

**THE PREVALENCE OF PREDIABETES AND ITS RISK FACTORS
AMONG ADULTS IN SELECTED COMMUNITIES IN ACCRA.**



BY

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DECLARATION

I, Akyea-Boakye, Brobbey Kweku, hereby do declare that, with the exception of the references cited in this work which have been duly acknowledged, the work presented here was conducted by me through research, under the supervision of Dr. Frederick Vuvor and Dr. Justina Serwaah Owusu of the Department of Nutrition and Food Science, University of Ghana, Legon.

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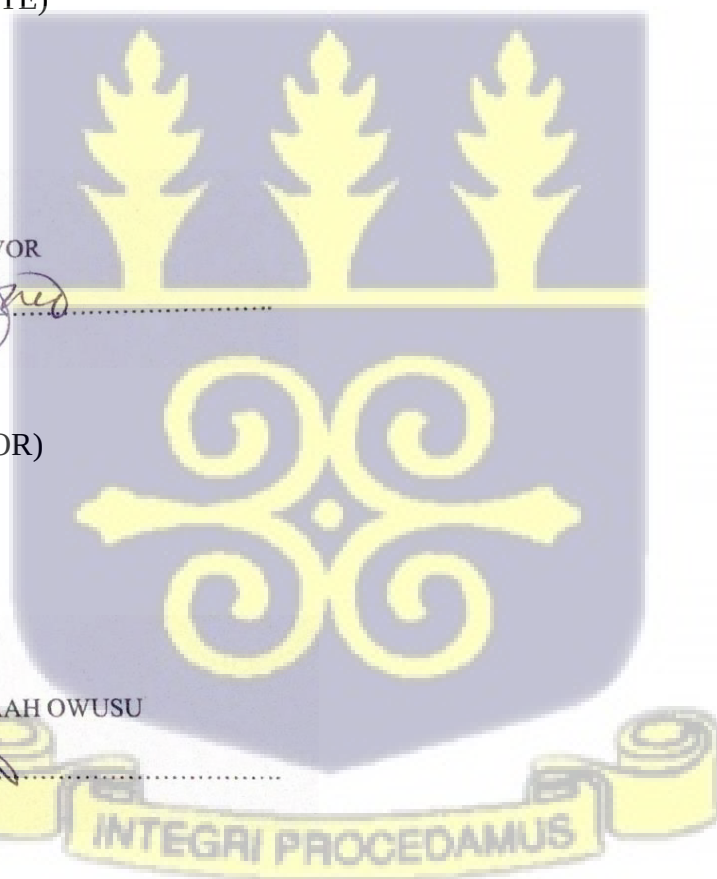
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DEDICATION

This dissertation is dedicated to the Almighty God for His grace, wisdom, strength and guidance which enabled me to undertake and complete this work and also to my supervisors for their time, encouragement and advice.

This dissertation is dedicated to my father; Mr. Seth Akyea-Boakye, my mother Ms. Emma Adwoa Appiah Osei-Duah and my junior sister; Miimi Tutuwaa Obeng-Baah for their endless support and prayers which contributed to the success of this work.



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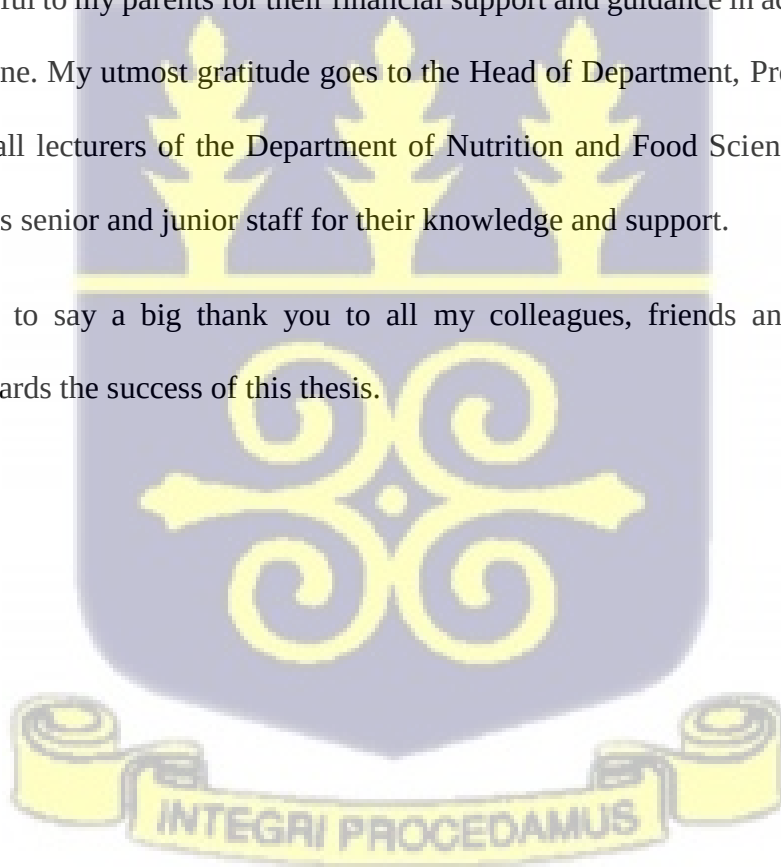


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LIST OF ABBREVIATIONS

WHO – World Health Organization

DM - Diabetes Mellitus

CDC – Centre for Disease Control and Prevention

ADA – American Diabetes Association

IDF – International Diabetes Federation

BMI – Body Mass Index

IFG – Impaired Fasting Glucose

IGT – Impaired Glucose Tolerance

HbA1c – Glycated Hemoglobin

T1DM – Type 1 Diabetes Mellitus

T2DM – Type 2 Diabetes Mellitus

GDM – Gestational Diabetes Mellitus

HIV – Human Immunodeficiency Virus

HDL – High Density Lipoprotein

PSS – Perceived Scale Stress

FFQ – Food Frequency Questionnaire

IPAQ – International Physical Activity Questionnaire

CHAG – Christian Health Association of Ghana

SBP – Systolic Blood Pressure



DBP – Diastolic Blood Pressure

SPSS – Statistical Package for Social Sciences

GHS – Ghana Health Service

ERC – Ethical Review Committee

ECBAS – Ethics Committee for Basic and Applied Sciences

METs – Metabolic Equivalents

NCDs – Non-communicable Diseases

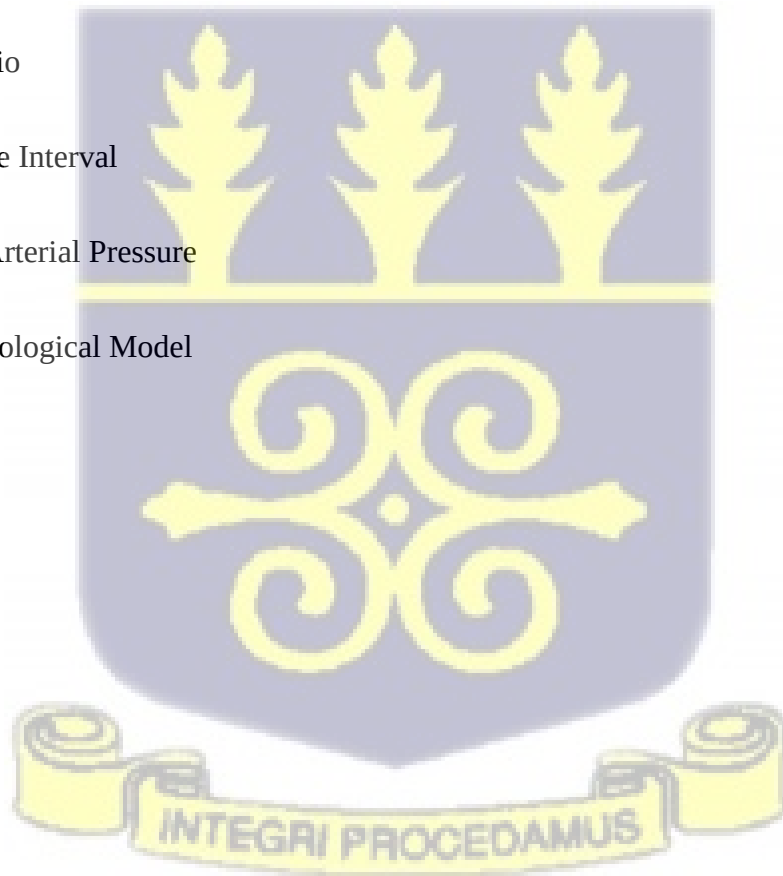
SDGs – Sustainable Development Goals

OR – Odds Ratio

CI – Confidence Interval

MAP – Mean Arterial Pressure

SEM – Socioecological Model



ABSTRACT

Introduction/Background: Diabetes mellitus is a global health issue, with cases projected to surge from 180,000,000 in 1980 to over 693,000,000 by 2045. Prediabetes precedes a full-blown type 2 diabetes which must be diagnosed early and take appropriate measures.

Methods: This was a cross-sectional study conducted among adults ≥ 18 years of age ($n = 360$). Fasting blood glucose levels were determined using glucometer. Sociodemographic variables, behavioral patterns, dietary intakes, anthropometric measures and clinical indicators were collected. Logistic regression was employed to estimate associations between all variables and prediabetes status.

Results: The prevalence of prediabetes and diabetes was 26.7% and 29.4% respectively. Results showed significant correlations between prediabetes and sociodemographic factors such as female sex (OR: 2.03, 95% CI: 1.02-4.59) age group 40-59 years (OR: 2.97, 95% CI: 1.10-8.32) and being single (OR: 2.60, 95% CI: 1.05-6.43). Behavioural factors including salt consumption (AOR: 6.25, 95% CI: 1.69-23.02), smoking (AOR: 10.14, 95% CI: 1.21-111.03), caffeine consumption (AOR: 2.51, 95% CI: 1.53-11.88), low physical activity (AOR: 3.53, 95% CI: 1.83-7.89) and high stress levels (AOR: 8.29, 95% CI: 3.30-20.80) were significantly associated with prediabetes.

Dietary factors including increased consumption of starchy foods (AOR: 3.63, 95% CI: 1.74-7.58), animal-sourced foods (AOR: 2.54, 95% CI: 1.36-4.86), fats and oils (AOR: 5.87, 95% CI: 2.76-12.51), legumes (AOR: 2.45, 95% CI: 1.23-6.11), and confectionaries (AOR: 2.25, 95% CI: 1.19-5.23) were significantly associated with prediabetes. Participants with BMI over 25 (AOR: 4.55, 95% CI: 2.12-18.11), high mean arterial pressure (AOR: 4.21, 95% CI: 1.50-11.81) and stage 1 hypertension (AOR: 6.74, 95% CI: 1.50-30.29) showed significant association with prediabetes.

Conclusion: This shows an unacceptably high prevalence of the condition with significant factors identified. Targeted public health interventions to mitigate the risk and prevalence of prediabetes are needed.



1.0 INTRODUCTION

1.1 Background information

Diabetes mellitus is a disease that has been seen to increase globally per the World Health Organization's global report. This makes the disease one of public health concern and cannot be categorized as an issue only plaguing developed and first world countries but all countries. According to a report by the World Health Organization (2023), the number of people with diabetes has risen from 180 million in 1980 to 422 million in 2014 with increasing prevalences experienced rapidly in lower and middle-income countries and 2019 an estimated 2 million deaths globally was a result of diabetes and kidney disease due to diabetes. Cho et al. (2018) add to this by stating that there is an expected increase of people living with diabetes to 693 million by 2045 and estimating that approximately half of all individuals living with diabetes are undiagnosed. The diabetic condition is defined by high blood sugar levels due to a lack of concentration or activity of insulin in the body which manages glycemia.

Until the previous decade, diabetes mellitus was underestimated as a worldwide health problem. Inaccurate data for monitoring and surveillance creates significant gaps in understanding the impact, particularly in developing countries (Zimmet et al., 2016). According to Zimmet et al. (2014), there have been several studies that have highlighted the alarming increases of the prevalence of DM over time. The previous decade has seen numerous international bodies in the diabetic community raise alarms on the need to curb diabetes mellitus as a global public health epidemic.

There are three main different types of diabetes mellitus being type 1 diabetes mellitus, type 2 diabetes mellitus and gestational diabetes mellitus with type 1 diabetes mellitus also regarded

to as “juvenile/childhood onset diabetes” and is characterized by deficient insulin production in the human body and its treatment requires a constant administration of insulin shots to the body (American Diabetes Association, 2018; Tao, Shi, & Zhao, 2015). Type 2 diabetes is defined by the insulin resistance of the body which is seen as the inefficiency of the body to respond to insulin produced by the body and is associated to many risk factors including obesity, family history of DM, physical activity and dietary choices (World Health Organization, 2016). Gestational diabetes mellitus is identified as the condition where there is elevated blood glucose in a pregnant woman without a previous history of DM and also puts the unborn infant at risk of developing DM later in adulthood.

The definition of impaired glucose tolerance was founded in 1979 with no change being done since, people with impaired glucose tolerance are at an increased risk of developing type 2 diabetes with a 10-year incidence reaching levels as high as 60% in some studies done and also at a greater risk of 50% chance of developing coronary heart disease (Yudkin et al., 1990; Unwin et al., 2002). After excerpts from an ADA committee in 1997 and WHO in 1999 the criteria for the diagnosis of diabetes was changed to a fasting plasma glucose of ≥ 7.0 mmol/L with the intermediate category representing prediabetes being impaired fasting glucose (6.1-6.9mmol/L) (World Health Organization, 1999; Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 1997). According to Bansal (2015), an increased risk of macrovascular disease, early retinopathy, small fiber neuropathy, and early nephropathy are among the diabetic repercussions that are linked to prediabetes, according to observational research. According to many studies, lifestyle modifications can effectively prevent diabetes by reducing the relative risk in those with prediabetes by 40% to 70%.

A large meta-analysis of studies by Yip et al. (2017) shows a reported prevalence of impaired fasting glucose in Caucasian and Asian cohorts at 36% and Karve & Hayward (2010) adds that in a cohort of 1547 American adults without diabetes the prevalence of prediabetes was 19.8%. According to the CDC's National Diabetes Statistics Report, 37% and 51% of adults in the United States over the ages of 20 and 65 respectively had prediabetes in 2009-2012, as measured by fasting glucose. When extrapolated to the whole US population in 2012, these results suggest that around 86 million individuals live with prediabetes in the US alone (Centers for Disease Control and Prevention, 2014). It was estimated in 2010 that 343 million people worldwide (7.8%) had prediabetes, with 5.8% living in Southeast Asia and 11.4% in North America and the Caribbean. According to the International Diabetes Federation, 471 million people worldwide will have prediabetes by 2035 (International Diabetes Federation, 2013).

It is estimated that 19.8 million people are living with diabetes in Africa with approximately 75% of them being undiagnosed. The most significant type of the condition is type 2 DM which is accountable for up to 90% of all diabetic cases. This increase in the prevalence of DM in sub-Saharan Africa is directly proportional to the increase in obesity and other cardiovascular risk factors (World Health Organization, 2016; International Diabetes Federation, 2023; Kengne et al., 2013).

Low- and middle-income nations, especially those in sub-Saharan Africa, are predicted to account for more than two-thirds of the increase in diabetes prevalence. From an estimated 7.1 million people in the early 2000s to an anticipated 18.6 million by 2030, the number of diabetic sick people in Africa has significantly grown (Wild et al., 2004; Azevedo & Alla, 2008). Sarfo-Kantanka et al. (2014) adds on by stating diabetes prevalence trends in Ghana are comparable

to those in other Sub-Saharan African nations, with current statistics ranging from 6.2% to 13.9%. Although diabetes poses a growing public health challenge in Ghana, limited data availability and fragmented surveillance systems have contributed to knowledge gaps among key stakeholders regarding its true prevalence. This is mostly due to the fact that the evidence currently in use is based on cross-sectional data, which raises the possibility of bias and underdiagnosis. Additionally, the majority of the studies were carried out in several parts of the nation, each with significantly varied incidence rates and risk variables. Despite these limitations, there has been no systematic evaluation of the existing studies.

1.2 Rationale

Prediabetes is a growing health concern around the world, with serious implications for public health. It is a precursor to type 2 diabetes, which is linked to a slew of health issues such as cardiovascular disease, kidney problems, and neuropathy. Increased sedentary lifestyles, dietary trends toward higher calorie and refined foods, and decreased physical exercise are all known risk factors for diabetes.

Screening for prediabetes is mostly missing in developing nations, limiting the capacity of healthcare professionals to intervene to prevent diabetes (Khalil et al., 2019). Although several international and regional studies have documented the burden of prediabetes and its determinants, there remains a significant local data gap in Ghana, particularly at the community level in urban settings like Accra. Existing national reports often focus on diabetes prevalence without disaggregating prediabetes or exploring its early-stage predictors in context. Moreover, few studies in Ghana have assessed the combined impact of behavioral, dietary, and physiological risk factors using both household and clinical-based data. This study addresses

these gaps by providing context-specific evidence on the prevalence and predictors of prediabetes in Accra, thereby supporting early detection, targeted intervention design, and the potential integration of prediabetes screening into routine primary healthcare services. By grounding the analysis in both population-level and hospital-attending adults, this study offers a more nuanced understanding of urban prediabetes risk, which can inform future public health programming in Ghana. The findings of the study can help Accra develop evidence-based policies and healthcare practices for prediabetes prevention and management.

1.3 Conceptual Framework

This study is underpinned by the Socioecological Model (SEM), which posits that health outcomes such as prediabetes arise from interrelated factors operating at multiple levels: individual, interpersonal, and environmental (Kousoulis & Goldie, 2021). The SEM provides a multi-dimensional lens for identifying and analyzing the behavioral, demographic, and contextual variables that shape chronic disease risk.

At the individual level, the study considers behavioral and biological risk factors including dietary habits, physical activity, smoking, caffeine intake, stress, sleep, BMI, and blood pressure. These are directly related to Objective 2, which seeks to identify the risk factors associated with prediabetes.

The interpersonal level is reflected through variables such as marital status and sex, which influence lifestyle patterns and support systems and may modulate health behaviors and access to care. These social determinants inform both Objectives 1 and 2.

At the clinical and environmental level, the study incorporates hospital- and community-based recruitment and considers access to routine screening and urban dietary environments, aligning

with Objective 3, which explores anthropometric and blood pressure associations with prediabetes.

The application of this model strengthens the coherence between the literature, variable selection, and analytical focus, and allows the study to explore the interconnected drivers of prediabetes in urban Ghana with greater conceptual clarity.



1.4 Objectives

1.4.1 Main objective

To determine the prevalence of prediabetes amongst adults in Accra and to identify the risk factors associated with the condition.

1.4.2 Specific objectives

1. To estimate the prevalence of prediabetes among adults in selected communities in Accra.
2. To identify risk factors associated with prediabetes among the sample.
3. To identify the association between BMI and blood pressure with prediabetes.



