age at last birthday measured in years	Continous
Sex	Male, Female	Binary
Highest educational level	Noeducation, primary, JHS/JSS/Middle, secondary(SSS/SHS/Technical/Vocational), tertiary	Nominal
Religion	Islam, Christianity, Traditional	Nominal
Marital Status	Unmarried (single, divorced, widowed), married.	Binary
Monthly Income	Last monthly income received in Ghanaian cedis	Continuous
Residence	Rural, Urban	Binary
BMI	Weight over squared height	Continuous
Family History of Diabetes	No, Yes	Binary
Knowledge on diabetes	inadequate, adequate	Binary
Smoking Cigarette/Tobacco	Non-smoker, former smoker, current smoker	Nominal
Alcohol drinking	Non-drinker, former drinker, current drinker	Nominal
Regular physical exercise	No, Yes	Binary
Diet habits	Poor, Good	Binary
Treatment adherence	Poor, Good	Binary

3.5 Sample Size Determination

The sample size was determined using the formula proposed by Cochran (1963) for population proportions in a cross-sectional study. The proportion of poor glycemic control in patients with type 2 diabetes was 70.0% (Mobula et al., 2018). The sample size was calculated as;

$$n = \frac{Z_{\frac{\alpha}{2}}^2 \times P \times (1 - P)}{e^2}$$

Where:

n= The estimated sample size

z = z-score of population distribution = 1.96

p = The proportion of poor glycemic control in patients with type 2 diabetes =70.0%.

e = margin of error =5%

The sample size computation using the Cochran (1963) is given as;

$$n = \frac{1.96^2 \times 0.7 \times (1 - 0.7)}{(0.05)^2} = 323 \approx 323$$

Accounting for a 10% non-response rate, the total number of participants was calculated as follows: $323 + (0.10 \times 323) = 355$. Therefore, the required minimum sample size needed for the study was 355.

3.6 Sampling Method

All patients who were diagnosed with type 2 diabetes and attended the diabetes clinic of Tamale Teaching Hospital who met the inclusion criteria stood an equal chance of being selected as a study participant. Based on this assumption, we employed the simple random technique in selecting study participants through the balloting method. 'yes' and 'no' were written on pieces of papers and folded into a box. Patients were then asked to pick one each,

those that picked‘yes’ were included after consent was given. Those that picked ‘no’ were not included. This was repeated on each clinic day until the sample size of 355 was reached.

3.7 Source of Data and Data Collection

The study used primary data collected from type 2 diabetes patients attending Tamale Teaching Hospital from October 6, 2021, to October 29, 2021, through the administration of questionnaires. The questionnaire was designed in simple English to reflect the study variables and allow easy translation by research assistants. However, questions were asked or translated into local dialects for participants who did not receive formal education for better understanding. At the Diabetic clinic in the Tamale Teaching Hospital, a simplified presentation was done, including the risk and benefits of participation, as described in the participant information sheet. After then, the participants were invited to participate in the study. Those who agreed to participate were asked to fill and sign the consent form and participant information sheet given to them by the research assistants.

The closed-ended questionnaire was used to solicit information on socio-demographic characteristics, lifestyle-related factors, and the glycemic control (Glycated Hemoglobin) of type 2 diabetic patients attending the diabetes clinic. The principal investigator was assisted by five nurses who were trained to collect the primary data with a closed-ended structured questionnaire during the pre-testing stage. The closed-ended questionnaire is in three parts. These parts are A, B, and C.

Section A obtained data on socio-demographic characteristics such as sex, age, marital status, educational level, employment status, monthly income, religion, BMI, residential status, knowledge of diabetes, and family history of diabetes. Knowledge of diabetes was assessed using the Revised Michigan Diabetes Knowledge Questionnaire (Michigan Diabetes Research and Training Center, 1998) and (Al-Hussaini & Mustafa, 2016) consisting of 25

items on a 3-point scale (true, false, and don't know). True responses represented a correct answer while false and don't know responses represent wrong answers. Each correct response was awarded one mark and zero for wrong answers. The total score ranges from 0 to 25 and a higher score indicates adequate knowledge of diabetes. An index variable comprising scores from Diabetes knowledge was generated.

Section B obtained data on lifestyle-related factors such as alcohol drinking, cigarette/tobacco smoking, diet habits, regular physical exercise, and adherence to diabetes treatment.

Section C recorded information on the measurement of glycated hemoglobin (HbA1c). The HbA1c test also known as the glycated hemoglobin test is an important blood test that indicates how good or poor glycemic control is. Blood sampling consisted of drawing 3 ml of blood from the antecubital vein under aseptic conditions using plain vacationer tubes were taken by a professionally trained laboratory technician. These blood were separated and frozen and transported to the Lancet Laboratory in Tamale on the same day of collection often within 4 hours. The samples were analyzed for HbA1c in the Lancet Laboratory in Tamale using validated high-performance liquid chromatography methods. The HbA1c level was determined on whole blood from all participants within 24 hours of sample collection using the Clover A1c Test Cartridge System.

Glycated hemoglobin (HbA1c) level was determined on whole blood from all subjects within 24 hours of sample collection using the Clover A1c Test Cartridge System (Infopia Co. Ltd., Korea). The Clover A1c system uses the principle of boronate affinity chromatographic method for the determination of HbA1c in whole blood. Reagents in the system lyse red cells and bind hemoglobin, also the boronate resins bind the cisdoils of glycated hemoglobin. These are measured separately within the system and the ratio of glycated hemoglobin to total hemoglobin was expressed as percentage.

3.8 Quality Control Measure

Data was collected with research assistants under close supervision. Data collected were cross-checked for validity and scrutinized to ensure that the data collected makes logical sense. The questionnaire was coded with numbers to avoid repetition. After data was entered, data on the questionnaire were compared to data entered into Microsoft Excel to ensure that valid information is entered.

3.8.1 Training of Research Assistants

Research assistants preferably professionally trained nurses drawn from the diabetes clinic of Tamale Teaching Hospital were trained and oriented on how to accurately interpret and administer the questionnaire. The training entailed a detailed explanation of the questionnaire, ethical guidelines of the study, and seeking informed consent from study participants. Furthermore, the content of the questionnaire was well explained to the research assistants to prevent interviewer bias.

3.8.2.2 Pre-testing and Review of Data Collection Instrument

Pre-testing of questionnaires was conducted at the diabetic clinic of Tamale Central Hospital among 20 participants. The questionnaire was then assessed for validity and reliability and the content was reviewed to produce the final questionnaire. Finally, challenges encountered during the data collection process were noted and addressed before the actual data collection.

3.9 Data Processing and Analysis

Data gathered from administered questionnaires were cleaned and edited to ensure accuracy before variables were coded and entered into Microsoft Excel and later imported into STATA version 16 for statistical analysis. Descriptive statistics were used to summarize the distribution of selected demographic characteristics of type 2 diabetes patients. Categorical variables were summarized using frequencies with their associated percentages, while continuous variables were summarized using mean with their associated standard deviations. Pie charts were used to show the proportion of glycemic control in patients with type 2 diabetes.

The main outcome variable was glycemic control, which was categorized into a dichotomous variable (poor [Hba1c $\geq$ 7%], good [Hba1c < 7%]). Bivariate analysis and multivariable logistic regression were fitted to determine the association between the dependent variable and independent variables. For bivariate analysis, the Chi-square test (Pearson's or Fisher's exact) was used to determine the association between glycemic control and independent variables. The statistical relationship between glycemic control and the socio-demographic factors and lifestyle related-factors was declared significant at a p-value of ≤ 0.05.

Since bivariate analyses do not consider cofounding effects, a univariate and multiple logistic regression model was fitted to determine whether socio-demographic characteristics and lifestyle-related factors were associated with glycemic control in patients with type 2 diabetes. Covariates with a p-value of less or equal to 0.2 in the univariate logistic regression model were included in the multiple logistic regression model. In the multivariable analyses, adjusted Odds Ratios (aOR) with respective 95% confidence intervals and p-value were reported. A statistical relationship between glycemic control and the independent variables was declared significant in the multiple logistic regression at a p-value of <0.05.

3.10 Ethical Consideration

Ethical clearance was sought from the Ghana Health Service review board. Permission was also sought from the appropriate authorities of Tamale Teaching Hospital where the study was conducted.

3.10.1 Study Participants

The study participants consisted of patients with type 2 diabetes attending the diabetes clinic of Tamale Teaching Hospital. Participants who were willing to participate in the study. Participants were well informed about the content of the study, and they were allowed to decide to take part in the study or not or withdraw from the study at any point in time without any consequences.

3.10.2 Risk/Benefits

There was minimal risk associated with participation in the study. Time spent during the interviews and discussions as well as procedures for blood sample collection may be of some inconvenience to the study participants. At the end of the sessions, participants were appreciated with refreshment for the time and energy spent.

3.10.3 Confidentiality

To ensure confidentiality, the names of the study participants were not disclosed. The participants were assured that the information collected was solely used for academic and research purposes. Code numbers were used to identify participants and an encrypted file was kept on a secured laptop.

3.10.4 Data Storage

Data collected for the study were kept safe under lock and key to prevent access by persons, not in the research team. Also, data were locked with restricted access on a secure laptop which can only be accessed by the principal investigator and direct supervisors. Furthermore, a soft copy was sent to the library of the School of Public Health, University of Ghana. The information stored was destroyed approximately a year after the dissertation is submitted and approved by the external examiner.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics of study participants

A total of 355 patients with Type 2 diabetes in the Tamale Teaching Hospital in the Northern Region of Ghana fulfilled the inclusion criteria and had completed the questionnaire making a response rate of 100%. Table 4.1 shows the summary of the socio-demographic characteristics of the participants. More than half 57.5% (204/355) of the participants, were females. The median age of the participants was 54 (IQR=43-66) years, with a minimum age of 23 years and a maximum age of 84 years. More than one-fourth 30.7% (109/355) of the participants belonged to the age group ≥ 60years. The majority of the participants 62.5% (222/355) were married and 65.6% (233/355) of the participants were unemployed.

More than one-third 32.7% (116/355) of the participants had completed secondary education, 80.0% (284/355) of the participants are Christians, and 78.0% (277/355) of the participants live in urban areas. Some of the participants 60.2% (214/355) had normal BMI, 57.7% (205/355) of the participants received a monthly income of Ghc 200-999.99, 73.0% (259/355) of the participants had adequate knowledge of diabetes, and 60.9% (216/355) of the participants had no family history of diabetes.