1.5 Study hypothesis

Null hypothesis (Ho): There exist no association between potential risk factors and the prevalence of prediabetes among adults in selected communities in Accra.

Alternative hypothesis (Ha): There exists an association between potential risk factors and the prevalence of prediabetes among adults in selected communities in Accra.



2.0 LITERATURE REVIEW

2.1 Introduction

2.1.1 Definition of Diabetes

According to the World Health Organization (2019), diabetes mellitus is identified as a group of metabolic disorders characterized by the presence of hyperglycemia and this includes impairments in insulin secretion and action also influencing macronutrient metabolism.

Diabetes mellitus can be classified into type 1 diabetes, an autoimmune condition that leads to the destruction of pancreatic beta-cells, and type 2 diabetes, which is a condition caused by continuous impaired glucose regulation due to a combination of insulin resistance and ill-adjusted pancreatic beta-cells (Blair, 2016).

Several symptoms can arise as a result of diabetes mellitus and these include frequent urination, increased appetite, and increased thirst if left untreated can lead to complications such as diabetic ketoacidosis, cardiovascular diseases, chronic kidney disease, cognitive impairment, and death (Mahendra & Aadya, 2020).

2.1.2 Definition of Prediabetes

According to Echouffo-Tcheugui & Selvin (2021), prediabetes is an intermediate stage between normal glycemic status and diabetes, this stage is notably prevalent amongst obese and the elderly. This condition can be associated with numerous health complications including diabetes, cardiovascular diseases, kidney diseases and the unfortunate end result of death (America Diabetes Association, 2020).

There has been an ever-increasing prevalence of prediabetes globally making it a major public health concern, negatively affecting management of the global diabetic condition by aiding in the growth of the diabetic epidemic and its complications (Ali et al., 2018; Schneider et al., 2016).

On the record of the National Diabetes Data Group (1979), prediabetes was the term used to address impaired glucose tolerance using a 2-hour post glucose load values in an oral glucose test with values of 7.8 - 11.0mmol/L. The American Diabetes Association and the World Health Organization adopted these prediabetes parameters in 1998 and subsequently improved upon them to give forth new blood glucose levels of 6.1 – 6.9mmol/L.

These classifications are intended to identify people on the hyperglycemia spectrum who are at a high risk of developing diabetes but do not currently fit the criteria for a diabetes diagnosis. Since early intervention for diabetes and cardiovascular disease is most successful when done so, it is critical from the perspectives of public health and clinical practice to identify and recognize this intermediate-risk group (Echouffo-Tcheugui et al., 2011; Siu, 2015).

There are other glycemic markers that have the potential for identifying prediabetes such as fructosamine and glycated albumin. According to Kengne et al. (2017) these markers strongly correlate with the golden standard of markers used to identify prediabetes such as glycated hemoglobin (HbA1c), fasting blood sugar and random blood sugar.

2.1.3 Classification of Diabetes Mellitus

2.1.3.1 Type 1 Diabetes Mellitus

Although the exact cause of type 1 diabetes is unknown, it is thought that the disease's pathology involves the T cell-mediated destruction of pancreatic beta-cells due to islet-targeting autoantibodies that target proteins linked to the secretory granules of the pancreatic beta-cells, such as insulin, insulinoma-associated protein 2, 65 kDa glutamic acid decarboxylase and zinc transporter 8 (Katsarou, et al., 2017).

According to Atkinson et al. (2014), type 1 diabetes is one of the most prevalent chronic illnesses in children, with peaks in disease presentation occurring throughout puberty or between the ages of 5-7. Despite being diagnosed at any age, the disease is highly prevalent in this age group.

2.1.3.2 Type 2 Diabetes Mellitus

The most prevalent kind of diabetes in the world, type 2 diabetes mellitus is primarily caused by a combination of two factors: impaired pancreatic beta-cell production of insulin and the tissues' incapacity to react to the effects of insulin. (Galicia-Garcia, et al., 2020).

Insulin resistance and beta-cell dysfunction have been found to occur in the early pathogenesis of type 2 diabetes mellitus in a study by Zheng et al. (2017). This discovery has been linked to the development of poor glucose tolerance from normal glucose tolerance leading to type 2 diabetes mellitus. However, it is still unknown if there is an autoimmune component to the pathophysiology of type 2 diabetes mellitus (Velloso et al., 2013; Winer et al., 2011).

2.1.3.3 Gestational Diabetes Mellitus

According to McIntyre et al. (2019) gestational diabetes mellitus is one of the most common complications of pregnancy due to the physiological changes that occur in the body leading to developed hyperglycemia that usually resolves after birth. Landon & Gabbe (2011) reiterates this by stating that this condition results in varying degrees of maternal hyperglycemia and pregnancy-associated risk.

There are several consequences of gestational diabetes mellitus with paramount ones being an increased risk of maternal cardiovascular diseases, type 2 diabetes, and cardiovascular disease in the child (Plows et al., 2018).

2.1.4 Aetiology of Diabetes

The susceptibility of genetic factors can be deemed as important but not sufficient in the causation of type 1 diabetes mellitus. This can be explained by environmental factors playing an important role in the progression of the condition from islet autoimmunity to the critical development of the disease. This is possibly because healthy living standards have been associated with better management of the disease (Forouhi & Wareham, 2018).

Van Belle et al. (2011) states that although autoimmunity is widely recognized as the main effector of the type 1 diabetes mechanism, it may not be the underlying cause of the illness. Instead, the condition is observed to be dominant in genetically susceptible individuals as a consequence of an environmental trigger.

For some time now the probable causes of type 2 diabetes have been debated with regard to the dysfunction of pancreatic beta-cells and insulin resistance, with a majority believing that insulin resistance was the main abnormality in type 2 diabetes with pancreatic beta-cell dysfunction as a late manifestation of the illness (Kahn et al., 2014). In the record of Kautzky-Willer et al. (2016), the progression to type 2 diabetes is characterized by many genetic, lifestyle, and environmental factors.

2.1.5 Significance of Prediabetes

Prediabetes is a critical stage in the progression of diabetes. Knowledge of prediabetes is critical in driving public health initiatives to avoid the progression of prediabetes to full-blown diabetes, hence lowering the disease's total burden.

The study of prediabetes allows us to identify those who are at risk and adopt measures to avoid or postpone the onset of diabetes. This preventative strategy could involve encouraging healthier behaviors, weight management, and pharmaceutical therapies. A better understanding of prediabetes in Accra will help inform public health measures focused at lowering the prevalence of both prediabetes and diabetes.

Assessing risk factors and prevalence in the context of the local community enables culturally relevant interventions and educational campaigns, ensuring that preventative efforts are successfully customized to the population.

2.1.6 Global Prevalence of Prediabetes and Diabetes

In 2017, there was an estimate of 451 million people in the age ranges of 18-99 living with diabetes with an expected increase to 693 million people by the year 2045, even though such a rise is projected almost half of the population has diabetes (49.7%) are undiagnosed (Cho et al., 2018). In a study reported by Beagley (2014), an estimated 83.8% of undiagnosed diabetes mellitus globally is found in low and middle-income countries.

The prevalence of impaired fasting glucose was estimated to be 5.8% (298 million individuals) worldwide in 2021 and is expected to increase to 6.5% (414 million people) in 2045. Rooney et al. (2023) found that impaired glucose tolerance and impaired fasting glucose were important markers of prediabetes. The prevalence of impaired glucose tolerance was 9.1% (464 million people) and was expected to increase to 10% (638 million people) in 2045. Observations showed that high-income countries had the highest prevalence of both impaired glucose tolerance and impaired fasting glucose. Conversely, low-income countries would experience the biggest relative growth in prevalence as it is predicted to climb.

Because of differences in the populations investigated, the tests conducted, and the diagnostic criteria used, the prevalence of prediabetes reported in the literature varies significantly. A significant meta-analysis of studies reporting the prevalence of prediabetes in Asian and Caucasian cohorts using WHO standards revealed that IFG prevalence was 36.0% and 53.1%, respectively. Comparable prevalence percentages, however, were discovered by the same meta-analysis for persons with both IFG and IGT: 15.8% for WHO recommendations and 20.2% for ADA guidelines (Yip et al., 2017).

The ADA recommendations state that an abnormal finding of any of the criteria used to detect prediabetes is adequate to confirm prediabetes even though relying on a single test may underestimate prevalence (American Diabetes Association, 2019).

2.1.7 African Prevalence of Prediabetes and Diabetes

The estimated average prevalence of undiagnosed diabetes in Africa, according to Dessie et al. (2020), is 3.85%. Regional prevalence is as follows: 4.43% in Eastern Africa, 4.72% in Western Africa, 4.27% in Northern Africa, and 1.46% in Southern Africa. According to the study's findings, undiagnosed prediabetes is more common in the West African region.

A multilevel analysis by Adekanmbi (2019) states that in Namibia, using the WHO criteria for defining prediabetes (6.1 – 6.9 mmol/L) the prevalence of prediabetes was 6.8% and with the ADA criteria for defining prediabetes (5.6 – 6.9 mmol/L) the prevalence of prediabetes was 20.1%. The combined urban and rural prevalence of prediabetes was seen to be 13.8% in Tanzania and Uganda with majority of the contribution to prevalence held by the urban population (Chiwanga, et al., 2016).

A multiethnic study by Shen et al. (2016) indicated that the prevalence of prediabetes in South Africa was 9.9%, this prevalence was condensed amongst the age group of 65 years and above. Compared to other ethnic groups being South Asia, Peru and the Southern Cone of Latin America, South Africa had the lowest prevalence of prediabetes.

2.1.8 Prevalence of Prediabetes and Diabetes in Ghana

An estimated amount of 540,000 Ghanaians have diabetes, with a significant proportion of Ghanaians ignorant that they have the disease and stay untreated (Asamoah-Boaheng et al., 2019). The weighted prevalence of diabetes among adults 50 years of age and older was found to be 3.5%, which is consistent with the trend in Ghana's adult population as a whole. Male and female comparisons revealed that the prevalence of prediabetes was substantially higher in older females (Gatimu et al., 2016).

In a study containing 744 participants 13.2% of people living with HIV were on antiretroviral therapy, 27.9% of people living with HIV were not on antiretroviral therapy and 27.3% of HIV-negative persons had prediabetes. A two-fold higher prevalence of prediabetes was observed amongst person with HIV not on antiretroviral therapy as compared to those on antiretroviral therapy (Sarfo et al., 2021).

According to Nyavor et al. (2017), prediabetes was shown to be more common among merchants in the Hohoe municipality than type 2 diabetes, with sedentary traders being more likely to develop prediabetes than mobile traders. The prevalence of prediabetes was found to be 18.4%.

2.2 Risk factors associated with prediabetes

Prediabetes is linked to a number of risk factors. Numerous categories, including sociodemographic, nutritional, and lifestyle variables can be used to categorize the risk factors. These risk factors are divided into two categories by the World Health Organization: modifiable risk factors which include smoking, excessive alcohol consumption, unhealthy

eating habits, low physical activity, and hypertension, and non-modifiable risk factors, which include age, gender, and genetics or family history.

2.2.1 Lifestyle factors

2.2.1.1 Physical Activity

Physical activity is a widely advised lifestyle change method for the prevention and management of prediabetes. Per a systematic review done by Jadhav et al. (2017), the intervention of physical activity in the prevention and management of individuals with prediabetes is effective and helps reduce the risk of developing type 2 diabetes mellitus by the improvement of glucose tolerance.

Regardless of age, gender, ethnicity, or body mass index, physical inactivity has been linked to an increased risk of type 2 diabetes. Type 2 diabetes is mostly connected with two risk factors; obesity and physical inactivity. Studies reveal that individuals with low physical activity levels have a greater prevalence of diabetes, and a lack of physical activity is also independently associated with a higher chance of developing prediabetes (Admiraal et al., 2011; Knight, 2012; Longo-Mbenza et al., 2010).

A Nigerian study by Mahat et al. (2019) discovered a strong correlation between prediabetes and insufficient physical exercise. This may be related to findings that physical inactivity lowers insulin sensitivity and leads to poor cellular metabolism of fats and carbohydrates.

Individuals with prediabetes when exhibiting increasing levels of physical activity from low to moderate levels show improvements in insulin sensitivity and women aged 50 and above when exposed to high levels of physical activity showed reversion into normal blood sugar levels (Færch et al., 2017).

2.2.1.2 Smoking

Over the past 20 years, a growing body of research has established the link between smoking and an increased risk of type 2 diabetes mellitus. Furthermore, according to Campagna et al. (2019), the risk of non-insulin dependent diabetes mellitus was approximately 3 times higher for people who smoked 16–25 cigarettes per day than for non-smokers.

Smoking, whether done actively or passively, significantly increases the risk of diabetes. When quitting for the first time, the risk of acquiring diabetes rises; however, as time passes, the risk considerably decreases (Pan et al., 2015). According to a study by Akter et al. (2017), which supports the findings of Pan et al. (2015), the risk of type 2 diabetes mellitus remained high among individuals who had stopped smoking within the previous five years, but it gradually decreased with longer cessation periods, reaching a risk level equivalent to that of non-smokers after ten years. These findings suggest that smoking is linked to an increased risk of type 2 diabetes mellitus.



2.2.1.3 Alcohol consumption

A meta-analysis done by Schrieks et al. (2015) showed that moderate alcohol consumption had no effect on insulin sensitivity estimations or fasting glucose levels, although it did lower fasting insulin concentrations and HbA1c. According to the meta-analysis, men and women

respond differently to alcohol intake levels in terms of insulin sensitivity. Alcohol intake had an influence on insulin sensitivity exclusively in women, according to subgroup analyses, but the pooled effects in men and women were not substantially different.

It was discovered that different kinds of alcoholic beverages had varying effects on lowering the risk of type 2 diabetes with reference to the risk of the disease through prediabetes. While drinking beer or spirits was linked to a somewhat lower risk of type 2 diabetes, wine consumption was linked to a significantly lower risk (Huang et al., 2017).

2.2.1.4 Stress

A lack of balance between various aspects of a person's life leads to the accumulation of stress and this stress is mostly dealt with by physiological stress response mechanisms. In an extensive review done by Kelly & Ismail (2015) it was observed that factors related to the development or accumulation of stress in an individual were associated with the risk of impairment of insulin sensitivity thus putting an individual at risk for prediabetes and in the long run type 2 diabetes.

There is an adverse effect noticed when psychological stress is observed on human behaviors such as food choice, physical activity, and adherence to medications this is done by the mobilization of biological responses by releasing glucose into the blood. The management of stress is associated with the relief of symptoms related to diabetes but there is no establishment on disease progression (Hackett & Steptoe, 2017).

2.2.2 Dietary factors

2.2.2.1 Salt and Sodium Intake

A study done by He et al. (2020) identified an association between excessive salt intake by assessing the diet quality and an increased risk of prediabetes. Per the study of Oh et al. (2015) and Meng et al. (2013) there is an agreeing statement with He et al. (2020) of the intake of salt on increasing the risk of prediabetes via insulin resistance, this is developed by the ability of excess sodium to raise blood pressure and cause hypertension a condition which is associated with insulin resistance.

2.2.2.2 Dietary Patterns

The dietary pattern of an individual can be a risk factor of prediabetes due to diet-related risk factors of prediabetes such as high consumption of alcohol, salt, and sodium intake. Low carbohydrate diets are diets that have less than 45% of energy gained attributed to carbohydrates, four studies have reported a reduction in increased glycated hemoglobin levels following the implementation of a low carbohydrate diet (Westman et al., 2008; Elhayany et al., 2010; Yamada et al., 2014; Rock et al., 2014).

2.2.3 Genetics and Family History

Genetics and family history are key non-modifiable risk factors of prediabetes. Zhang et al. (2015) indicate in a study that with an increasing family history risk of diabetes there is an increased risk in developing type 2 diabetes and also experiencing prediabetes due to significant decline in production of insulin.

There is no doubt that genetic factors influence the risk of type 2 diabetes, and many of them have already been identified. While each identified variant describes only a very small proportion of the risk of the disease in the human population, they have added to our understanding of disease pathogenesis (Prasad & Groop, 2015).

2.2.4 Sociodemographic factors

2.2.4.1 Gender

Globally, men and women have slightly equal rates of diabetes; however, there are some disparities, with men over 60 having a higher frequency than women. Generally, males are more likely than women to have diabetes, even though more women than men have the disease. This can be explained by the fact that older populations tend to have a higher proportion of older women than older men, as well as the fact that diabetes risk increases with age (Ekpenyong et al., 2012).

While middle-aged males are undoubtedly more likely than women to have type 2 diabetes, children seem to exhibit the opposite tendency. Prepubescent girls are more likely than age-matched boys to have increased insulin resistance, and there is compelling evidence that type 2 diabetes affects more teenage girls than boys (Sattar, 2013). This pattern was noted in a study by Choi et al. (2009), which found that while females have higher insulin resistance before and during puberty, post-puberty alterations occur, with males having a higher risk of type 2 diabetes due to increasing insulin resistance relative to females.

2.2.4.2 Age

Given that aging impairs insulin production and increases insulin resistance through obesity and sarcopenia, it has been observed that age increases the chance of acquiring and advancing from prediabetic stage to type 2 diabetes (Lee & Halter, 2017). In line with this, Cho et al. (2018) report that type 2 diabetes is most common in older individuals (>65) than in any other age group, with an estimated 253.4 million cases of the disease in this age group by 2045.

Because of the unique data that exists, it is incorrect to assume that type 2 diabetes in young adults is just an older adult variant of the disease that strikes faster. Adults with type 2 diabetes who are younger may have a higher risk of obesity and a stronger family history of the condition, which can result in severe insulin resistance and early loss of the first and second phases of insulin secretion (Lascar et al., 2018).

2.2.4.3 Income

The risk of diabetes has been seen to increase and its prevalence more common amongst adults of lower- and middle-income levels as compared to adults of high-income levels (Hosseini et al, 2019).

Bird et al. (2015) agrees with Hosseini et al. (2019) by stating that increased household income is strongly associated with the progression of diabetes and is also associated with other conditions like overweight, obesity, high blood pressure and a major behavioral factor of physical inactivity.

2.2.5 Clinical and biological risk factors

2.2.5.1 Hypertension

In a study done by Diaz-Redondo et al. (2015), it was identified that obesity, low HDL cholesterol and hypertension acted as modifiable risk factors for prediabetes in both males and females, the intensity or magnitude of association between these risk factors and prediabetes was seen more in males as compared to females. According to a study by Kim et al. (2015), there is a consensus regarding the role of hypertension as a risk factor for prediabetes and that both hypertension and prehypertension are strongly linked to the onset of diabetes.