Table 4.1: Socio-demographic characteristics of study participants

Characteristics	Frequency N =355	Percentage (%)
Sex		
Male	151	42.5
Female	204	57.5
Age		
<30 years	27	7.6
30-39 years	57	16.0
40-49 years	63	17.8
50-59 years	99	27.9
≥ 60years	109	30.7
Marital Status		
Unmarried (Single/Divorced/Widow)	133	37.5
Married	222	62.5
Employment Status		
Unemployed	233	65.6
Employed	122	34.4
Educational Level		
No Education	44	12.4
Primary	40	11.2
Middle/JHS/JSS	78	22.0
Secondary (SSS/SHS/Technical/Vocational)	116	32.7
Tertiary	77	21.7
Religion		
No Religion	24	6.8
Christianity	284	80.0
Islam	47	13.2
Residential Status		
Rural	78	22.0
Urban	277	78.0
BMI		
Underweight ($< 18.5 kg/m^2$)	35	9.9
Normal ($18.5 - 24.9 kg/m^2$)	214	60.2
Overweight ($25.0 - 29.9 kg/m^2$)	67	18.9
Obese ($\geq 30 kg/m^2$)	39	11.0
Monthly Income		
<Ghc 200	76	21.4
Ghc 200- Ghc999.99	205	57.7
≥Ghc 1000	74	20.9
Knowledge on Diabetes		
Inadequate	96	27.0
Adequate	259	73.0
Family History of Diabetes		
No	216	60.9
Yes	139	39.1

4.2 Lifestyle related-factors of study participants

Table 4.2 shows the lifestyle-related factors of the study participants. The lifestyle-related factors used in the study comprise alcohol drinking, cigarette/tobacco smoking, regular physical exercise, diet habits, and adherence to diabetes treatment. From Table 4.2, one out of seven 70.7% (251/355) of the participants were former alcohol drinkers, 73.0% (259/355) of the participants had never smoked cigarette/tobacco, 60.0% (213/355) of the participants do physical exercise regularly, 52.4% (186/355) of the participants had poor diet habits, and 61.1% (217/355) of the participants had good adherence to diabetes treatment.

Table 4.2: Lifestyle related-factors of study participants

Factors	Frequency N =355	Percentage (%)
Alcohol drinking		
Non-drinker	104	29.3
Former drinker	251	70.7
Cigarette/tobacco smoking		
Non-smoker	259	73.0
Former smoker	96	27.0
Regular physical exercise		
No	142	40.0
Yes	213	60.0
Diet habits		
Poor	186	52.4
Good	169	47.6
Adherence to diabetes treatment		
Poor	138	38.9
Good	217	61.1

4.3 Glycemic control among study participants

The proportion of glycemic control among study participants is shown in Figure 4.1. From Figure 4.1, 47.3% (95% CI=42.0% -52.7%) of the participants had poor glycemic control.

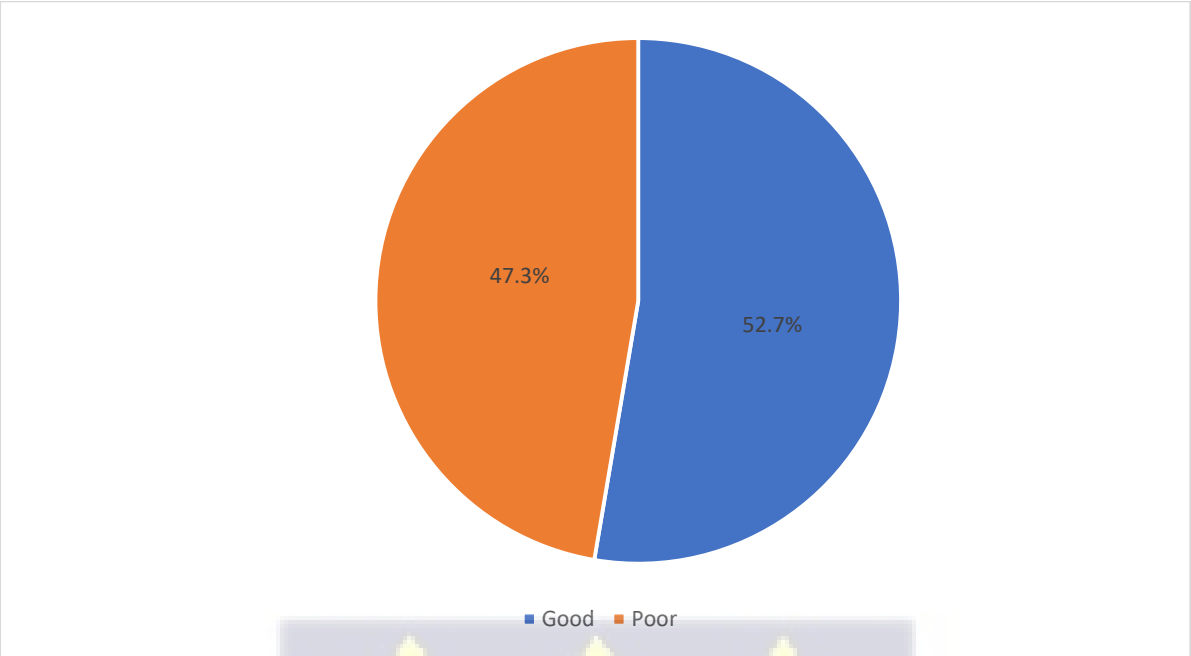

Figure 4.1: The proportion of glycemic control among study participants

4.4 Relationship between socio-demographic characteristics and glycemic control among study participants

Table 4.3 shows the relationship between socio-demographic characteristics and glycemic control among study participants. The age group of the participants was significantly related to glycemic control among study participants (p=0.039). That is, poor glycemic control was highest 30.3% (51/168) and lowest 3.6% (6/168) among participants who belonged to the age group ≥ 60 years and <30 years, respectively, as shown in Table 4.3. The marital status of the participants was significantly related to glycemic control among study participants (p=0.008). That is, the proportion of participants who had poor glycemic control was 55.4% (93/168)

among those who are married compared to 44.6% (75/168) among those who are unmarried, as shown in Table 4.3.

The participant's employment status was significantly related to glycemic control among study participants (p=0.002). That is, the proportion of participants who had poor glycemic control was 26.2% (44/168) among those who are employed compared to 73.8% (124/168) among those who are unemployed, as shown in Table 4.3.

The educational level of the participants was significantly related to glycemic control among study participants (p=0.024). That is, poor glycemic control was highest 30.4% (51/168) and lowest 11.3% (19/168) among participants who had completed secondary education and primary education, respectively, as shown in Table 4.3.

The residential status of the participants was significantly related to glycemic control among study participants (p<0.001). That is, the proportion of participants who had poor glycemic control was 69.0% (116/168) among urban residents compared to 31.0% (52/168) among rural residents, as shown in Table 4.3.

The monthly income of the participants was significantly related to glycemic control among study participants (p<0.001). That is, poor glycemic control was highest 60.1% (101/168) and lowest 11.3% (19/168) among participants who received a monthly income of Ghc 200-Ghc999.99 and ≥Ghc 1000,respectively, as shown in Table 4.3.

The knowledge of diabetes of the participants was significantly related to glycemic control among study participants (p=0.022). That is, the proportion of participants who had poor glycemic control was 67.3% (113/168) among those who had adequate knowledge of diabetes compared to 32.7% (55/168) among those who had inadequate knowledge of diabetes, as shown in Table 4.3.

Table 4.3: Relationship between socio-demographic characteristics and glycemic control among study participants

Characteristics	Glycemic control: Good N (%)	Poor N (%)	Total N (%)	Pearson Chi-square	P-value
Sex				1.4193	0.234
Male	74 (39.6)	77 (45.8)	151 (42.5)		
Female	113 (60.4)	91 (54.2)	204 (57.5)		
Age				**10.0566**	**0.039***
<30 years	21 (11.3)	6 (3.6)	27 (7.6)		
30-39 years	27 (14.4)	30 (17.9)	57 (16.0)		
40-49 years	27 (14.4)	36 (21.4)	63 (17.8)		
50-59 years	54 (28.9)	45 (26.8)	99 (27.9)		
≥ 60 years	58 (31.0)	51 (30.3)	109 (30.7)		
Marital Status				**7.0140**	**0.008***
Unmarried	58 (31.0)	75 (44.6)	133 (37.5)		
Married	129 (69.0)	93 (55.4)	222 (62.5)		
Employment Status				**9.4512**	**0.002***
Unemployed	109 (58.3)	124 (73.8)	233 (65.6)		
Employed	78 (41.7)	44 (26.2)	122 (34.4)		
Educational Level				**11.1918**	**0.024***
No Education	15 (8.0)	29 (17.2)	44 (12.4)		
Primary	21 (11.2)	19 (11.3)	40 (11.2)		
Middle/JHS/JSS	37 (19.8)	41 (24.4)	78 (22.0)		
Secondary	65 (34.8)	51 (30.4)	116 (32.7)		
Tertiary	49 (26.2)	28 (16.7)	77 (21.7)		
Religion				3.2690	0.195
No Religion	14 (7.5)	10 (6.0)	24 (6.8)		
Christianity	143 (76.5)	141 (83.9)	284 (80.0)		
Islam	30 (16.0)	17 (10.1)	47 (13.2)		
Residential Status				**15.0032**	**<0.001***
Rural	26 (13.9)	52 (31.0)	78 (22.0)		
Urban	161 (86.1)	116 (69.0)	277 (78.0)		
BMI				2.7423	0.433
Underweight	15 (8.0)	20 (11.9)	35 (9.9)		
Normal	118 (63.1)	96 (57.2)	214 (60.2)		
Overweight	32 (17.1)	35 (20.8)	67 (18.9)		
Obese	22 (11.8)	17 (10.1)	39 (11.0)		
Monthly Income				**21.8663**	**<0.001***
<Ghc 200	28 (15.0)	48 (28.6)	76 (21.4)		
Ghc 200- Ghc999.99	104 (55.6)	101 (60.1)	205 (57.7)		
≥Ghc 1000	55 (29.4)	19 (11.3)	74 (20.9)		
Knowledge on Diabetes				**5.2444**	**0.022***
Inadequate	41 (21.9)	55 (32.7)	96 (27.0)		
Adequate	146 (78.1)	113 (67.3)	259 (73.0)		
Family History of Diabetes				**4.9539**	**0.026***
No	124 (66.3)	92 (54.8)	216 (60.9)		
Yes	63 (33.7)	76 (45.2)	139 (39.1)		

p*<0.05

Finally, the family history of diabetes of the participants was significantly related to glycemic control among study participants (p=0.026). That is, the proportion of participants who had poor glycemic control was 45.2% (76/168) among those who had a family history of diabetes compared to 54.8% (92/168) among those who had no family history of diabetes, as shown in Table 4.3.

4.5 Relationship between lifestyle related-factors and glycemic control among study participants

The alcohol drinking of the participants was significantly related to glycemic control among study participants (p=0.017). That is, the proportion of participants who had poor glycemic control was 76.8% (129/168) among former alcohol drinkers compared to 23.2% (39/168) among non-alcohol drinkers, as shown in Table 4.4.