2.2.5.2 Dyslipidemia

Lipid abnormalities are observed to be common in people with type 2 diabetes with their prevalence varying among different populations. Dyslipidemia (triglycerides > 1.7 mmol/L) is associated with the disease by the action of insulin release as insulin is a key agent for the production and release of chylomicrons and thus defective insulin action can lead to chronic overproduction of chylomicrons which is responsible for increased fat levels in the liver and blood (Taskinen & Boren, 2015).

According to Chapman et al. (2011) dyslipidemia is a common feature of type 2 diabetes with Schofield et al. (2016) agreeing to this statement and indicating that this correlation is responsible for an increased risk of coronary heart diseases in patients with diabetes at any given level of serum cholesterol, and its association with hypertriglyceridemia is stronger as compared to the general population.

2.2.5.3 Metabolic syndrome

According to the most recent consensus definition, increased blood sugar levels are one indicator of metabolic syndrome, and the majority of those who have it also have abdominal obesity. The extra fat that is stored in the body produces an excess of fatty acids along with a range of adipokines, which trigger metabolic risk factors that make people more susceptible to diabetes and cardiovascular disease (Grundy, 2012; Deng & Scherer, 2010).

According to Shin et al. (2013) many large-scale clinical trials have shown that the presence of metabolic syndrome irrespective of its definition was highly predictive of the onset of type 2 diabetes mellitus.

2.3 Health implications of prediabetes

Prediabetes, which is frequently regarded as a precursor to type 2 diabetes, represents a significant point in an individual's health trajectory. This transitional state is linked to an increased risk of a variety of negative health consequences and problems. Understanding the health consequences of prediabetes is critical in clinical practice and public health because it allows for early intervention and preventative efforts to reduce the progression to full-blown diabetes and its accompanying health burdens. There are numerous health implications associated with prediabetes, ranging from cardiovascular risks to neuropathic issues.

2.3.1 Progression to type 2 diabetes

Insulin resistance is defined as a decreased physiologic response of target tissues, especially the muscle, adipose, and liver, to insulin stimulation. A body that is insulin resistant finds it more difficult to use glucose. This is significant because it contributes to the development of

type 2 diabetes by causing the body to accumulate extra fat, even though hereditary factors have also been identified. Type 2 diabetes, metabolic syndrome, and nonalcoholic fatty liver disease (NAFLD) can all develop from insulin resistance (Freeman & Pennings, 2018).

According to studies, excessive obesity throughout childhood and adolescence increases the incidence of type 2 diabetes mellitus in children and young people. When dealing with prediabetes, this condition advances quickly, putting obesity at a higher risk of acquiring type 2 diabetes mellitus (Malone & Hansen, 2018).

Six prospective studies were analyzed to determine the rate of progression from prediabetes to type 2 diabetes mellitus. The results showed that the rate increased gradually with increasing blood glucose levels but was exponential among those in the upper quartile of fasting plasma glucose levels (Brannick & Dagogo-Jack, 2018).

2.3.2 Cardiovascular risk

A current meta-analysis of 35 studies found an association between myocardial infarction and congestive heart failure, along with coronary artery disease and atherosclerosis, among people with prediabetes (Brannick & Dagogo-Jack, 2018). This is further explained by Cai et al. (2020) stating that people with prediabetes by the indicator of impaired glucose tolerance carry a higher risk of developing cardiovascular diseases.

2.4 Vulnerable Populations

While prediabetes affects a wide spectrum of people, certain groups are especially sensitive to its inception. Recognizing these susceptible populations is critical for public health initiatives and healthcare providers to successfully target preventative and intervention methods.

2.4.1 Overweight and Obesity

Overweight people are significantly at risk of developing prediabetes, this nutritional status leads to the future development of diabetes mellitus and is an important catalyst for the progression from prediabetes to diabetes. Bjerregaard et al. (2018) agree by further stating per results of their study that people who are overweight at the ages of 7 years, 13 years, and early adulthood have a positive association with the increased risk of developing type 2 diabetes mellitus.

Obesity and overweight are linked to insulin resistance and poor glucose metabolism, both of which are symptoms of prediabetes. Excess adipose tissue buildup, particularly in abdominal depots, promotes inflammation and the production of adipokines, which alter insulin signaling and glucose balance (Hameed et al., 2015). This process explains why overweight people are more likely to develop prediabetes.

2.4.2 Women who have had gestational diabetes.

The advent of glucose intolerance in pregnant women is known as gestational diabetes, which normally resolves after birth but puts them at risk of developing type 2 diabetes in the future. Pandey et al. (2015) reinforces this by pointing out that the idea behind developing gestational diabetes is due to the nutritional and hormonal imbalance that occurs in the mother which may

permanently change the physiology, structure and metabolism of both mother and child predisposing them to the risk of developing prediabetes.

2.5 Research gap

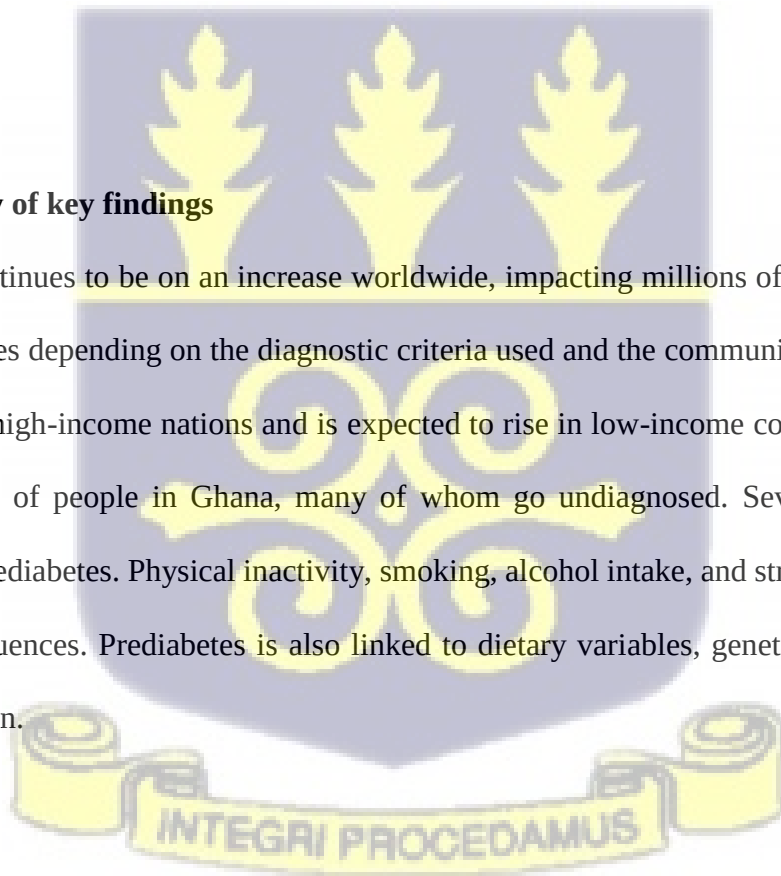
There is a significant lack of thorough research examining the prevalence of prediabetes and associated risk factors among people in Accra, Ghana, despite the fact that numerous studies have examined these topics in other national, international, and regional contexts. This research gap is particularly important because of the growing prevalence of non-communicable illnesses in low- and middle-income nations and the demand for specialized preventative strategies.

2.6 Conclusion

2.6.1 Summary of key findings

Prediabetes continues to be on an increase worldwide, impacting millions of individuals. The prevalence varies depending on the diagnostic criteria used and the communities investigated. It is highest in high-income nations and is expected to rise in low-income countries. It affects a large number of people in Ghana, many of whom go undiagnosed. Several risk factors contribute to prediabetes. Physical inactivity, smoking, alcohol intake, and stress are examples of lifestyle influences. Prediabetes is also linked to dietary variables, genetics, age, income, and hypertension.

Despite the fact that prediabetes has been studied, there is still a large knowledge gap about the prevalence and risk factors of prediabetes in Accra, Ghana. Given the rising prevalence of non-



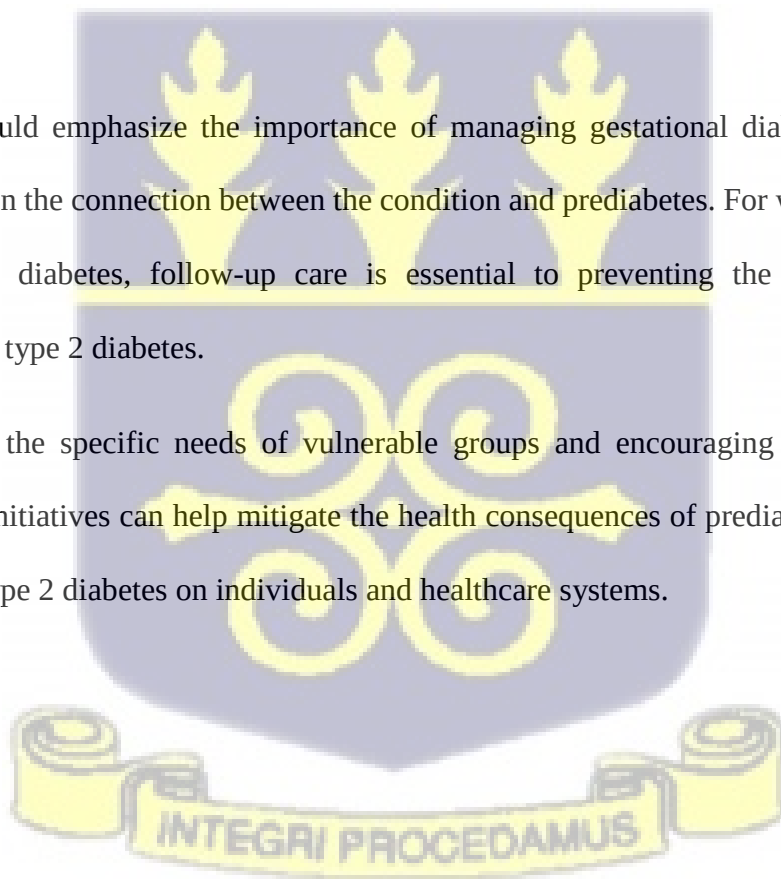
communicable illnesses in low- and middle-income nations and the demand for focused preventative therapies, closing this gap is essential.

2.6.2 Implications for public health policy

Public health policy should emphasize the adoption of comprehensive prediabetes screening programs, particularly in susceptible groups such as older persons and those with a family history of diabetes. It is critical to raise awareness about the need for frequent check-ups and diagnostic testing. To avoid prediabetes, health promotion efforts might emphasize the need for physical exercise, a good diet, and stress management.

The policy should emphasize the importance of managing gestational diabetes throughout pregnancy, given the connection between the condition and prediabetes. For women who have had gestational diabetes, follow-up care is essential to preventing the development of prediabetes and type 2 diabetes.

By catering to the specific needs of vulnerable groups and encouraging healthy lifestyle choices, these initiatives can help mitigate the health consequences of prediabetes and reduce the burden of type 2 diabetes on individuals and healthcare systems.



3.0 METHODOLOGY

3.1 Research design

This study was a cross-sectional study conducted in the city of Accra where socio-demographic characteristics of participants, behavioral and lifestyle factors, dietary factors and other potential risk factors of prediabetes were assessed using a pre-tested questionnaire. This study was conducted over a six month period, from January to June 2024.

3.2 Study sites

Five communities North Kaneshie, Madina, Teshie, Lapaz, and Legon, all of which are part of the Greater Accra Region and the city of Accra were the subjects of this study (three household outreaches and two hospital outreaches). North Kaneshie and Lapaz are part of the Okaikoi South Sub Metropolitan District, which is home to 34,800 homes and 13,378 houses, with a population of 148,897. It borders Ablekuma Central to the west, Okaikoi North to the north, Osu Klottey to the south, and Ayawaso West to the east.

The selected communities Madina, North Kaneshie, Teshie, Lapaz, and Legon were purposively chosen to reflect the demographic, socioeconomic, and health service diversity of Accra. These communities span a wide geographic and economic spectrum: Madina and Lapaz are high-density peri-urban areas characterized by informal food markets and mixed-income populations; Teshie represents a coastal urban community with a strong presence of artisanal trade and transitional housing; North Kaneshie is a mid-income area with established health infrastructure; while Legon is a more affluent, low-density academic and residential enclave. This selection strategy allowed the study to capture variation in lifestyle patterns, dietary behaviors, and access to health services factors known to influence prediabetes risk. By

incorporating both household and hospital-based sampling across these diverse settings, the study enhances its representativeness and offers findings that are broadly applicable to urban Accra's adult population.

Madina is situated in the northern region of the Greater Accra Area, in the La Nkwantanang-Madina Municipal District. The Municipality is located between longitudes 0° 24'0" W and 0° 13'1" W and between latitudes 5° 81'3" N and latitude 5° 67'7" N. The Akwapim South District borders it on the north, Accra Metropolitan borders it on the south, Adentan Municipal borders it on the east, and Ga East Municipal borders it on the west. In May 1997, the Church of Pentecost founded Pentecost Hospital, Madina (previously known as Alpha Medical Center) to serve the medical needs of the people living in Madina and the neighboring communities. The hospital registered with the Christian Health Association of Ghana (CHAG) after receiving government approval in 1999. It is the officially named La-Nkwantanang Madina Municipal Hospital, and it takes referrals from medical facilities and clinics both inside and outside the municipality.

Teshie is in the Ledzokuku Municipal District, which is bordered to the east by the Krowor Municipal Assembly, to the north by the Adentan and Ayawaso West Municipal Assemblies, and to the south by the Gulf of Guinea. Additionally, La Dade-Kotopon Municipal Assembly forms its western boundary.

At latitude 0°06'W and longitude 0°5'35"N is where Legon is located. It is bordered on the north by La Nkwantanang-Madina Municipal Assembly, on the east by Adentan Municipal Assembly, on the west by Ledzokuku Municipal Assembly, on the south by La Dade Kotopon,

on the west by Ayawaso North Municipal Assembly, on the west by Accra Metropolitan Assembly, on the west by Okaikwei North Municipal Assembly, and on the north-west by Ga East Municipal Assembly. The University of Ghana Hospital, popularly known as the Legon Hospital, was established and officially opened in 1957. It is legally owned by the University of Ghana. It is regarded as a quasi-government hospital with 130 beds. It has general wards, a maternity wing, a casualty and emergency ward, a pediatric unit, a dental unit, and an operating theater.

3.3 Study population

The sample size calculated using Cochran's formula (1997) using a confidence level of 95%, margin of error of 2% and a population proportion of 3.9% from Vuvor et al. (2011) was estimated to be 360.

The individuals that were included in this study were adults aged 18 and above living in Accra. Three hundred and sixty (360) adults aged 18 and above were recruited into this study. They were randomly sampled from the five communities being Madina, East Legon, Teshie, Lapaz and North Kaneshie.

3.4 Sampling procedure

A multistage sampling approach was employed for participant selection. Within each community, specific towns and major streets were also identified through convenience sampling.

For the community-based recruitment, a simple directional strategy was employed: after selecting the target street, one side of the street was arbitrarily designated for data collection while the opposite side was excluded. Households were visited sequentially along the

designated side. In households with more than one eligible adult (aged 18 years or older), a simple random selection was conducted using a balloting method, where individuals picked folded slips without replacement to determine who would participate.

For the hospital-based component, the sampling frame consisted of daily patient lists provided by the outpatient department, specifically those recommended for blood sugar testing on the day of data collection. Each eligible patient was assigned a numerical code based on their position on the list. A random number generator was then used to select participants from this numbered list. Individuals corresponding to the randomly selected numbers were approached and invited to participate in the study.

This combination of community-based and hospital-based sampling allowed the study to engage a diverse participant pool while preserving random selection within each setting to reduce selection bias and enhance representativeness.

3.5 Inclusion and exclusion criteria

Inclusion criteria for this study included individuals who were aged 18 and above, residents of Accra, and who gave consent to be a part of the study. The selected individuals had not eaten and had an overnight fast of 10-12 hours to checking their blood sugar.

Exclusion criteria for this study included pregnant and lactating mothers and individuals with critical medical and mental conditions.

3.6 Participant recruitment

A research participant is chosen through random sampling from the hospital or household in the designated communities. Those who consent to participate in the study do so either verbally

or in writing. Any person who was chosen to participate in the study and chose not to was replaced with a different person from the family or hospital who was of a similar sex and age. Participants from households were advised to observe an overnight fast between the hours of 10 and 12 since they were enrolled in the study the day before blood samples were collected for biochemical analysis. Hospital participants were recruited into the study on the day of data collection due to the fact that they were already fasted overnight for the 10-12 hour period.

3.7 Data collection and instruments

3.7.1 Sociodemographic questionnaire

A semi-structured questionnaire was employed to obtain socio-demographic information on the participants of the study. The information collected included the sex of participants, age, level of education, religion, marital status and monthly income.

3.7.2 Behavioral and lifestyle questionnaire

A semi-structured questionnaire was used to get information concerning the behavioral and lifestyle factors of participants. The information obtained included average daily meal consumption, salt consumption, snacking, alcohol consumption, coffee or energy drink consumption, smoking and length of sleep.

3.7.3 Stress assessment

The stress levels of participants were assessed using the Cohen (1988) Perceived Stress Scale (PSS). This was to help us measure the degree to which situations in the life of the participants were perceived to be stressful.

3.7.4 Dietary assessment

A seven day food frequency questionnaire was used to collect information on the types of foods consumed in a 7-day span period and the frequencies with which they were consumed. This consisted of seven food groups being whole grains and tubers, vegetables, fruits, animal sourced foods, healthy fats and oils, legumes and nuts and discretionary foods.

3.7.5 Physical activity assessment

Participants were administered a modified version of Craig et al. (2003)'s International Physical Activity Questionnaire (IPAQ) to help them estimate their physical activity over the past seven days. To meet the Ghanaian setting, the example of activities for the various categories of physical activities was changed. As a result, several of the physical activities included on the original questionnaire, such as jumping rope, and participating in sports that require a lot of running (basketball, soccer, hockey, etc.), were changed to jogging/running, carrying heavy loads, brisk walking and carrying light loads. The questionnaire classified physical activity into three broad categories: vigorous physical activity (jogging, carrying heavy loads, etc.), moderate physical activity (brisk walking, carrying light loads, etc.), and light physical activity (sitting, time spent during work, etc.).

3.7.6 Anthropometric measurements

3.7.6.1 Height

Each participant's height (in cm) was measured using a manual stadiometer measured to the nearest 0.1cm using standardized techniques by the World Health Organization (WHO).

Measurements were taken twice to ensure accuracy and precision, and the average of the two measurements was used.

3.7.6.2 Weight

Each participant's weight (in kg) was measured using a Seca digital scale measured to the nearest 0.1kg using standardized techniques by the World Health Organization (WHO). Measurements were taken twice to ensure accuracy and precision, and the average of the two measurements was used.