The cigarette/tobacco smoking of the participants was significantly related to glycemic control among study participants (p<0.001). That is, the proportion of participants who had poor glycemic control was 37.5% (63/168) among former cigarette/tobacco smokers compared to 62.5% (105/168) among non-cigarette/tobacco smokers, as shown in Table 4.4.

The regular physical exercise of the participants was significantly related to glycemic control among study participants (p=0.005). That is, the proportion of participants who had poor glycemic control was 52.4% (88/168) among those who had regular physical exercise compared to 47.6% (80/168) among those who had irregular physical exercise, as shown in Table 4.4.

The diet habits of the participants were significantly related to glycemic control in study participants (p=0.003). That is, the proportion of participants who had poor glycemic control

was 39.3% (66/168) among those who had good diet habits compared to 60.7% (102/168) among those who had poor diet habits, as shown in Table 4.4.

Table 4.4: Relationship between lifestyle related-factors and glycemic control among study participants

Glycemic control					
Factors	Good N (%)	Poor N (%)	Total N (%)	Pearson Chi-square	P-value
Alcohol drinking				**5.6946**	**0.017***
Non- drinker	65 (34.8)	39 (23.2)	104 (29.3)		
Former drinker	122 (65.2)	129 (76.8)	251 (70.7)		
Cigarette/tobacco smoking				**17.6790**	**<0.001***
Non-smoker	154 (82.3)	105 (62.5)	259 (73.0)		
Former smoker	33 (17.7)	63 (37.5)	96 (27.0)		
Regular physical exercise				**7.7141**	**0.005***
No	62 (33.2)	80 (47.6)	142 (40.0)		
Yes	125 (66.8)	88 (52.4)	213 (60.0)		
Diet habits				**8.8510**	**0.003***
Poor	84 (44.9)	102 (60.7)	186 (52.4)		
Good	103 (55.1)	66 (39.3)	169 (47.6)		
Adherence to diabetes treatment				0.6486	0.421
Poor	69 (36.9)	69 (41.1)	138 (38.9)		
Good	118 (63.1)	99 (58.9)	217 (61.1)		

p*<0.05

4.6 Multiple logistic regression analysis of factors associated with glycemic control of study participants

Table 4.5 shows the multiple logistic regression analysis of the factors influencing glycemic control in patients with Type 2 diabetes in Tamale Teaching Hospital. The Wald Chi-square value of 98.85 with p<0.05 showed the overall significance of the multiple logistic regression model that was used to explain the factors that influence glycemic control in patients with type 2 diabetes. Hence, the multiple logistic regression model is appropriate.

The multiple logistic regression analysis showed that age, employment status, educational level, residential status, monthly income, family history of diabetes, alcohol drinking, smoking cigarette/tobacco, and regular physical exercise had a statistically significant association with glycemic control in patients with Type 2 diabetes.

Participants who belonged to the age group 40-49 years had 5.9 times (Adjusted Odds Ratio [aOR] $= 5.9, 95\%$ CI $= [1.7 - 21.0]$) higher odds of having poor glycemic control compared to participants who belonged to the age group < 30 years. Participants who belonged to the age group ≥ 60 years had 4.0 times (aOR $= 4.0, 95\%$ CI $= [1.2 - 13.3]$) higher odds of having poor glycemic control compared to participants who belonged to the age group < 30 years.

Participants who were employed had 60% (aOR $= 0.4, 95\%$ CI $= [0.2 - 0.7]$) reduced odds of having poor glycemic control compared to unemployed participants.

Participants who had attained secondary education had 70% (aOR $= 0.3, 95\%$ CI $= [0.1 - 0.8]$) reduced odds of having poor glycemic control compared to participants who had no education. Participants who had attained tertiary education had 70% (aOR $= 0.3, 95\%$ CI $= [0.1 - 0.7]$) reduced odds of having poor glycemic control compared to participants who had no education.

Participants who live in urban areas had 60% (aOR $= 0.4, 95\%$ CI $= [0.2 - 0.7]$) reduced odds of having poor glycemic control compared to participants who are rural residents.

Participants who received a monthly income of ≥Ghc 1000 had 80% (aOR $= 0.2, 95\%$ CI $= [0.1 - 0.4]$) reduced odds of having poor glycemic control compared to participants who received a monthly income of <Ghc 200.

The odds of having poor glycemic control were 1.8 times ($\text{aOR} = 1.8, 95\%\ \text{CI} = [1.1 - 3.1]$) higher among participants who had a family history of diabetes compared to participants who had no family history of diabetes.

Participants who were former alcohol drinkers had 2.2 times ($\text{aOR} = 2.2, 95\%\ \text{CI} = [1.2 - 3.8]$) higher odds of having poor glycemic control compared to participants who were non-alcohol drinkers.

The odds of having poor glycemic control were 1.8 times ($\text{aOR} = 1.8, 95\%\ \text{CI} = [1.0 - 3.2]$) higher among participants who were former cigarette/tobacco smokers compared to participants who were non-cigarette/tobacco smokers.

Participants who had regular physical exercise had 40% ($\text{aOR} = 0.6, 95\%\ \text{CI} = [0.4 - 0.9]$) reduced odds of having poor glycemic control compared to participants who had irregular physical exercise.

Table 4.5: Multiple logistic regression analysis of factors associated with glycemic control of study participants

Observations	Crude Odds Ratio				Adjusted Odds Ratio	
	Good	Poor	OR (95% CI)	p-value	OR (95% CI)	p-value
Age						
<30 years	21	6	Ref		Ref	
30-39 years	27	30	**3.9 (1.4 - 11.1)**	**0.011***	3.5 (0.9 - 12.5)	0.051
40-49 years	27	36	**4.7 (1.7 - 13.1)**	**0.004***	**5.9 (1.7 - 21.0)**	**0.006***
50-59 years	54	45	**2.9 (1.1 - 7.8)**	**0.034***	2.9 (0.9 - 9.7)	0.076
≥ 60 years	58	51	**3.1 (1.2 - 8.2)**	**0.025***	**4.0 (1.2 - 13.3)**	**0.023***
Marital Status						
Unmarried	58	75	Ref		Ref	
Married	129	93	**0.6 (0.4 - 0.9)**	**0.037***	0.9 (0.5 - 1.5)	0.697
Employment Status						
Unemployed	109	124	Ref			
Employed	78	44	**0.5 (0.3 - 0.8)**	**0.002***	**0.4 (0.2 - 0.7)**	**0.001***
Educational Level						
No Education	15	29	Ref			
Primary	21	19	0.5 (0.2 - 1.1)	0.091	0.4 (0.1 - 1.1)	0.069
Middle/JHS/JSS	37	41	0.6 (0.3 - 1.2)	0.154	0.5 (0.2 - 1.2)	0.128
Secondary	65	51	**0.4 (0.2 - 0.8)**	**0.015***	**0.3 (0.1 - 0.8)**	**0.014***
Tertiary	49	28	**0.3 (0.1 - 0.6)**	**0.002***	**0.3 (0.1 - 0.7)**	**0.007***
Residential Status						
Rural	26	52	Ref			
Urban	161	116	**0.4 (0.2 - 0.6)**	**<0.001***	**0.4 (0.2 - 0.7)**	**0.001***
Monthly Income						
<Ghc 200	28	48	Ref			
Ghc 200- Ghc999.99	104	101	**0.6 (0.3 - 0.9)**	**0.039***	0.5 (0.3 - 1.0)	0.058
≥Ghc 1000	55	19	**0.2 (0.1 - 0.4)**	**<0.001***	**0.2 (0.1 - 0.4)**	**<0.001***
Knowledge on diabetes						
Inadequate	41	55	Ref			
Adequate	146	113	**0.6 (0.4 - 0.9)**	**0.023***	0.8 (0.4 - 1.3)	0.327
Family History of Diabetes						
No	124	92	Ref			
Yes	63	76	**1.6 (1.1 - 2.5)**	**0.026***	**1.8 (1.1 - 3.1)**	**0.020***
Alcohol drinker						
Non-drinker	65	39	Ref			
Former drinker	122	129	**1.8 (1.1 - 2.8)**	**0.018***	**2.2 (1.2 - 3.8)**	**0.007***
Cigarette/tobacco smoking						
Non-smoker	154	105	Ref			
Former smoker	33	63	**2.6 (1.6 - 4.3)**	**<0.001***	**1.8 (1.0 - 3.2)**	**0.035***
Regular physical exercise						
No	62	80	Ref			
Yes	125	88	**0.5 (0.4 - 0.8)**	**0.006***	**0.6 (0.4 - 0.9)**	**0.041***
Diet habits						
Poor	84	102	Ref			

Good	103	66	**0.5 (0.3 - 0.8)**	**0.003***	0.7 (0.4 - 1.1)	0.137

p*<0.05

CHAPTER FIVE

DISCUSSION

5.1 Glycemic control in type 2 diabetic patients

The burden of diabetes mellitus can be reduced by strictly maintaining the blood glucose level of patients in the normal range (Mariye et al., 2018). For the proportion of glycemic control in patients with type 2 diabetes attending the Tamale Teaching Hospital, 47.3% had poor glycemic control. This proportion is lower than the proportion of 59.4% in the Greater Accra Regional Hospital of Ghana (Djonor et al., 2021) and 70% in five health facilities in Ghana (Mobula et al., 2018). Also, the proportion is lower than the proportion in other African countries, such as 59.2% in Shanan Gibe Hospital, Southwest Ethiopia (Yigazu&Desse, 2017), 71.4% in Kenya (Otieno et al., 2021), 86.0% in Democratic Republic of Congo (Blum et al., 2020), and 85.0% in Sudan (Noor et al., 2017).

Furthermore, globally, this proportion is lower than the proportion of 73.2 % in Yemen (Saghir et al., 2019), 74.9% in Saudi Arabia (Alzaheb&Altemani, 2018), 64.2 in three out-patient hospitals in Beijing, China (Lin et al., 2017), 60.8% in King Abdullah University Hospital in Jordan (Al-Eitan et al., 2016), and 57.1% in Greece (Souliotis et al., 2020). The possible reasons for these differences could be due to differences in the study population, sample size, available health care service, method used to assess the glycemic level, and characteristics of the patients.

5.2 Association between socio-demographic characteristics and glycemic control in persons with type 2 diabetes

The study found that socio-demographic characteristics such as age and family history of diabetes are risk factors that have an association with glycemic control in persons with type 2 diabetes.