3.7.7 Clinical measurements

3.7.7.1 Blood sugar

Participants' blood glucose levels were assessed using a Glucometer (Oncall plus). The process was carried out in accordance with the manufacturer's guidelines found in the provided manual. Test strips are included with the glucometer; blood samples were deposited onto the strip and the strip was then placed into the glucometer to determine the blood sample's fasting blood glucose levels. This was measured using a digital glucometer.

3.7.7.2 Blood pressure

The blood pressure (in mmHg) of each participant was measured using an Omron sphygmomanometer. Measurements were taken twice on the left using a 5-minute break to assure accuracy and precision, and the average of the two measurements was used.

3.8 Diagnostic criteria

The three main criteria used in the study were the International Diabetes Federation (IDF), World Health Organization (WHO) and the American Diabetes Association (ADA) reference criteria for determining diabetic status and nutritional status. The various criteria are shown in Table 3.1, however the WHO standards were used for this study.

Table 3.1 WHO, IDF and ADA standards for diagnosing type 2 diabetes mellitus and nutritional status

Indicator	WHO criteria	IDF criteria	ADA criteria
Hypoglycemia	< 3.9mmol/L	< 3.9mmol/L	< 3.9mmol/L
Normal glycemia	(3.9 – 6.0)mmol/L	(3.9 – 6.0)mmol/L	(3.9 – 5.5)mmol/L
Pre-diabetes	(6.1 – 6.9)mmol/L	(6.1 – 6.9)mmol/L	(5.6 – 6.9)mmol/L
Hyperglycemia	≥ 7.0 mmol/L	≥ 7.0 mmol/L	≥ 7.0 mmol/L
Low weight	< 18.5kg/m ²	< 18.5kg/m ²	< 18.5kg/m ²
Normal weight	(18.5 – 24.9)kg/m ²	(18.5 – 24.9)kg/m ²	(18.5 – 24.9)kg/m ²
Overweight	(25 – 29.9)kg/m ²	(25 – 29.9)kg/m ²	(25 – 29.9)kg/m ²
Obese	≥ 30.0kg/m ²	≥ 30.0kg/m ²	≥ 30.0kg/m ²

3.9 Data quality assurance

Anthropometric measurements, biochemical assays, and the questionnaire were all subjected to quality control. Three field assistants were chosen and given comprehensive training on how to administer the questionnaire. Pretests of the questionnaire and data collection tools were conducted in Agbogba, a community that shared similar features with the study communities but was not included in the study. Before any real fieldwork was conducted, all problems found during pretesting were used to rectify the procedures for collecting anthropometric and biochemical data as well as the questionnaire.

3.10 Data management

3.10.1 Stress status

The Perceived Stress Scale scored the various responses for the 10 questions asked from 0 to 4. However, for questions 4, 5, 7 and 8, the scores were reversed (4 to 0). The total score ranges from 0 to 40 where 0-13 is low stress, 14-26 is moderate stress and 27-40 is high stress.

3.10.2 Length of sleep

The length of sleep was grouped into two sections; unhealthy and healthy. Hours of sleep ranging from 1-5 and 9 and above were classified as unhealthy whereas 6-8 hours of sleep was classified as healthy.

3.10.3 Dietary intake

Seven food groups were used and food frequencies of consumption of these groups were recorded from day one of the seven days to day seven. Individuals were grouped into two groups under consumption of the food groups four days and less and five days and more.

3.10.4 Physical activity

A spreadsheet was used to automatically evaluate the IPAQ data for the physical activity assessment (Cheng, 2016). METs, multiples of the resting metabolic rate, were used to score the IPAQ. MET-min per week is the product of MET level and minutes of activity/day divided by days per week (MET level x minutes of activity/day x days per week). There are three different levels of activity: light (3.3 METs), moderate (4.0 METs), and vigorous (8.0 METs).

A person was considered physically active if they performed three days of intense exercise and accumulated at least 1500 MET minutes per week. If a person completed three or more days of vigorous-intensity exercise for at least twenty minutes each day, five or more days of moderate-intensity exercise and/or thirty minutes of walking per day, or five or more days of any combination of walking, moderate-intensity, or vigorous-intensity activities achieving at least 600 MET-min/week, then that person was deemed to have a moderate level of physical activity. A person is classified as having a low level of physical activity if they do not fit the criteria for high or moderate levels of physical activity.

3.10.5 Nutritional status

The weight and height measurements of the subjects were converted to BMI. Using WHO cut-offs (WHO, 1995), individuals with a BMI less than 18.5kg/m^2 were categorized as underweight, those with a BMI between 18.5kg/m^2 and 24.9 kg/m^2 as normal, those with a BMI between 25 kg/m^2 and 29.9 kg/m^2 as overweight and those with 30kg/m^2 and over as obese.

3.10.6 Blood pressure

In determining the hypertensive status of participants, using cut-off points developed by the American Heart Association, participants with systolic and diastolic pressures less than 120mmHg and 80mmHg respectively were categorized as normal. Systolic and diastolic pressures between 120-129mmHg and less than 80mmHg respectively were classified as elevated hypertensive participants. Participants who had between 130-139mmHg systolic pressure and between 80-89mmHg diastolic pressure were classified as hypertensive stage 1

and participants with systolic pressure above 140mmHg and diastolic pressure above 90mmHg were classified as hypertensive stage 2.

3.10.7 Mean arterial pressure

Mean arterial pressure was calculated using the systolic blood pressure and diastolic blood pressure in a mathematical formula of $\frac{SBP+2 \times DBP}{3}$. The mean arterial pressure was categorised into low, normal and high. Low mean arterial pressure ranges from 0-70 mmHg, normal mean arterial pressure ranges from 70-100 mmHg and high mean arterial pressure ranges from 100 mmHg and above.

3.11 Data analysis

Microsoft Excel was used for data entry and cleaning and the Statistical Package for Social Sciences (SPSS) version 26 software was used for all data analysis.

The categorical socio-demographic variables of the participants were summarized into frequencies and percentages using descriptive tests and the continuous socio-demographic variables were analyzed using mean and standard deviation.

Binary logistic regression was used in predicting the risk factors of prediabetes by explaining the relationship between the dependent variable (prediabetes) and the independent variables (physical activity, age, religion, education level, monthly income, length of sleep, salt intake, BMI, dietary factors, marital status, smoking, stress management, blood pressure status and mean arterial pressure).

Three confounding variables identified using bivariate analysis for the logistic regression model were marital status, sex and age. They were controlled and adjusted for in the model.

3.12 Ethical consent

This study was approved ethically by the Ethics Committee for Basic and Applied Science (ECBAS 021/23-24) and the Ghana Health Service (GHS-ERC 031-12-23). Participants were informed about the goals and objectives of the study, as well as the benefits and risks of participation, during the process of getting their informed consent. The work technique, confidentiality of the information collected, voluntariness to participate, and costs or compensations were all fully disclosed to the participants before they agreed to take part in the study. Both the researcher and each participant signed a consent form that they had provided in writing and verbally. Every participant and researcher received a copy of this since it was done in duplicate.



4.0 RESULTS

Preamble

This section provides a detailed analysis of the collected data, offering insights into various sociodemographic, behavioral, lifestyle, and dietary factors associated with prediabetes. It begins with a descriptive analysis of the background characteristics of the participants, offering a snapshot of the demographic and socioeconomic profile of the study population.

It highlights the study's key findings, beginning with the prevalence of prediabetes and diabetes among participants. It then investigates the sociodemographic characteristics linked with prediabetes, looking at how variables like age, gender, education level, and income affect the chance of acquiring the disease.

The chapter next discusses behavioral and lifestyle variables, such as physical activity, smoking, and alcohol intake, and how these relate to prediabetes. Dietary aspects, such as food kinds and frequency of intake, are also investigated. This section discusses the role of food in prediabetes risk, highlighting certain dietary components that may either prevent or increase the probability of developing prediabetes.

The chapter further investigates the role of body mass index (BMI) and blood pressure with prediabetes. Presenting detailed data on BMI categories and blood pressure levels among participants with the inclusion of mean arterial pressure adds another layer of understanding to the cardiovascular health profile of the study population.

4.1 Background characteristics of participants

Table 4.1 presents the background characteristics of participants in this study. The mean age of the participants was 49 years, with a standard deviation of 15 years. The distribution by sex showed a predominance of females, being 57.8% of the sample. Religious affiliation revealed that the majority of participants identified as Christian, constituting 82.5% of the sample. Regarding marital status, more than half of the participants were married (55%). In terms of education level, the secondary level was the most common, with 43.3% of participants having attained this level of education. Analysis of income distribution showed that 47.8% of participants earned a monthly income ranging from 1001 to 2000 Ghana cedis.



Table 4.1 Background characteristics of participants (N = 360)

Characteristic	n (%)
Sex	
Male	152 (42.2)
Female	208 (57.8)
*Age (years)	49 $\pm$ 15
Religion	
Christian	297 (82.5)
Muslim	58 (16.1)
Others	5 (1.4)
Level of education	
Primary	140 (38.9)
Secondary	156 (43.3)
Tertiary	64 (17.8)
Marital status	
Married	198 (55.0)
Single	162 (45.0)
Income (GHS)	
$\leq$ 1000	65 (18.1)
1001-2000	172 (47.8)
$\geq$ 2001	123 (34.1)

* Means data is represented in means and standard deviations



4.2 Prevalence of prediabetes/diabetes among participants

Figure 4.1 illustrates that a significant portion of the participants in this study exhibited blood sugar levels within the range of 3.9mmol/L – 6mmol/L, comprising 43.3% of the total sample. Blood sugar levels in the range of 7mmol/L and above were observed in 29.4% of participants. Moreover, 26.7% of individuals displayed blood sugar levels within the range of 6.1mmol/L – 6.9mmol/L, whereas 0.6% had blood sugar levels below 3.9mmol/L.

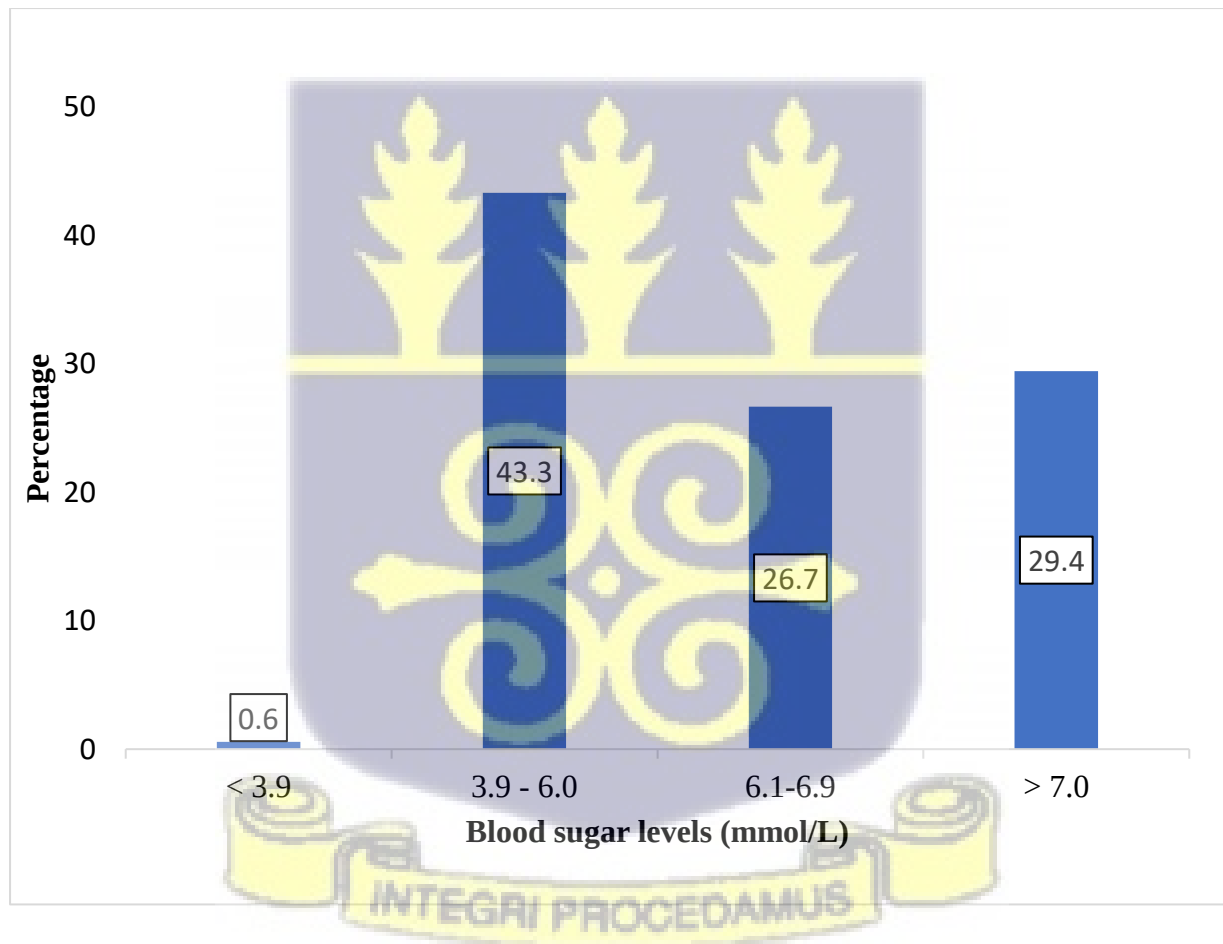


Figure 4.1 Blood sugar levels of participants (N = 360)

4.3 Socio-demographic factors associated with pre-diabetes among participants

Table 4.2 shows the results from a multivariate logistic regression analysis of socio-demographic factors associated with pre-diabetes covering sex, age, level of education, marital status and income. Females had a higher significant odds ratio as compared to males in this study (OR: 2.03, 95% CI: 1.02-4.59, $p = 0.031$). Both age ranges of 40-59 years and 60+ years had increased odds as compared to the reference of 18-39 with the age range of 40-59 having significant increased odds of pre-diabetes (OR: 2.97, 95% CI: 1.10-8.32, $p = 0.039$). While primary education was associated with a higher odds ratio for prediabetes compared to tertiary education, this association did not reach statistical significance. Similarly, there were no significant associations observed for secondary education. Single individuals exhibited a significantly elevated odds ratio for prediabetes compared to married individuals (OR: 2.60, 95% CI: 1.05-6.43, $p = 0.038$).



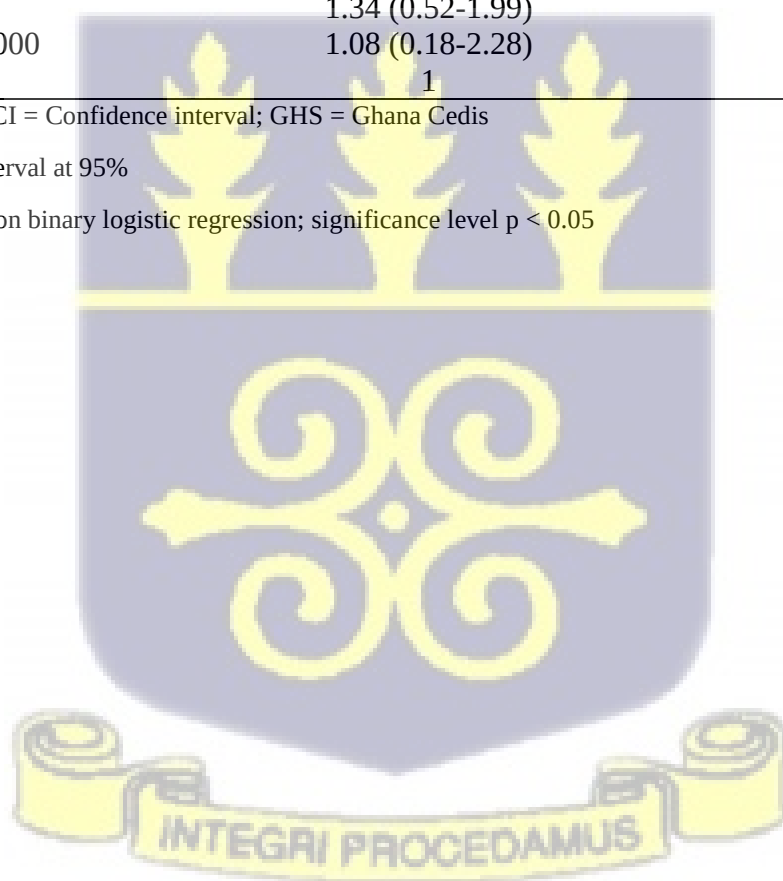
Table 4.2 Sociodemographic predictors associated with prediabetes among participants (n = 256)

Characteristic	OR (CI ¹)	p-value ²
Sex		
Male	1	
Female	2.03 (1.02-4.59)	0.031
Age (years)		
18-39	1	
40-59	2.97 (1.10-8.32)	0.039
60+	1.53 (0.60-3.94)	0.377
Level of education		
Primary	1.85 (0.96-3.55)	0.066
Secondary	1.34 (0.47-1.89)	0.535
Tertiary	1	
Marital status		
Married	1	
Single	2.60 (1.05-6.43)	0.038
Income (GHS)		
≤ 1000	1.34 (0.52-1.99)	0.972
1001-2000	1.08 (0.18-2.28)	0.489
≥ 2001	1	

OR = Odds ratio; CI = Confidence interval; GHS = Ghana Cedis

¹ = Confidence interval at 95%

² = p-value based on binary logistic regression; significance level $p < 0.05$



4.4 Behavioral and lifestyle factors associated with prediabetes among participants

Table 4.3 shows the logistic regression of behavioral and lifestyle factors associated with prediabetes among participants in the study. Participants who reported consuming salt exhibited a significantly higher risk of prediabetes compared to non-consumers (adjusted OR: 6.25, 95% CI: 1.69-23.02, $p = 0.006$). Similarly, individuals reporting caffeine intake showed an increased risk of prediabetes, although this association did retain significance after adjustment (adjusted OR: 2.51, 95% CI: 1.53-11.88, $p = 0.012$). Smoking emerged as a risk factor, with smokers showing significantly elevated odds of prediabetes compared to non-smokers (adjusted OR: 10.14, 95% CI: 1.21-111.03, $p = 0.002$). Moreover, participants with unhealthy lengths of sleep demonstrated increased odds of prediabetes (adjusted OR: 5.11, 95% CI: 1.54-9.43, $p = 0.005$). Also, individuals consuming more than three meals per day exhibited elevated odds of prediabetes (adjusted OR: 2.54, 95% CI: 1.83-5.56, $p = 0.004$). Conversely, alcohol intake and snacking did not show significant associations with prediabetes status.