Type 2 diabetic patients who belonged to the age group 40-49 years and ≥ 60 years had higher odds of having poor glycemic control compared to patients who belonged to the age group < 30 years. This shows that age has an increasing trend with glycemic control. This is consistent with studies by Abdissa and Hirpa (2022) and Almetwazi et al. (2019), who found that poor glycemic control was higher among older type 2 diabetic patients. According to ADA (2018), older adults are at increased risk of using multiple medications or having injurious falls, cognitive impairment, persistent pain, and urinary incontinence. Also, older adults have had diabetes for longer periods than younger adults since the longer duration of diabetes is linked to poor glycemic control, probably due to progressive β-cell impairment and reduced insulin secretion (Chia, Egan, &Ferrucci, 2018). On the contrary, Angamo, Melese, and Ayen (2013) found that younger diabetic patients are more likely to have poor glycemic control compared to older diabetic patients. According to Angamo, Melese, and Ayen (2013), younger diabetes patients may be hesitant regarding disease control, self-care, and adherence to medication recommendations due to busy life schedules or less communication with health care providers.

Type 2 diabetic patients who had a family history of diabetes had higher odds of having poor glycemic control compared to patients who had no family history of diabetes. This is consistent with a study by Gebermariam et al. (2020) and Alzaheb and Altemani (2018),who found that type 2 diabetic patients who had a family history of diabetes are more likely to have poor glycemic control compared to type 2 diabetic patients who had no family history of

diabetes. According to Gong et al. (2008), diabetes mellitus has hereditary risk factors that can affect the severity and duration of the disease.

The study also found that socio-demographic characteristics such as employment status, educational level, residential status, and monthly income are protective factors associated with glycemic control in persons with type 2 diabetes.

Type 2 diabetic patients who are employed had reduced odds of having poor glycemic control compared to unemployed patients. This is consistent with a study by Dedefo et al. (2020) who found that employed type 2 diabetic patients are less likely to have poor glycemic control compared to unemployed type 2 diabetic patients. According to Dedefo et al. (2020), unemployed patients may not be able to afford their prescriptions which may influence their adherence, resulting in poor glycemic control.

Type 2 diabetic patients who had attained secondary or tertiary education had reduced odds of having poor glycemic control compared to patients who had no education. This is similar to a study by Yigazu and Desse (2017), who found that patients with a higher level of education are at a lower risk of having poor glycemic control compared to those having a low level of education. According to Yigazu and Desse (2017), a low level of education may result in a low level of knowledge regarding disease management, bad self-management practices, lower self-efficacy, and lower continuity of care resulting in poor glycemic control.

Type 2 diabetic patients who live in urban areas had reduced odds of having poor glycemic control compared to patients who are rural residents. This is consistent with studies by Abebe et al. (2015) and Fiseha et al. (2018), who found that poor glycemic control in type 2 patients was higher among rural residents. According to Supiyev et al. (2016), diabetic patients who are rural residents have lower awareness, treatment, and control of diabetes.

Type 2 diabetic patients who receive a monthly income of ≥Ghc 1000 had reduced odds of having poor glycemic control compared to patients who receive a monthly income of <Ghc 200. This is consistent with a study by Yosef, Nureye, and Tekalign (2021), who found that low monthly income was significantly associated with poor glycemic control. This could be due to a lack of financial resources to purchase diabetic self-monitoring devices and diabetes-friendly foods that aid glycemic management (Fekadu et al., 2019).

5.3 Association between lifestyle-related factors and glycemic control in persons with type 2 diabetes

The study found that lifestyle-related factors such as alcohol drinking and smoking cigarettes/tobacco are risk factors that have an association with glycemic control in persons with type 2 diabetes.

Type 2 diabetic patients who were former alcohol drinkers had higher odds of having poor glycemic control compared to patients who were non-alcohol drinkers. This is consistent with studies by Marjanović et al., 2021; Abdissa&Hirpa, 2022 who found that alcohol consumption was significantly associated with poor glycemic control. According to Cullmann et al. (2012), high alcohol consumption, including binge drinking increases the risk of poor glycemic control among patients with type 2 diabetes.

Type 2 diabetic patients who were former cigarette/tobacco smokers had higher odds of having poor glycemic control compared to patients who were non- cigarette/tobacco smokers. This is similar to a study by Ohkuma et al. (2015) that patients who smoke cigarette/tobacco are more likely to have poor glycemic control compared to non-cigarette/tobacco smoking patients. According to Petrie, Guzik, and Touyz (2018)., smoking hastens and worsens complications from diabetes such as nephropathy, retinopathy, peripheral artery diseases, and

cardiovascular diseases. On the contrary, studies by Wireno et al. (2021) and Fiagbe et al. (2017) found no significant association between smoking and glycemic control.

The study found that lifestyle-related factors such as regular physical exerciseis protective factors that have an association with glycemic control in persons with type 2 diabetes. Type 2 diabetic patients who had regular physical exercise had reduced odds of having poor glycemic control compared to patients who had irregular physical exercise. This is consistent with studies by Abdissa and Hirpa (2022), Mobula et al. (2018), and Hailu et al. (2012), who found that patients who have inadequate physical activities have poor glycemic control. This is due to patients having insufficient knowledge about the importance of physical exercise and fear of hypoglycemia (Abdissa&Hirpa, 2022).

There were some limitations. The source of the data was solely dependent on type 2 diabetes patients who are attending Tamale Teaching Hospital in the Northern Region of Ghana. As type 2 diabetes patients who attend the hospital are systematically different from those who do not, there is a selection bias and the findings of the study will not be representative of the entire type 2 diabetes population in Ghana. Also, there was the possibility of respondent biases which may result in inaccuracies in the responses of the participants that could be found in any self-reported questionnaire. There is social desirability bias where some participants might have given information to look good to the interviewers. Finally, the nature of the study design (i.e cross-sectional study) does not permit causal inferences.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

This study sought to determine the proportion of poor glycemic control in type 2 diabetes patients attending Tamale Teaching Hospital in the Northern Region of Ghana. It further investigated the socio-demographic characteristics and lifestyle-related factors among type 2 diabetes patients attending Tamale Teaching Hospital in the Northern Region of Ghana.

In conclusion, the proportion of poor glycemic control in type 2 diabetes patients was moderate. Major factors such as age, employment status, educational level, residential status, monthly income, and family history of diabetes are associated with glycemic control in persons with type 2 diabetes attending Tamale Teaching Hospital in the Northern Region of Ghana. Also, alcohol drinking, smoking cigarettes/tobacco, and regular physical exercise are associated with glycemic control in persons with type 2 diabetes attending Tamale Teaching Hospital in the Northern Region of Ghana.

6.2 Recommendations

Tamale Teaching Hospital

- The management of the Diabetic Clinic, through the authorities of Tamale Teaching Hospital, should advocate for more diabetic drugs to be included in national or private health insurance schemes or make the drug affordable for the less financially endowed patients to access quality drugs for good glycemic control.
- Clinic staff should educate patients more about the disease condition to improve their knowledge levels for better glycemic control.

Ghana Health Service

- It is recommended that Ghana Health Service should, in the short term (1-12 months from now) develop intervention programs that will provide education on healthy lifestyles such as avoiding smoking cigarettes and drinking alcohol and performing regular physical exercises to increase their general wellbeing and promote the quality of life.

6.3 Future Studies

The study recommends that future studies by academicians use rigorous designs such as intervention or experimental randomized controlled trials with a strong qualitative research component to better understand and measure causal relationships between important factors such as socio-demographic and lifestyle-related factors and glycemic control in persons with type 2 diabetes.

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APPENDICE-QUESTIONNAIRE

Q.N^{0}	Questions	Responses
	I.D	
	Date of interview	
	SECTION A	**SOCIO-DEMOGRAPHIC FACTORS**
1	Age	
2	Sex	Male Female
3	What is your Marital Status?	Single Married Divorced Widowed
4	What is your level of education?	No Education Primary Middle/HS/JSS Secondary (SSS/SHS/Technical/Vocational) Tertiary
5	How much money do you earn at the end of the month?	Gh₵……..per month
6	Where is your place of residence?	Urban Rural
7	Religion	No Religion Christianity Islam Traditional/Spiritualist Others……

8	Height	……m
9	Weight	……kg
10	Do you have any family history of diabetes?	No Yes
11	How long have you been a diabetic	…….. years
12	Do you have other existing condition?	No Yes
13	If you answered "Yes" to Question 12, kindly state the condition	……..
14	Knowledge on Diabetes	
14a	Diabetes is a condition of high blood sugar	True False
14b	Diabetes is a condition of not enough insulin in blood	True False
14c	Diabetes is curable	True False

14d	If I am a diabetic, my children have a higher chance of being diabetic	True False
14e	Diabetes is non-contagious or non-communicable	True False
14f	Medication is more important than diet and exercise to control my diabetes	True False
14g	Diabetes occurs in children, adolescents, and adults	True False
14h	Eating refined sugar, brown sugar, honey, and sweetened drinks is good for diabetes	True False
14i	Constant feeling of thirst,Frequent urination, Weight loss despite normal appetite are all symptoms of low blood sugar	True False
14j	Blurred vision, Slow heeling of cuts and wounds,Tiredness and weakness are **not** symptoms of uncontrolled diabetes	True False
14k	Diabetics should take extra care when cutting their toenails	True False
14l	Shaking and sweating are signs of high blood sugar	True False
14m	Amputation of the limb, Kidney Damage, Blindness, Stroke, heart attack can all be caused by diabetes	True False
14n	Diabetics should eat a lot of carbohydrate diets	True False
14o	Diabetic diet should be low in fat and high in fiber	True False
14p	Insulin injections are available for the control of diabetes	True False

14q	High blood glucose levels may be caused by too much insulin	True False
14r	Tablets and capsules are available for the control of diabetes	True False
14s	Having regular check-ups with your doctor can help spot the early signs of diabetes complications	True False
14t	Glycosylated hemoglobin (HbA1c) is a test that measures your average blood glucose level in the past week	True False
14u	For a person in good control, exercising has no effect on blood sugar levels	True False
14v	Diabetics should have good weight control	True False
14w	Diabetics should wear tight shoes	True False
14x	Infection is likely to cause an increase in blood sugar levels.	True False
	SECTION B: LIFESTYLE-RELATED FACTORS	
15	Do you smoke tobacco?	Non-smoker Former Smoker Current Smoker
16	Do you drink alcohol?	Non-drinker Former Drinker Current Drinker
17	Do you exercise regular?	No Yes
18	What is your main food staple?	Carbohydrates Vegetables

19	Which of these do you use as a diabetic?	Refined Sugar Sweetener
20	What is your main source of protein?	Meat Fish Eggs
21	Do you take sugar containing beverages (soft drinks)?	No Yes
22	Have you ever visited a dietician for counselling on your diet?	No Yes
23	Are you on any diet recommendation?	No Yes
24	Do you take your diabetes medications as prescribed and regularly?	No Yes
25	Do you use Herbal Medicines in addition or in place of your prescribed DM medications?	No Yes
26	Do you attend clinic sessions on your scheduled review dates?	No Yes
27	Have you defaulted treated or review dates?	No Yes
	SECTION C: GLYCEMIC CONTROL	
28	HbA1c	……..