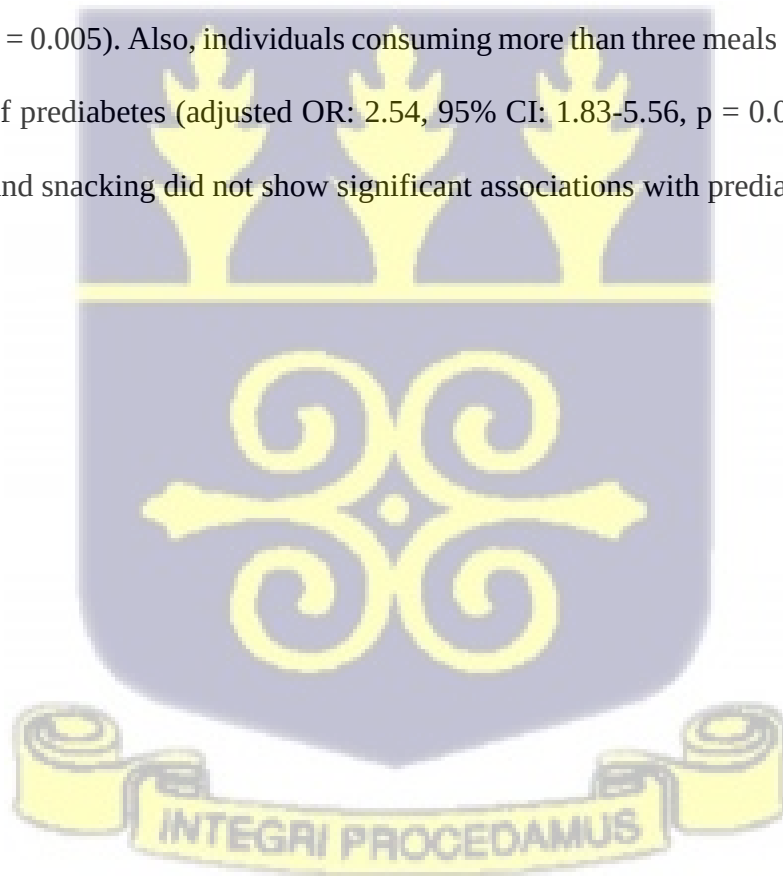


Table 2.3 Behavioral and lifestyle factors associated with prediabetes among participants (n = 256)

Risk factor	Unadjusted		Adjusted	
	OR (CI ¹)	p-value ²	OR (CI ¹)	p-value ²
Salt intake				
Yes	6.58 (1.87-23.22)	0.003	6.25 (1.69-23.02)	0.006
No	1		1	
Alcohol intake				
Yes	1.50 (0.47-4.91)	0.144	1.54 (0.18-3.52)	0.060
No	1		1	
Caffeine intake				
Yes	1.89 (1.19-6.78)	0.039	2.51 (1.53-11.88)	0.012
No	1		1	
Smoking				
Yes	8.90 (1.29-84.08)	0.004	10.14 (1.21-111.03)	0.002
No	1		1	
Snacking				
Yes	1 (0.53-1.90)	0.992	1.24 (0.65-2.38)	0.520
No	1		1	
Length of sleep				
Healthy	1		1	
Unhealthy	2.53 (1.05-5.24)	0.041	5.11 (1.54-9.43)	0.005
Meals in a day				
≤2	1		1	
≥3	2.00 (1.11-3.04)	0.021	2.54 (1.83-5.56)	0.004

OR = Odds ratio; CI = Confidence interval

Adjusted for age, sex and marital status.

¹ = Confidence interval at 95%

² = p-value based on binary logistic regression; significance level $p < 0.05$

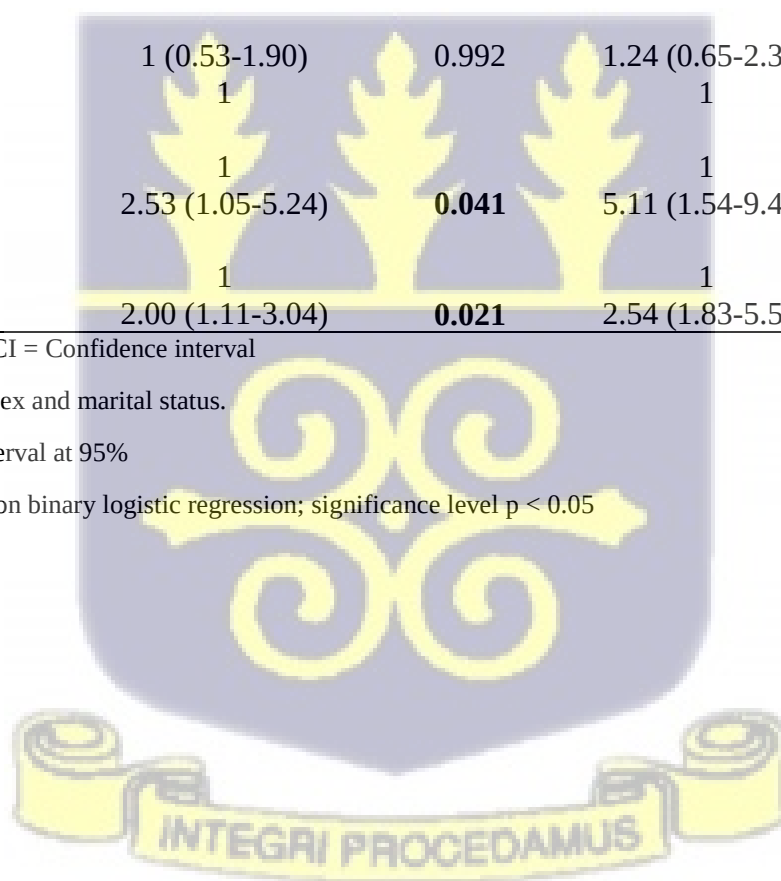


Table 4.4 shows the logistic regression analysis of physical activity and stress levels with prediabetes among participants in this study. Participants engaging in low physical activity demonstrated significantly heightened odds of prediabetes compared to those with high activity levels (adjusted OR: 3.53, 95% CI: 1.83-7.89, $p < 0.001$), a trend persisting after adjustment for confounding factors. Additionally, individuals reporting high stress levels exhibited increased odds of prediabetes compared to those with moderate stress levels (adjusted OR: 8.29, 95% CI: 3.30-20.80, $p < 0.001$), a significant association retained even after adjustment.



Table 4.4 Physical activity levels and stress levels associated with prediabetes among study participants (n = 256)

Risk factor	Unadjusted		Adjusted	
	OR (CI ¹)	p-value ²	OR (CI ¹)	p-value ²
Physical activity				
Low	3.20 (1.45-7.03)	<0.001	3.53 (1.83-7.89)	<0.001
Moderate	2.22 (1.03-4.76)	0.005	1.53 (1.21-5.33)	0.003
High	1		1	
Stress levels				
Moderate	1		1	
High	6.36 (2.79-14.47)	0.004	8.29 (3.30-20.80)	<0.001

OR = Odds ratio; CI = Confidence interval

Adjusted for age, sex and marital status.

¹ = Confidence interval at 95%

² = p-value based on binary logistic regression; significance level $p < 0.05$



4.5 Dietary factors associated with prediabetes among participants

Table 4.5 shows participants consuming starchy foods for 5 days and more displayed notably increased odds of prediabetes compared to those consuming for fewer days (adjusted OR: 3.63, 95% CI: 1.74-7.58, $p = 0.007$). Individuals with lower vegetable consumption exhibited elevated odds of prediabetes (adjusted OR: 2.22, 95% CI: 1.02-5.07, $p = 0.049$). Similarly, participants with lower fruit intake demonstrated significantly increased odds of prediabetes (adjusted OR: 4.90, 95% CI: 2.57-9.37, $p = 0.031$). Consumption of animal-sourced foods for 5 days and above associated with significantly increased odds of prediabetes (adjusted OR: 2.54, 95% CI: 1.36-4.86, $p = 0.015$), as was an intake of fats and oils (adjusted OR: 5.87, 95% CI: 2.76-12.51, $p = 0.001$). Consumption of legumes and nuts for 5 days or more was associated with elevated odds of prediabetes (adjusted OR: 2.45, 95% CI: 1.23-6.11, $p = 0.045$), with increased intake of confectionaries also demonstrating a significant association with prediabetes risk (adjusted OR: 2.25, 95% CI: 1.19-5.23, $p = 0.019$).

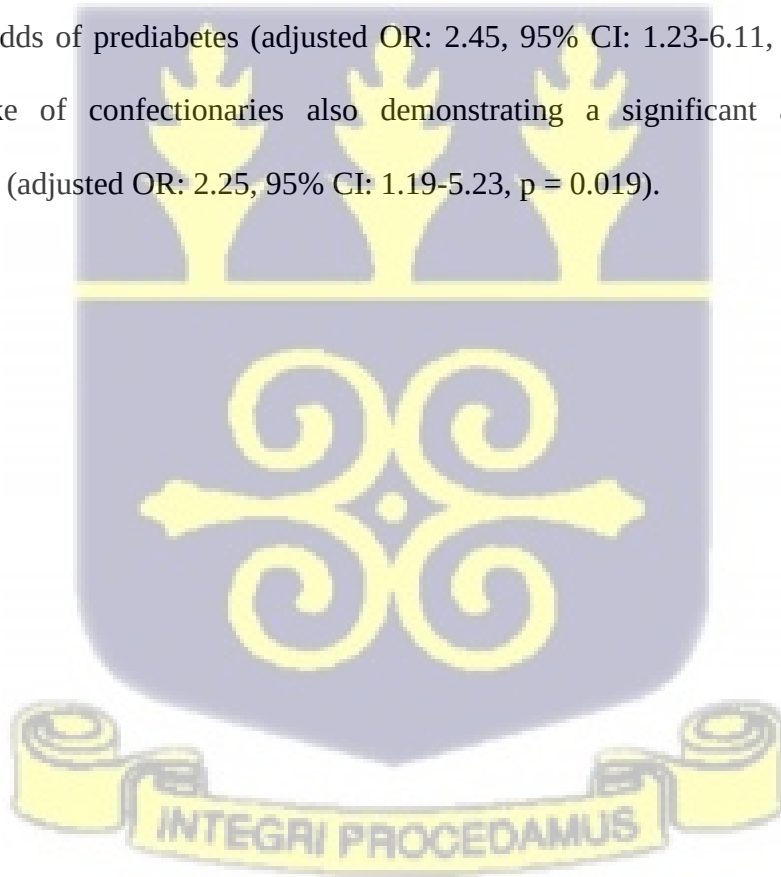


Table 4.5 Seven day food frequency consumption associated with prediabetes among participants (n = 256)

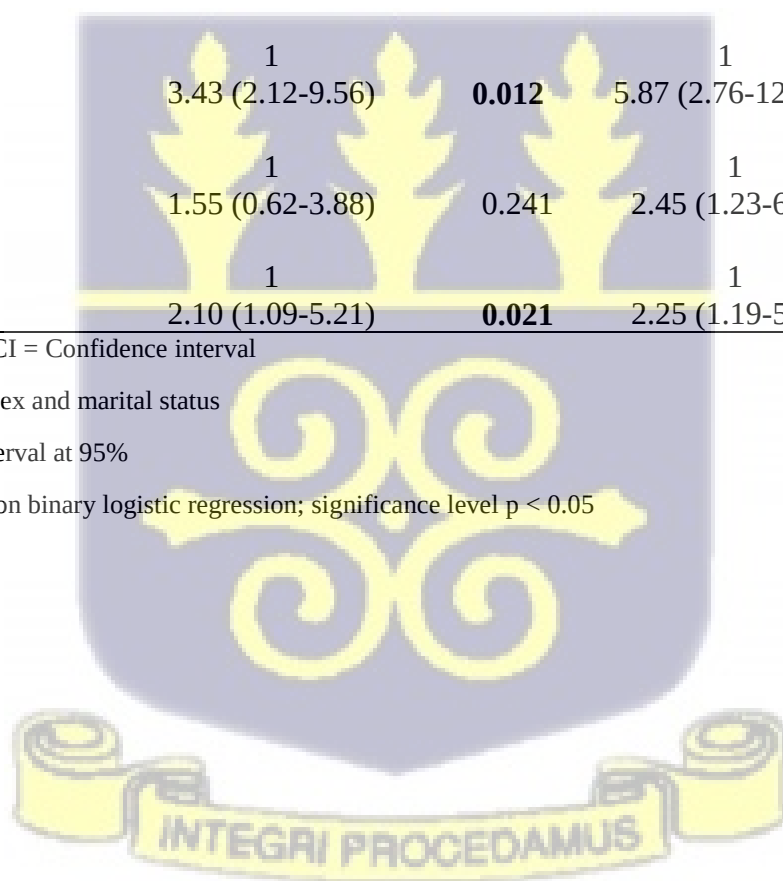
Food group	Unadjusted		Adjusted	
	OR (CI ¹)	p-value ²	OR (CI ¹)	p-value ²
Starchy foods				
≤ 4	1		1	
≥ 5	2.60 (1.43-6.82)	0.004	3.63 (1.74-7.58)	0.007
Vegetables				
≤ 4	2.43 (1.03-5.72)	0.043	2.22 (1.02-5.07)	0.049
≥ 5	1		1	
Fruits				
≤ 4	1.23 (0.27-3.21)	0.059	4.90 (2.57-9.37)	0.031
≥ 5	1		1	
Animal sourced foods				
≤ 4	1		1	
≥ 5	1.24 (1.01-2.93)	0.032	2.54 (1.36-4.86)	0.015
Fats and oils				
≤ 4	1		1	
≥ 5	3.43 (2.12-9.56)	0.012	5.87 (2.76-12.51)	0.001
Legumes and nuts				
≤ 4	1		1	
≥ 5	1.55 (0.62-3.88)	0.241	2.45 (1.23-6.11)	0.045
Confectionaries				
≤ 4	1		1	
≥ 5	2.10 (1.09-5.21)	0.021	2.25 (1.19-5.23)	0.019

OR = Odds ratio; CI = Confidence interval

Adjusted for age, sex and marital status

¹ = Confidence interval at 95%

² = p-value based on binary logistic regression; significance level $p < 0.05$



4.6 Body mass index of participants

Figure 4.2 shows that a considerable amount of the participants in this study had body mass index in the normal range of 18.5-24.9kg/m² (33.6%). A few of the participants were underweight (6.4%) with a BMI of < 18.5kg/m², with the overweight range of 25-29.9kg/m² and obese range of > 30kg/m² having respectively 29.1% and 30.8% of participants.

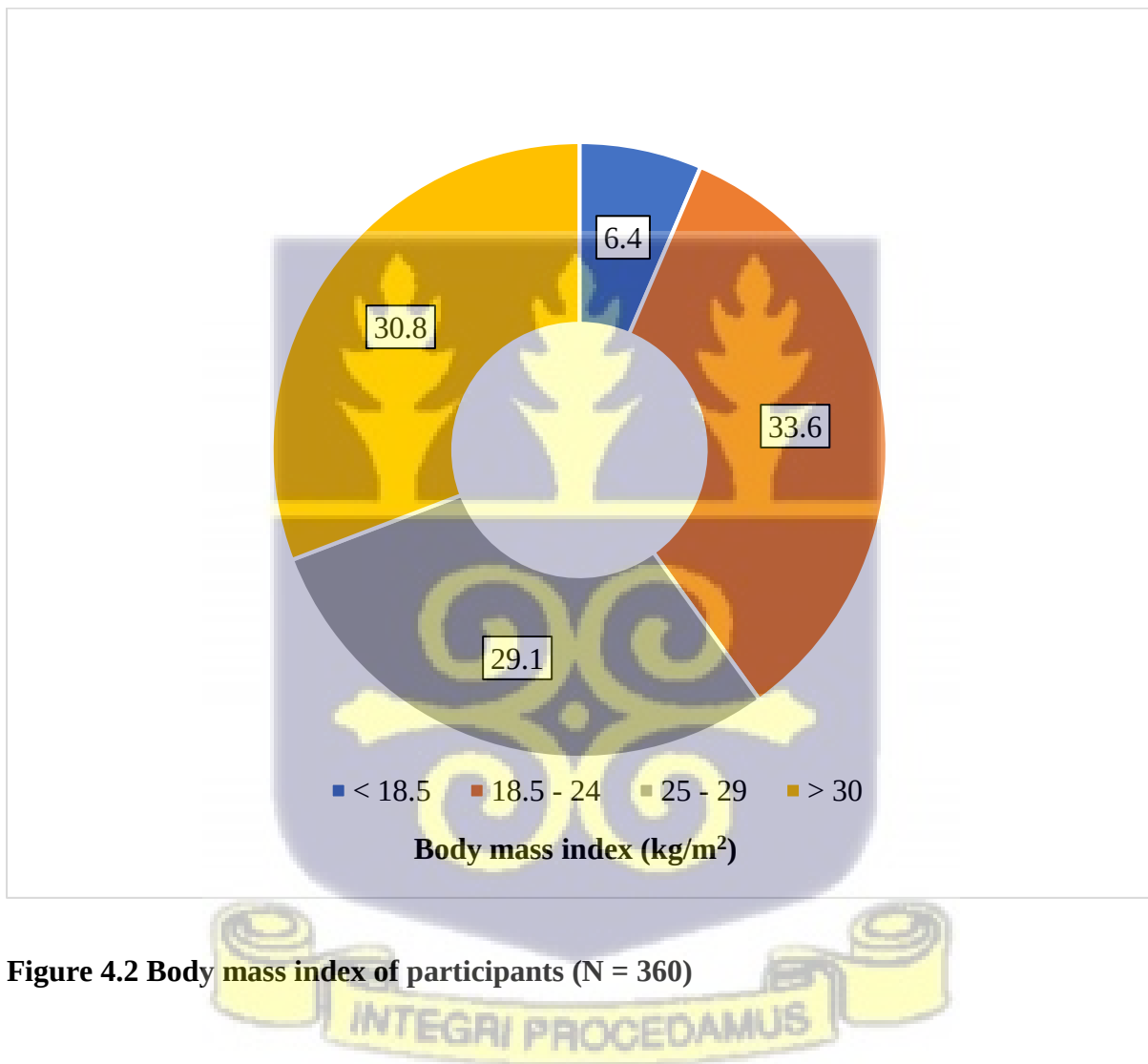


Table 4.6 shows participants with a BMI greater than 25 displayed significantly increased odds of prediabetes compared to those with a BMI below 25 (adjusted OR: 4.55, 95% CI: 2.12-18.11, $p < 0.001$). This association remained significant even after adjusting for potential confounders.

Table 4.6 Association between BMI with prediabetes among participants (n = 256)

Risk factor	Unadjusted		Adjusted	
	OR (CI ¹)	p-value ²	OR (CI ¹)	p-value ²
BMI (kg/m²)				
≤ 25	1		1	
>25	3.45 (1.54-12.11)	0.003	4.55 (2.12-18.11)	<0.001

*Values represented in means and standard deviation.

OR = Odds ratio; CI = Confidence interval

Adjusted for age, sex and marital status.

¹ = Confidence interval at 95%

² = p-value based on binary logistic regression; significance level $p < 0.05$



4.7 Blood pressure among participants

Figure 4.3 below shows the blood pressure status of participants in this study. A considerable amount of participants were seen to be stage 1 and stage 2 hypertensive being 37.8% and 31.9% respectively. One fifth (20.3%) of participants had normal blood pressure with 10.0% being elevated.

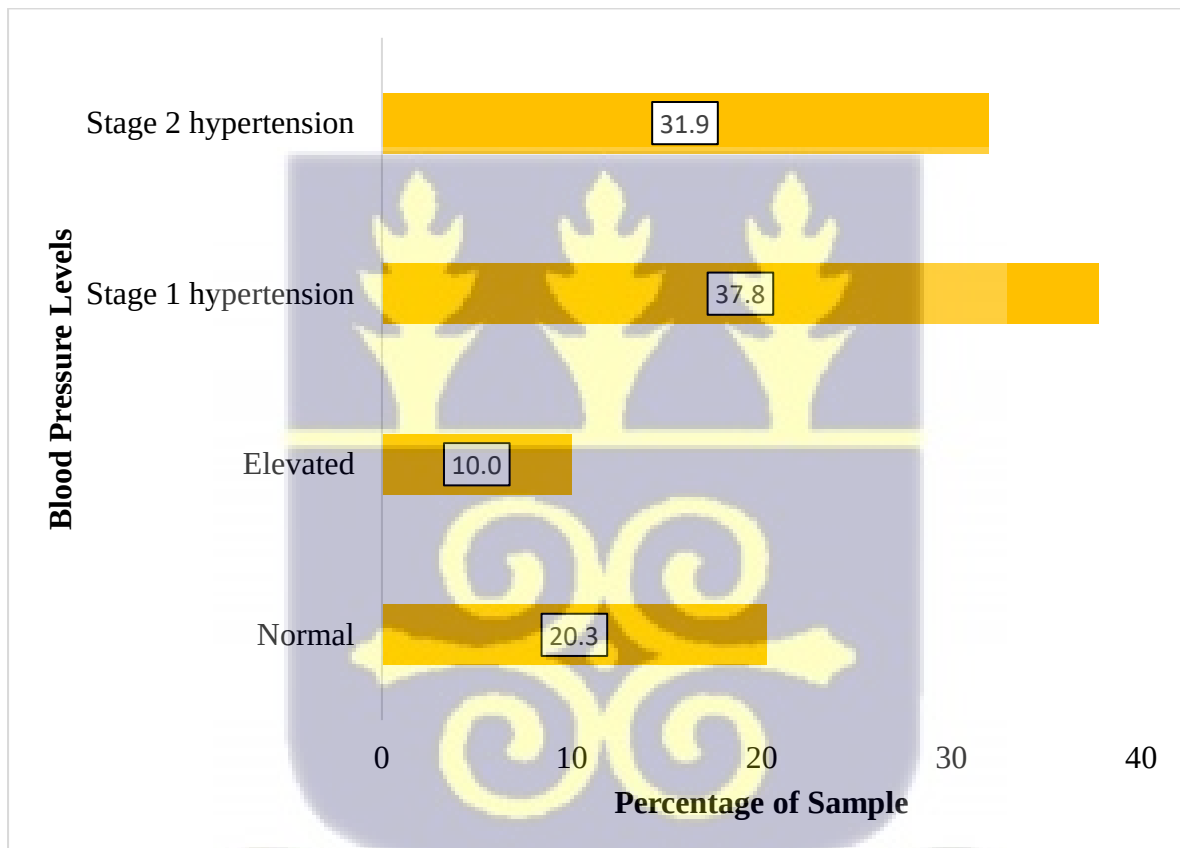


Figure 4.3 Blood pressure status of participants (N =360)

Table 4.7 illustrates the relationship between blood pressure levels and prediabetes status among participants. Using participants with normal blood pressure as the reference category, those with elevated blood pressure displayed a trend towards increased likelihood of prediabetes (unadjusted OR: 3.21, 95% CI: 0.43-18.83, $p = 0.132$), which strengthened after adjustment (adjusted OR: 4.51, 95% CI: 1.14-22.12, $p = 0.032$), signifying a significant association. Similarly, individuals with stage 1 hypertension showed a non-significant trend towards higher odds of prediabetes in the unadjusted analysis (OR: 4.55, 95% CI: 0.84-25.91, $p = 0.244$), which became significant after adjustment (adjusted OR: 6.74, 95% CI: 1.50-30.29, $p = 0.015$). In contrast, stage 2 hypertension exhibited a significant association with prediabetes, with both unadjusted (OR: 3.70, 95% CI: 1.33-10.31, $p = 0.045$) and adjusted (adjusted OR: 2.77, 95% CI: 1.04-7.39, $p = 0.038$). Participants classified with high mean arterial pressure levels demonstrated significantly elevated odds of prediabetes compared to those with normal MAP levels (adjusted OR: 4.21, 95% CI: 1.50-11.81, $p = 0.006$), even after adjusting for potential confounders. These findings highlight significant associations between elevated, stage 1 hypertension, stage 2 hypertension and high mean arterial pressure with prediabetes after adjusting for sex, age and marital status.

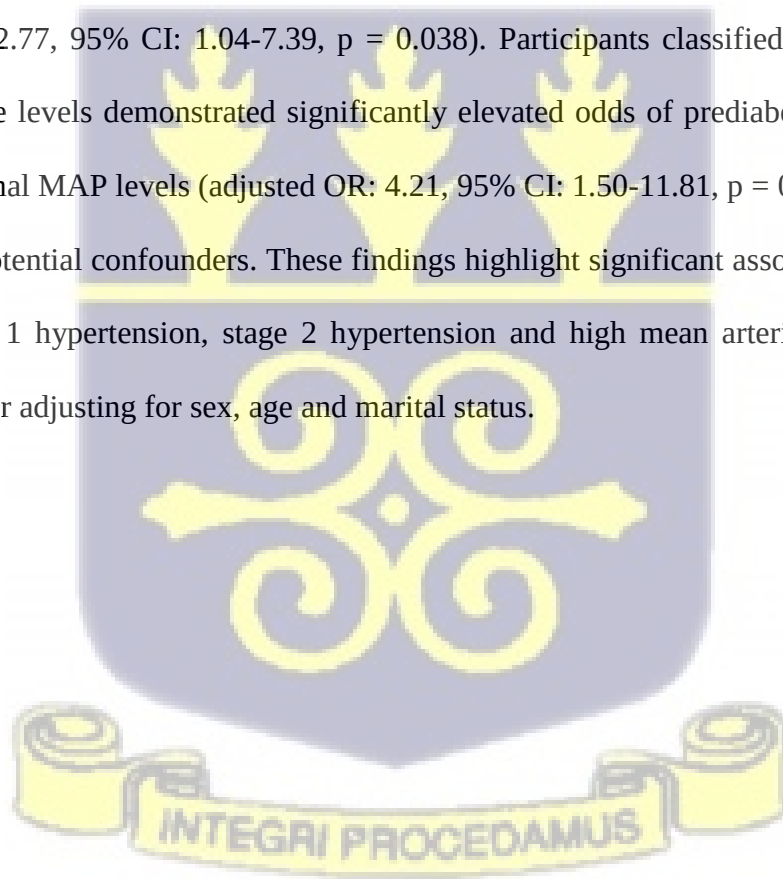


Table 4.7 Association between blood pressure status and prediabetes among participants (n = 256)

Risk factor	Unadjusted		Adjusted	
	OR (CI)¹	p-value²	OR (CI)¹	p-value²
Blood Pressure				
Normal	1		1	
Elevated	3.21 (0.43-18.83)	0.132	4.51 (1.14-22.12)	0.032
Stage 1 hypertension	4.55 (0.84-25.91)	0.244	6.74 (1.50-30.29)	0.015
Stage 2 hypertension	3.70 (1.33-10.31)	0.045	2.77 (1.04-7.39)	0.038
Mean Arterial Pressure				
Normal	1		1	
High	3.66 (1.26-10.64)	0.017	4.21 (1.50-11.81)	0.006

OR = Odds ratio; CI = Confidence interval

Adjusted for age, sex and marital status.

¹ = Confidence interval at 95%

² = p-value based on binary logistic regression; significance level $p < 0.05$

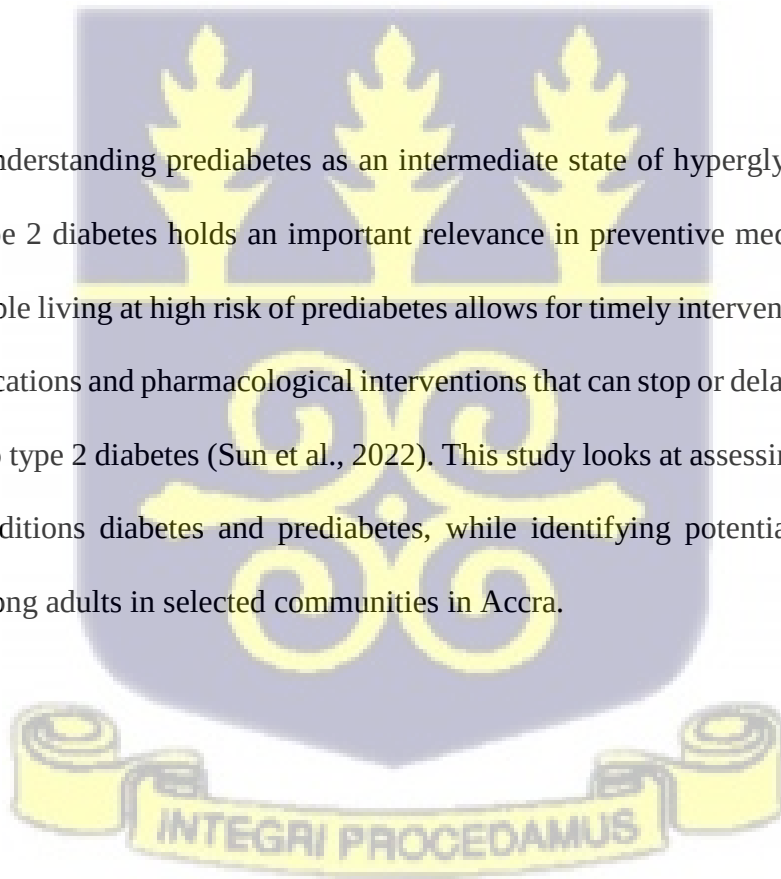


5.0 DISCUSSION

5.1 Preamble

The prevalence of several non-communicable diseases (NCDs) is rising, with diabetes and prediabetes among adults rising at an alarming rate. This is a major worry in the modern world. It is predicted that the prevalence of prediabetes rise significantly worldwide in the next years, with no discernible gender difference (International Diabetes Federation, 2023). In Ghana, especially within the urban landscape of Accra, the rising prevalence of diabetes and prediabetes presents a multidimensional problem to public health initiatives. This study is in line with the third goal of the Sustainable Development Goals (SDGs) which seeks to provide good health and well-being.

Furthermore, understanding prediabetes as an intermediate state of hyperglycemia preceding the onset of type 2 diabetes holds an important relevance in preventive medicinal strategies. Identifying people living at high risk of prediabetes allows for timely interventions that include lifestyle modifications and pharmacological interventions that can stop or delay the progression of the disease to type 2 diabetes (Sun et al., 2022). This study looks at assessing the prevalence of the two conditions diabetes and prediabetes, while identifying potential risk factors of prediabetes among adults in selected communities in Accra.



5.2 Prevalence of prediabetes/diabetes

The prevalence of prediabetes and diabetes within the sample population was assessed based on blood sugar levels categorized into four groups: hypoglycemia (<3.9 mmol/L), normoglycaemia (3.9–6.0 mmol/L), prediabetes (6.1–6.9 mmol/L), and diabetes (>7.0 mmol/L). These categories reflect a range of blood glucose levels among the study participants.

A large proportion of the sample, 43.3%, was observed to fall within the normoglycaemic range of 3.9–6.0 mmol/L, indicating that a significant portion of the population maintains healthy blood sugar levels. A study by Shani et al. (2022) reported a higher prevalence of 73.3% in the normoglycemic range across urban and rural Ghana, suggesting better glycemic control in their sample compared to the present study. Nevertheless, the majority of participants in both studies appear to follow healthy glycemic practices.

In contrast, 29.4% of the sample population was found to be diabetic, signaling a significant public health concern. This prevalence is considerably higher than those reported by Vuvor et al. (2011), Bawah et al. (2019), and Grijalva-Eternod et al. (2024), who found diabetes prevalence rates of 3.9%, 5.4%, and 8.2%, respectively, with over 25% of people living with diabetes unaware of their condition. The higher prevalence in the present study may be attributed to increased urbanization and the growing influence of Western lifestyle changes in Ghana, which are known contributors to rising diabetes rates, as noted by Amoah et al. (2002). These findings align with global projections of increasing numbers of people living with diabetes and prediabetes (International Diabetes Federation, 2023).

The prevalence of prediabetes in this sample was 26.7%, compared to 17.3% reported by Bawah et al. (2019) in the Ho municipality. Although lower than the current study, this rate is still high when contrasted with global estimates of 15.8% (Yip et al., 2017). The elevated prevalence of prediabetes highlights an urgent public health concern, emphasizing the need for targeted interventions to prevent progression to type 2 diabetes mellitus. Early detection and management of prediabetes are critical to preventing the onset of diabetes and related complications (International Diabetes Federation, 2023). Similar to diabetes, the high prevalence of prediabetes may be linked to factors such as urbanization and Western lifestyle influences, as noted by Amoah et al. (2002), given the shared metabolic pathways between the two conditions.

Less than 1% of the sample population was classified as hypoglycemic (<3.9 mmol/L), which is consistent with findings by Bosu (2015), who reported that hypoglycemia is less prevalent compared to hyperglycemia in urban Ghanaian populations. One possible explanation for this low prevalence is the dietary habits of urban populations, where high-carbohydrate and processed foods are more common, leading to a higher likelihood of elevated blood sugar levels rather than low ones (Mohan et al., 2018).

While the study reveals a high prevalence of normoglycemia, the substantial proportions of participants in the prediabetic and diabetic ranges are cause for concern. The increasing trend in blood sugar disorders aligns with the global rise in non-communicable diseases, underscoring the need for immediate public health interventions (International Diabetes Federation, 2023).

5.3 Association between sociodemographic factors and prediabetes

There was a significant association between sex and prediabetes status. Females had an adjusted odds ratio (OR) of 2.03 (CI: 1.02–4.59, p -value = 0.031) compared to males. This means that females in the study were approximately twice as likely to develop prediabetes as males. This finding is consistent with existing literature. Several studies have also reported a higher prevalence of prediabetes among women, potentially due to differences in fat distribution, hormonal influences, and health-seeking behaviors (Kautzky-Willer et al., 2016; Huebschmann et al., 2019). Hormonal fluctuations during pregnancy, menstruation, and menopause are known to affect glucose metabolism, which may predispose women to future glucose intolerance and the development of prediabetes.

Age was also significantly associated with prediabetes. Participants aged 40–59 years had an OR of 2.97 (CI: 1.10–8.32, p -value = 0.039) compared to those aged 18–39 years. However, participants aged 60 and above did not show a statistically significant association (OR: 1.53, CI: 0.60–3.94, p -value = 0.377). Middle-aged adults (40–59 years) were nearly three times more likely to develop prediabetes compared to younger adults. This finding is consistent with other studies, such as Tabak et al. (2012) and Mainous et al. (2016), which have identified middle adulthood as a significant period for the onset of prediabetes due to factors such as reduced physical activity, age-related metabolic changes, and weight gain.

The level of education did not show a strong association with prediabetes. While primary education showed a borderline significant association with an OR of 1.85 (CI: 0.96–3.55, p -value = 0.066), secondary education did not demonstrate any significant association (OR: 1.34, CI: 0.47–1.89, p -value = 0.535). This suggests that lower educational attainment might be

linked to a higher risk of prediabetes, potentially due to factors like lower health literacy, poorer dietary choices, and limited access to healthcare services, as discussed by Montez and Zajacova (2013).

Marital status was significantly associated with prediabetes, with single participants having an OR of 2.60 (CI: 1.05–6.43, p-value = 0.038). This indicates that single individuals were almost three times more likely to develop prediabetes compared to married individuals. Literature on this topic has been mixed; for instance, Rahmanian et al. (2016) found no significant association in an Iranian community, while Aldossari et al. (2018) identified marital status as a significant risk factor for prediabetes, consistent with this study's findings. The higher likelihood of prediabetes among single individuals may be linked to healthier lifestyle choices and social support typically associated with marriage in Ghana.

Income levels did not show a significant association with prediabetes. Participants earning less than GHS 1000 had an OR of 1.34 (CI: 0.52–1.99, p-value = 0.972), and those earning GHS 1001–2000 had an OR of 1.08 (CI: 0.18–2.28, p-value = 0.489) compared to those earning more than GHS 2001. These findings suggest that income, within the ranges studied, may not be a major determinant of prediabetes in this population. Although previous research has highlighted income's role in determining access to healthier food choices and lifestyles, it is possible that other factors, such as marital status and lifestyle habits, play a more critical role in this context (Bird et al., 2015).

5.4 Association of behavioral and lifestyle factors with prediabetes

This section explores the association between various behavioral and lifestyle factors that participants of this study engage in with the prediabetic condition. Data regarding this is presented in table 4.3 and categorizes individuals based on their prediabetic status, evaluating their odds ratios for each risk factor, along with corresponding confidence intervals and p-values.

5.4.1 Salt intake

High salt intake was observed in this study to have a significant association with prediabetes with individuals reporting salt consumption after meals are prepared having an unadjusted OR of 6.58 (CI: 1.87-23.22, p-value = 0.003) and adjusted OR of 6.25 (CI: 1.69-23.02, p-value = 0.006). This finding explains that individuals who consume high amounts of salt have an increased odds of developing prediabetes by approximately 6 times as compared to people who do not add salt to already prepared food. The findings observed are consistent with literature, including studies done by Bagheri et al. (2016) and Wang et al. (2023) which indicate that increased consumption of salt or addition of salt to prepared meals is significantly associated to impaired fasting glucose with the risk of type 2 diabetes. Increased blood sugar levels can be attributed by this through the effect of sodium on disrupting insulin signaling pathways which makes it difficult for cells to absorb glucose from the bloodstream (He et al., 2020).

5.4.2 Alcohol consumption

The unadjusted OR of 1.50 (CI: 0.47-4.91, p-value = 0.144) and adjusted OR of 1.54 (CI: 0.18-3.52, p-value = 0.060) did not reveal a significant association between alcohol intake and prediabetes even though it is observed that when adjusted for confounding variables persons

who consume alcohol are 1.5 times more likely of being prediabetic in this study sample. This result aligns with mixed findings observed in the literature, where some studies can show no significant effect of alcohol on blood sugar levels and others indicate a potential risk of alcohol consumption on prediabetes (Cullman et al., 2012; Knott et al., 2015; Li et al., 2016; Zhang et al., 2021). This observed variation can be as a result of differences in alcohol consumption patterns, genetic factors and types of alcoholic beverages consumed.

5.4.3 Caffeine intake

Caffeine intake showed a significant association with prediabetes. Individuals consuming caffeine had an unadjusted OR of 1.89 (CI: 1.19-6.78, $p = 0.039$) and an adjusted OR of 2.51 (CI: 1.53-11.88, $p = 0.012$). This indicates that caffeine intake increases the odds of prediabetes in this sample, this is corroborated by findings from Jiang et al. (2013), who reported that increased caffeine intake per day is significantly associated with the incidence of type 2 diabetes mellitus. The potential of caffeine to impair insulin action and increase glucose levels is a possible explanation for this association. This mechanism can be explained by the ability of caffeine to stimulate the release of certain stress hormones, particularly adrenaline (epinephrine), which in turn signals the liver to release more glucose into the bloodstream with this increase in blood glucose leading to insulin impairment and prediabetes (Barcelos et al., 2020).

5.4.4 Smoking

In this sample smoking was observed to have a significant association with the prediabetic condition, having an unadjusted OR of 8.90 (CI: 1.29-84.08, $p = 0.004$) and an adjusted OR of 10.14 (CI: 1.21-111.03, $p = 0.002$). These results indicate that smokers are ten times more

likely to develop the prediabetic condition as compared to non-smokers. These findings are in line with Cetin et al. (2018), which highlighted the significance of smoking as a risk factor for the development of prediabetes and type 2 diabetes mellitus and also suggesting the mechanism of the harmful effects of smoking on pancreatic β -cell function and insulin sensitivity being a cause of this heightened risk.

5.4.5 Snacking

No significant association was found between snacking and prediabetes, with an unadjusted OR of 1 (CI: 0.53-1.90, $p = 0.992$) and an adjusted OR of 1.24 (CI: 0.65-2.38, $p = 0.520$). This suggests that the presence of snacking does not significantly impact prediabetes status. This is consistent with literature that suggests that the presence of snacking or its frequency may be less important as compared to the nutritional content of foods consumed (Kant & Graubard, 2015).

5.4.6 Length of sleep

Sleep duration was associated with prediabetes, particularly with unhealthy sleep hours being 5 hours and less or 9 hours and more. The unadjusted OR was 2.53 (CI: 1.05-5.24, $p = 0.041$) and the adjusted OR was 5.11 (CI: 1.54-9.43, $p = 0.005$). This finding suggests that both short and long sleep durations could be linked to an increased risk of prediabetes, reflecting a U-shaped relationship between sleep and glucose metabolism (Knutson, 2010). These findings can be supported by a study done by Guyer (2018) which states that sleep disturbances and excessive prolonged hours of sleep are associated with increased blood sugar levels.

5.4.7 Meals in a Day

The number of meals consumed per day showed a significant association with prediabetes. Individuals who ate more than three meals per day had an unadjusted OR of 2.00 (CI: 1.11-3.04, $p = 0.021$) and an adjusted OR of 2.54 (CI: 1.83-5.56, $p = 0.004$). This indicates that frequent meals may be associated with an increased risk of prediabetes, possibly due to higher overall caloric intake and frequent spikes in blood sugar levels though after adjustment for BMI in a study its effect was reduced (Mekary et al., 2012).

5.4.8 Physical activity

The level of physical activity was significantly associated with prediabetes. The data show that individuals with low physical activity had an unadjusted OR of 3.20 (CI: 1.45-7.03, $p < 0.001$) and an adjusted OR of 3.53 (CI: 1.83-7.89, $p < 0.001$). Participants with moderate physical activity had an unadjusted OR of 2.22 (CI: 1.03-4.76, $p = 0.005$) and an adjusted OR of 1.53 (CI: 1.21-5.33, $p = 0.003$). These results indicate that low and moderate physical activity levels significantly increase the odds of developing prediabetes compared to high physical activity levels.

These results are consistent with earlier research on the relationship between physical activity and glycaemic management, which found that a key risk factor for the development of type 2 diabetes mellitus and prediabetes is low levels of physical activity (Colber et al., 2016). Sedentary lifestyles increase the risk of type 2 diabetes mellitus, which is linked to numerous metabolic hazards and poorer glycaemic control (Dunstan et al., 2007; Fritschi et al., 2016).

For individuals engaging in moderate physical activity, the risk of prediabetes is lower compared to those with low activity but still elevated relative to highly active individuals. This aligns with Reljic et al. (2021), which has found that while moderate physical activity can reduce the risk of metabolic disorders, its effects are often less pronounced than those seen with high-intensity physical activity.

Participants with high levels of physical activity serve as the reference group in the analysis, indicating that this level of activity offers significant protective effects against prediabetes. Research consistently shows that higher-intensity physical activity leads to more substantial improvements in insulin sensitivity, glucose uptake, and fat oxidation (Jadhav et al., 2017; Marcinko et al., 2015). These effects are crucial in preventing the development of prediabetes, as they directly target the physiological mechanisms that contribute to impaired glucose metabolism.

5.4.9 Stress levels

Stress levels were also found to have a significant association with prediabetes. Participants with high stress levels had an unadjusted OR of 6.36 (CI: 2.79-14.47, $p = 0.004$) and an adjusted OR of 8.29 (CI: 3.30-20.80, $p < 0.001$). This indicates that high-stress levels significantly increase the odds of developing prediabetes compared to moderate stress levels. In line with these findings, a study by Agyei-Mensah and de-Graft Aikins (2010) indicated that the urban lifestyle in Accra, characterized by high-stress levels and sedentary behaviours, significantly contributes to the high burden of prediabetes and diabetes.

5.5 Impact of dietary intake on prediabetes

Starchy foods remain a dominant part of daily consumption in urban Ghana, largely due to their affordability and energy-providing properties. However, increased daily consumption of starchy foods was significantly associated with prediabetes in this study. Participants who consumed starchy foods for five days or more were over three times more likely to be prediabetic compared to those who consumed such foods less frequently (adjusted OR: 3.63, CI: 1.74–7.58, $p = 0.007$). These findings are consistent with studies such as Livesey et al. (2019), which report that diets high in glycemic index and glycemic load elevate the risk of type 2 diabetes and prediabetes by promoting repeated postprandial spikes in blood glucose, eventually impairing insulin sensitivity.

Low vegetable intake was also significantly associated with prediabetes. Participants who consumed vegetables fewer than five days per week had more than twice the odds of being prediabetic compared to those with higher vegetable intake (adjusted OR: 2.22, CI: 1.02–5.07, $p = 0.049$). This finding affirms previous evidence from Carter et al. (2010) and Wang et al. (2016), which underscore the role of vegetables in glycaemic control through their fiber content, antioxidant properties, and micronutrient profile. Similarly, inadequate fruit consumption (≤ 4 days/week) was associated with a markedly increased risk of prediabetes (adjusted OR: 4.90, CI: 2.57–9.37, $p = 0.031$). The protective effects of fruits are well-documented and largely attributed to their dietary fiber, phytochemicals, and their ability to modulate glucose absorption (Muraki et al., 2013; Halvorsen et al., 2021).

Consumption of animal-sourced foods for five or more days per week also showed a strong positive association with prediabetes (adjusted OR: 2.54, CI: 1.36–4.86, $p = 0.015$). This aligns

with literature by Chen et al. (2018), which links diets high in red and processed meats to increased insulin resistance, largely due to saturated fat, heme iron, and pro-inflammatory compounds. Fats and oils consumption revealed the strongest dietary association in this study; participants consuming these foods five or more days per week had nearly six times the odds of prediabetes compared to those consuming less frequently (adjusted OR: 5.87, CI: 2.76–12.51, $p = 0.001$). These findings support work by de Souza et al. (2015), which demonstrated that diets rich in trans and saturated fats impair insulin signaling pathways. However, some oils (e.g., omega-3-rich or unsaturated vegetable oils) may confer a protective effect, suggesting the need for disaggregated analysis of fat types in future work (Bradley, 2018).

Interestingly, frequent consumption of legumes and nuts (≥ 5 days/week) was also significantly associated with prediabetes (adjusted OR: 2.45, CI: 1.23–6.11, $p = 0.045$), contradicting several studies that portray these foods as protective. Marta et al. (2017) and Nerea et al. (2018) highlight their beneficial effects on glycemic control via fiber and unsaturated fats. However, in this study, local preparation methods involving palm oil, large portion sizes, and combinations with high-carbohydrate staples may attenuate their health benefits, reflecting the complexity of contextual dietary patterns.

Increased consumption of confectionaries was significantly associated with prediabetes (adjusted OR: 2.25, CI: 1.19–5.23, $p = 0.019$). These foods, typically high in refined sugars and low in fiber or protein, are known to contribute to metabolic dysregulation through their effects on weight gain, insulin spikes, and increased fat storage (Khan & Sievenpiper, 2016; O'Connor et al., 2018).

5.6 Association of BMI and blood pressure with prediabetes

This study found a strong association between elevated body mass index (BMI) and prediabetes. Participants with a BMI above 25 kg/m² were significantly more likely to be prediabetic than those with a BMI below 25 (adjusted OR: 4.55, 95% CI: 2.12–18.11, $p < 0.001$). This aligns with findings from Nayak et al. (2018), where increased BMI was linked to insulin resistance and subsequent glucose intolerance. As adiposity increases, the resulting inflammatory state and altered adipokine profile are known to disrupt glucose metabolism, thereby elevating diabetes risk.

Blood pressure also demonstrated significant associations with prediabetes after adjustment for confounding variables. Participants with elevated blood pressure had a higher likelihood of prediabetes (adjusted OR: 4.51, 95% CI: 1.14–22.12, $p = 0.032$). Stage 1 hypertension and stage 2 hypertension showed adjusted odds ratios of 6.74 (95% CI: 1.50–30.29, $p = 0.015$) and 2.77 (95% CI: 1.04–7.39, $p = 0.038$), respectively. These findings are supported by literature suggesting that elevated systolic and diastolic pressure may contribute to vascular inflammation and endothelial dysfunction, which impair insulin sensitivity (Wei et al., 2011). Notably, this relationship appears particularly pronounced among African populations, possibly due to compounded cardiometabolic risk.

Elevated mean arterial pressure (MAP) further confirmed this association. Participants with high MAP levels had an adjusted OR of 4.21 (95% CI: 1.50–11.81, $p = 0.006$), indicating a substantial risk increase. Mechanistically, high MAP may reflect sustained arterial stiffness and sympathetic over activity, which contribute to impaired glucose transport and increased hepatic glucose output. These results echo findings from the Isfahan Diabetes Prevention Study

and Guo et al. (2020), which reported similar links between elevated MAP and the development of type 2 diabetes mellitus.



5.7 Limitations and Strengths of the study

The findings of this study were presented with the following limitations:

1. The use of the 7-day food frequency questionnaire may lead to recall bias which can lead to inaccuracies if the memory of participants is faulty.
2. The use of the 7-day food frequency questionnaire does not always correlate accurately with the quantity of food consumed.
3. Due to social desirability bias, underreporting of behaviours like smoking and drinking may be experienced due to perceived social norms, stigma, or fear of judgment.
4. Being a cross-sectional study, causality of the prediabetic condition cannot be determined due to data being captured at a single point in time making it difficult to establish causal relationships between exposure and outcome.

In spite of these limitations, the study demonstrated several methodological strengths:

1. Validated tools such as the Perceived Stress Scale (PSS), Food Frequency Questionnaire (FFQ), and International Physical Activity Questionnaire (IPAQ) were used, ensuring data quality and comparability with other studies.
2. Data collection covered five distinct urban communities in Accra, offering contextual diversity and increasing the relevance of the findings for urban Ghanaian populations.
3. Anthropometric and clinical measures were conducted using WHO standardized protocols, enhancing measurement accuracy and reliability.
4. Pretesting of tools and thorough training of field assistants ensured consistency in data collection procedures and reduced measurement errors.

5. Logistic regression analysis was applied, with key confounders such as age, sex, and marital status statistically adjusted for, thereby improving the internal validity of observed associations.



6.0 CONCLUSION AND RECOMMENDATIONS

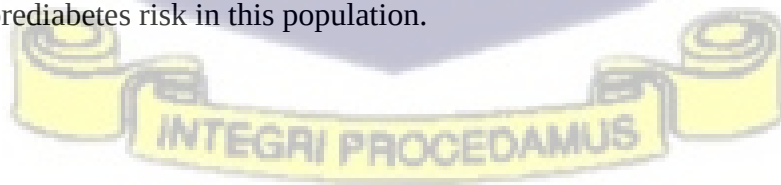
6.1 Conclusion

The present study explored the prevalence of prediabetes and its associated risk factors among adults in selected communities in Accra, yielding findings with important public health implications.

Objective 1: The prevalence of prediabetes and diabetes among the sampled adult population was found to be 26.7% and 29.4%, respectively. These figures are significantly high and point to a dual burden of undiagnosed hyperglycemic conditions in urban Ghana.

Objective 2: A number of behavioral, dietary, and sociodemographic risk factors were significantly associated with prediabetes. These include female sex, middle age (40–59 years), and being single. Lifestyle-related predictors such as high salt intake, caffeine use, smoking, low physical activity, and stress were found to increase the odds of prediabetes. In terms of diet, increased consumption of starchy foods, animal-sourced foods, legumes, fats and oils, and confectionaries were positively associated with the condition.

Objective 3: The study also demonstrated that individuals with BMI above 25 kg/m² and elevated mean arterial pressure or stage 1 hypertension had significantly higher odds of developing prediabetes. These anthropometric and clinical indicators underscore the metabolic dimensions of prediabetes risk in this population.



6.2 Recommendations

6.2.1 Health

The findings from this study underscore the need for multi-level interventions that are both context-specific and evidence-informed. The high prevalence of prediabetes (26.7%) and diabetes (29.4%) among the study population warrants the urgent incorporation of routine community-based glucose screening into existing primary healthcare delivery systems. Particular attention must be paid to individuals aged 40 to 59 years, a group found to be at significantly elevated risk, as well as to women, who constituted a disproportionate share of those with prediabetes. Integrating blood pressure and BMI assessments alongside glucose testing could improve early detection and management, especially given the strong associations observed between prediabetes, elevated BMI, and stage 1 hypertension.

6.2.2 Individual

The behavioral and lifestyle factors identified such as high salt intake, smoking, caffeine consumption, low physical activity levels, and high perceived stress highlight the need for sustained public health education and targeted behaviour change interventions. Health promotion campaigns should move beyond general messaging and instead focus on culturally relevant content that speaks directly to these modifiable risk factors. Nutrition education should emphasize reducing the intake of salt, stimulants, and energy-dense foods such as fats, oils, starchy staples, animal-sourced foods, legumes, and confectionaries, all of which were associated with increased odds of prediabetes. In parallel, community-led mental health interventions and initiatives that promote moderate to vigorous physical activity especially among women and single individuals could mitigate stress-related and sedentary lifestyle risks.

6.2.3 Research and Policy

At the policy level, there is a pressing need for national guidelines that address prediabetes prevention and management in urban Ghana. Such guidelines should consider both biomedical

indicators and sociobehavioral determinants. The significant association between single marital status and prediabetes suggests a deeper, possibly psychosocial dimension to disease risk that warrants further qualitative inquiry. Future studies should therefore aim to understand the mechanisms through which marital status, stress, and dietary habits intersect to influence glycemic outcomes. Moreover, longitudinal research would strengthen the causal interpretation of these risk factors and inform more targeted interventions. Taken together, these recommendations reflect an urgent call to action that aligns closely with the data-driven insights from this study and the growing burden of non-communicable diseases in Ghana.



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APPENDICES

Appendix 1. Supplementary results

Seven day food frequency of food groups among participants

Food groups	Frequency							
	Everyday	6/week	5/week	4/week	3/week	2/week	1/week	Never
n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Whole grains and tubers	183 (50.8)	25 (6.9)	22 (6.1)	58 (16.1)	36 (10)	36 (10)	0 (0)	0 (0)
Vegetables	259 (71.9)	25 (6.9)	12 (3.3)	15 (4.2)	24 (6.7)	17 (4.7)	7 (1.9)	1 (0.3)
Fruits	72 (20)	29 (8.1)	33 (9.2)	64 (17.8)	89 (24.7)	26 (7.2)	26 (7.2)	21 (5.8)
Animal sourced foods	143 (39.7)	40 (11.1)	58 (16.1)	28 (7.8)	62 (17.2)	24 (6.7)	2 (0.6)	3 (0.8)
Legumes and nuts	28 (7.8)	18 (5)	57 (15.8)	55 (15.3)	36 (10)	75 (20.8)	34 (9.4)	57 (15.8)
Healthy fats and oils	64 (17.8)	15 (4.2)	42 (11.7)	66 (18.3)	68 (18.9)	60 (16.7)	16 (4.4)	29 (8.1)
Confectionaries	0 (0)	0 (0)	0 (0)	10 (2.8)	23 (6.4)	9 (2.5)	15 (4.2)	303 (84.2)

Appendix 2. Letters

University of Ghana Hospital permission letter

 **UNIVERSITY OF GHANA**

DEPARTMENT OF NUTRITION AND FOOD SCIENCE
SCHOOL OF BIOLOGICAL SCIENCES
COLLEGE OF BASIC AND APPLIED SCIENCES

NFS/AC.4

October 26, 2023

The Administrator
University of Ghana Hospital
P. O. Box LG 25
Legon - Accra

Dear Sir/Madam,

LETTER OF INTRODUCTION:
KWEKU BROBBEY AKYEA-BOAKYE (ID: 11007259-0559333541)

I write to introduce the above-named second year M.Phil. student in the Department of Nutrition and Food Science, University of Ghana.

Kweku Brobbey Akyea-Boakye is conducting his thesis research under the supervision of Dr. Frederick Vuvor and Dr. Justina Owusu on the project titled: **"Assessing the Prevalence of Prebiabetes and its Risk Factors among Adults in Accra"**.

Kweku Brobbey Akyea-Boakye would like to request your permission to recruit study participants in your Hospital.

Thank you for your kind assistance.

Yours faithfully,


Prof. Seth Adu-Afarwuah
(Head of Department)



P. O. Box LG 134, Legon, Accra, Ghana | Tel: +233 (0) 303 965 367
Email: nfs@ug.edu.gh | Website: www.ug.edu.gh

 **UG**

Pentecost Hospital permission letter

 **UNIVERSITY OF GHANA**

DEPARTMENT OF NUTRITION AND FOOD SCIENCE
SCHOOL OF BIOLOGICAL SCIENCES
COLLEGE OF BASIC AND APPLIED SCIENCES

NFS/AC.4

October 26, 2023

The Administrator
Pentecost Hospital
P.O. Box 20790
Halogen St, Madina

Dear Sir/Madam,

LETTER OF INTRODUCTION:
KWEKU BROBBEY AKYEA-BOAKYE (ID: 11007259-0559333541)

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Kweku Brobbey Akyea-Boakye would like to request your permission to recruit study participants in your Hospital.

Thank you for your kind assistance.

Yours faithfully,


Prof. Seth Adu-Afarwuah
(Head of Department)

Request to be Service Coordinator

RECEIVED
10 NOV 2023
P.O. BOX OF 20790, ACCRA

INTEGRITY PROCEDAM

RECEIVED
17 NOV 2023
DIRECTOR
SIGNATURE
APS DR EDWARD A. KORANTENG

P. O. Box LG 134, Legon, Accra, Ghana | Tel: +233 (0) 303 965 367
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 **UG**

Department ethical request letter



**UNIVERSITY
OF GHANA**

DEPARTMENT OF NUTRITION AND FOOD SCIENCE
SCHOOL OF BIOLOGICAL SCIENCES
COLLEGE OF BASIC AND APPLIED SCIENCES

NFS/C.3.2

December 4, 2023

The Chairperson
Ghana Health Service Ethics Review Committee
Research and Development Division
P. O. Box MB190
Accra

Dear Sir/Madam,

APPLICATION FOR ETHICAL CLEARANCE:
MR. KWEKU BROBBEY AKYEA-BOAKYE (INDEX NO.11007259)

Mr. Kweku Brobbey Akyea-Boakye is an MPhil student in the Department of Nutrition and Food Science who is seeking ethics approval for his study. Mr. Kweku Brobbey Akyea-Boakye is working under the supervision of Dr. Frederick Vuvor and Dr. Justina Owusu on his project titled **"Prediabetes/Diabetes and Its Risk Factors among Adults in Selected Communities in Accra"**. Mr. Brobbey's proposal and other supporting documents have been reviewed and approved by his supervisor. The School of Biological Sciences has approved their topic and research area.

Thank you for your assistance.

Yours faithfully,

Prof. Seth Adu-Afarwaah
(Head of Department)

INTEGRI PROCEDAMUS

Main supervisor support letter



**UNIVERSITY
OF GHANA**

SCHOOL OF BIOLOGICAL SCIENCE

DEPARTMENT OF NUTRITION AND FOOD SCIENCE
COLLEGE OF BASIC AND APPLIED SCIENCE

Department of NFS
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21st November, 2023.

The Chairperson
Ghana Health Service Ethics Review Committee
Research and Development Division
P. O. Box MB190
Accra

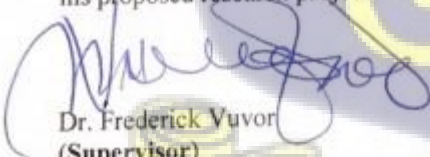
Dear Sir/Madam,

LETTER OF SUPPORT

I write to express my full support for the ethical clearance application submitted by Kweku Brobbey Akyea-Boakye, (a second-year MPhil student in the Department of Nutrition and Food Science, University of Ghana, Legon).

The proposed study is titled "Prevalence of prediabetes/diabetes and its risk factors among adults in selected communities in Accra,".

I, and the Department would be grateful for your assistance to grant him the ethical clearance for this study. I would be ready to provide any further information or clarification regarding his proposed research project.


Dr. Frederick Vuvor
(Supervisor)

INTEGRI PROCEDAMUS

Co-supervisor support letter



**UNIVERSITY
OF GHANA**

DEPARTMENT OF NUTRITION AND FOOD SCIENCE

SCHOOL OF BIOLOGICAL SCIENCES

COLLEGE OF BASIC AND APPLIED SCIENCES

NFS/C.3.2

December 11, 2023

The Chairperson
Ghana Health Service Ethics Review Committee
Research and Development Division
P. O. Box MB190
Accra

Dear Sir/Madam,

LETTER OF SUPPORT: KWEKU BROBBEY AKYEA-BOAKYE

I am writing to express my full support for Kweku Brobbey Akyea-Boakye research project titled "Prevalence of Prediabetes/Diabetes and Its Risk Factors Among Adults in Selected Communities in Accra". Kweku's project aims to investigate the prevalence of prediabetes and diabetes, as well as associated risk factors, among adults in selected communities in Accra.

Kweku has demonstrated a strong commitment to ethical research practices. He has ensured that the research design respects the rights and dignity of the participants. I will ensure that Kweku abides by the ethics procedure specified.

I kindly request that you grant the necessary ethical clearance for this project. Thank you for considering this request. I am confident that Kweku's research will make a significant contribution to our understanding of prediabetes and diabetes in Accra.

Sincerely,

Justina Serwaah Owusu, PhD, (RDN)



Appendix 3. Ethical approval and consent form

Ghana Health Service Ethics Approval

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.



My Ref. GHS/RDD/ERC/Admin/App /24 /019
Your Ref. No.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Digital Address: GA-050-3303
Mob: +233-50-3539896
Tel: +233-302-960628
Email: ethics.research@ghs.gov.gh
30th January 2024

Kweku Brobbey Akyea-Boakye
University of Ghana
School of Biology Sciences
Legon

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC: 031/12/23
Study Title	Prevalence of prediabetes/diabetes and its risk factors among adults in selected communities in the Accra metropolis.
Approval Date	30 th January, 2024
Expiry Date	29 th January, 2025
GHS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

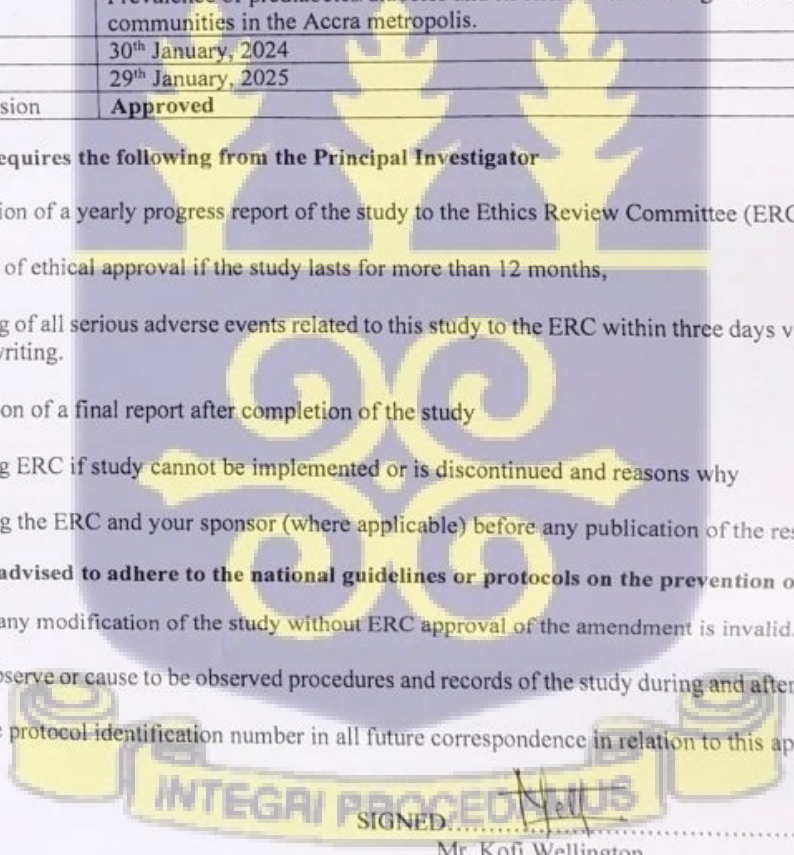
- Submission of a yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

You are kindly advised to adhere to the national guidelines or protocols on the prevention of COVID -19

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol



SIGNED.....
Mr. Kofi Wellington
(GHS ERC Chairperson)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

College of Basic and Applied Science Ethics Approval



UNIVERSITY OF GHANA

ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES (ECBAS)

P. O. Box LG 1195, Legon, Accra, Ghana

Ref. No: ECBAS 021/23-24

1st March, 2024

Kweku Brobbey Akyea-Boakye
Department of Nutrition and Food Science
University of Ghana
Legon, Accra

Dear Mr. Akyea-Boakye,

ECBAS 021/23-24: THE PREVALENCE OF PREDIABETES/DIABETES AND ITS RISK FACTORS AMONG ADULTS IN SOME COMMUNITIES IN ACCRA

This is to inform you that the above referenced study has been presented to the Ethics Committee for Basic and Applied Sciences for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date: 21/01/2025
On Agenda for: Initial Submission
Date of Submission: 22/11/2023
ECBAS Action: Approved
Reporting: Annually

Please accept my congratulations.

Yours sincerely,

Professor Doreas Osei-Safo
ECBAS Chairperson



PARTICIPANT'S INFORMATION SHEET

Title of study: Prevalence of prediabetes/diabetes and its risk factors among adults in selected communities in Accra

Introduction

My name is Kweku Brobbey Akyea-Boakye, second year MPhil student reading Nutrition at the Nutrition and Food Science Department in University of Ghana. To contact me my details are as follows (+233) 55 933 3541, kbakeaboakye@gmail.com and postal address of GM-077-9643.

Background and Purpose of Study

We are interested in learning about the prevalence prediabetes/diabetes and its risk factors in Accra. If you agree to participate in this study, we will ask you questions about your background, eating habits and lifestyle and also measure your blood pressure and blood sugar.

Nature of research

I am interested in finding the prevalence of prediabetes and diabetes in adults residing in Accra and also identify associated risk factors to the condition. This study would include data collection on 360 adults.

Participants Involvement

- **Duration/ what is involved:** A questionnaire would be used to ask you questions about your background, eating habits and lifestyle and also blood pressure, body measurements and blood sugar would be taken. This would only happen one time and would take 20 minutes long.
- **Potential risks:** Minimum risk is associated with participating in this study due to pricking the finger to measure blood sugar.
- **Benefits:** You will benefit from increased awareness and education about prediabetes, a condition that often goes undiagnosed. The study offers you free prediabetes screenings, including blood glucose and blood pressure testing.
- **Costs:** No cost would be incurred by you for this study.
- **Compensation:** A bottle of malt would be made available for participating in this study for your time.
- **Confidentiality:** All information you provide will be confidential. All your records will be kept safe and none of the information will identify you by your name. The information provided will only be used for academic purposes. Only the supervisors and student investigator will have access to research records.
- **Voluntary participation/Withdrawal:** Your participation is voluntary and you can withdraw at any point in time without any penalty and you will not be adversely affected if you decline to be a part of the study.
- **Outcome and Feedback:** Data collected would be used to determine the prevalence of prediabetes/diabetes and its risk factors and feedback would be made available through the contact information provided if participants are interested.
- **Funding information:** This study is self-funded by the principal investigator.
- **Sharing of participants information/data:** Data collected would be collected and protected by the principal investigator and is only shared with supervisors of the study.

- **Provision of Information and Consent for participants:** Participants would be given copies of the information sheet and consent form when signed or thumb printed to keep.
- **Who to Contact for Further Clarification/Question:** If there are any issues you might need clarification on in terms of your rights as a participant, you can contact my supervisors Dr. Frederick Vuvor and Dr. Justina Serwaah Owusu at fvuvor@ug.edu.gh or 024460834 and justinaserwaahowusu@gmail.com or 0547952307.

If you have any issues with your rights as a participant for this study you can contact Ghana Health Service Ethics Review Committee

Nana Abena Apatu

0503539896

ethics.research@ghs.gov.gh



CONSENT FORM

STUDY TITLE: Prevalence of prediabetes/diabetes and its risk factors among adults in selected communities in Accra.

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the purpose and contents of the Participants' Information Sheet read and all questions satisfactorily explained to me in a language I understand. I fully understand the contents and any potential implications as well as my right to change my mind even after I have signed this form.

I voluntarily agree to be part of this research.

Name of Participant.....

Participants' SignatureOR Thumb Print.....

Date:.....

INTERPRETERS' STATEMENT

I interpreted the purpose and contents of the Participants' Information Sheet to the afore named participant to the best of my ability in the language to his proper understanding. All questions, appropriate clarifications sort by the participant and answers were also duly interpreted to his/her satisfaction.

Name of Interpreter.....

Signature of Interpreter..... OR Thumb Print

Date:.....

STATEMENT OF WITNESS

I was present when the purpose and contents of the Participant Information Sheet was read and explained satisfactorily to the participant in the language he/she understood I confirm that he/she was given the opportunity to ask questions/seek clarifications and same were duly answered to his/her satisfaction before voluntarily agreeing to be part of the research.

Name:.....

Signature..... OR Thumb Print

Date:.....

INVESTIGATOR STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study. All questions and clarifications raised by the participant have been addressed.

Researcher's name.....

Signature

Date.....



Appendix 4. Questionnaire

University of Ghana
Department of Nutrition and Food Science

Respondent ID.....

Study site:

Date:

Title: A study to assess the prevalence of prediabetes and its risk factors among adults in selected communities in Accra, Ghana

The following questions are going to be based on your background information to give us an idea of the kind of factors that influence your daily living.

SECTION A: BACKGROUND SOCIO-DEMOGRAPHIC DATA.

1. What is your age? -----
2. Where do you live? -----
3. Which ethnic group do you belong to?-----
4. What is your religious affiliation?.....
5. What is the highest level of education you have completed?-----
6. What is your marital status? 1=Married ☐ 2=Single ☐
7. What is your monthly household income?
1=0-1000GHS[☐] 2=1001-2000GHS[☐] 3=2001-3000GHS[☐] 4=3001-4000GHS[☐]
5=4001-5000GHS[☐] 6=5001GHS+[☐]

SECTION B: BEHAVIORAL AND LIFESTYLE DATA

*This section covers the way at which you go about in eating food, determining your eating patterns and eating habits. It also looks at various aspects of lifestyle and behavioral choices that you take part in . **Record the answers accordingly to what the respondent states.***

8. How many times do you eat meals in a day?.....
9. Is salt included in your meals? 1 = Yes ☐ 2 = ☐
10. How often do you consume salt in your meals?
1= Daily ☐ 2= Weekly ☐ 3= Monthly ☐ 4= Rarely ☐
11. Do you ever take snacks? 1=Yes ☐ 2=No ☐
If Yes, how often do you take snacks apart from regular meals in a day?
12. What do you mostly consume as a snack?
1=Pastries ☐ 2=Fruit juices ☐ 3=Fruits/vegetables ☐ 4=Sweets ☐ 5=Fried Foods ☐ 6= Other (specify).....
13. Do you drink alcohol? 1=Yes ☐ 2=No ☐
If yes, what type of alcoholic beverage do you commonly consume?

14. How often do you consume alcohol?
1= Daily ☐ 2= Weekly ☐ 3= Monthly ☐ 4= Rarely ☐
15. How many bottles or cups of alcohol do you consume averagely?.....
16. Do you often drink coffee/cafeinated beverages? 1=Yes ☐ 2=No ☐
If Yes, do you drink them daily, weekly or monthly?
17. Is your daily diet mainly consisted of starchy foods (e.g., yams, rice, banku, etc.)?
18. Is your daily diet mainly consisted of lot of oil infused cooked products (e.g., fried plantain, fried fish, fried egg, palm nut soup, etc.)
19. Do you smoke cigarettes? 1=Yes ☐ 2=No ☐
If yes, how many sticks of cigarette do you smoke per day?
20. How long do you usually sleep at night?
21. What time do you usually wake up first from bed? 1= Before 5am ☐
2=5am-6am ☐ 3= After 6am ☐

SECTION C: STRESS ASSESSMENT

For each question choose from the following alternatives

0 - never 1 - almost never 2 – sometimes 3 - fairly often 4- very often

22. In the last month, how often have you been upset because of something that happened unexpectedly?
23. In the last month, how often have you felt that you were unable to control the important things in your life?
24. In the last month, how often have you felt nervous and stressed?
25. In the last month, how often have you felt confident about your ability to handle your personal problems?
26. In the last month, how often have you felt that things were going your way?
27. In the last month, how often have you found that you could not cope with all the things that you had to do?
28. In the last month, how often have you been able to control irritations in your life?
29. In the last month, how often have you felt that you were on top of things?
30. In the last month, how often have you been angered because of things that happened that were outside of your control?

31. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Dietary Intake Recall

* Write in the corresponding box the number of times at the various food groups were consumed.

FOOD GROUPS	Examples	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
STARCHY FOODS	Corn/maize, rice, wheat, Cassava, yam							
VEGETABLES	Carrot, tomatoes, onions, green pepper							
FRUITS	Mango, papaya, blueberries, oranges, banana, water melon, pineapples, apples, tangerine							
ANIMAL SOURCED FOODS	Beef, pork, eggs, fish, chicken							
LEGUMES AND SEEDS	Beans, peas, nuts, seeds, groundnuts, groundnut paste, sesame seeds							
CONFECTIONARIES	Sweets							

SECTION D: PHYSICAL ACTIVITY

I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer even if you do not consider yourself a physically active person. Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

32. During the last 7 days, on how many days did you do vigorous physical activities like Jogging/Running, Carrying heavy loads, etc.

..... days per week.

No vigorous physical activity, skip to question 34 []

33. How much time did you spend doing vigorous physical activities on one of those days?

..... Minutes per day.

Don't Know/Not Sure ☐

*Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.*

34. During the last 7 days, on how many days per week do you engage in moderate physical activities like carrying light loads, Brisk Walking, Housework and Domestic Chores.

Does not include walking.

..... days per week.

No moderate physical activity, skip to question 36 ☐

35. How much time did you spend doing those moderate physical activities on one of those days?

..... Minutes per day

Don't Know/Not Sure ☐

36. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

..... Days per week.

No walking, skip to question 40 ☐

37. How much time did you spend walking on one of those days?

..... Minutes per day.

Don't Know/Not Sure ☐

38. During the last 7 days, how much time did you spend sitting on a week day? This includes time spent while selling

..... Minutes per day

Don't Know/Not Sure ☐

39. Does your current occupation involve much physical activity? Example walking, lifting. 1=Yes ☐ 2=No ☐

40. How many hours per/day do you spend at work?

SECTION E: BIOLOGICAL AND CLINICAL DATA

This section covers your family history with key non-communicable diseases and also takes in clinical measurements from the participant.

41. Does your immediate family (parents, siblings) have a history of any of the following conditions?

1= Hypertension ☐

2= Diabetes ☐

3= Heart disease ☐

4=

Cancer ☐

Measurement	1 st Reading	2 nd Reading	Average
Blood pressure (mmHg)			
Weight (kg)			
Height (m)			
Blood sugar (mmol/L)			

Thank you for participating in this study.

