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Prevalence of Undiagnosed Diabetic Mellitus and Associated Risk Factors among Adults in Arba Minch City, Southern Ethiopia

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This is to certify that the thesis prepared by **Woshke Worade** (BSC): entitled Prevalence of Undiagnosed Diabetic Mellitus and Associated Risk Factors among Adults in Arba Minch City, Southern Ethiopia, and submitted in partial fulfillment of the requirements for the degree of Master of Science in Clinical Laboratory Sciences (Clinical Chemistry Speciality) complies with the regulations of the University and meets the accepted standards concerning originality and quality.

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Acronyms/Abbreviations

ADA	American Diabetic Association
ARHB	Amhara Regional Health Bureau.
BMI	Body-mass index
CHD	Coronary heart disease
DAG	Diacylglycerol
DM	Diabetes Mellitus
DR3	Death Receptor 3
DR4	Death Receptor 4
FFA	Free fatty acids
FBS	Fasting blood sugar
HLA	Human Leukocyte Antigen
IDF	International Diabetes Federation
IDDM	Insulin-dependent Diabetes Mellitus
LPL	Lipoprotein lipase
NIDDM	Non-Insulin-Dependent Diabetes Mellitus
NCD	Non-communicable disease
PAD	Peripheral arterial disease
RBS	Random blood sugar
SPSS	Statistical Package for Social Sciences
TCA	Tricarboxylic acid
UTI	Urinary tract infection
UDM	Undiagnosed diabetic mellitus
WHO	World Health Organization

Abstracts:

Background: Among the recognized increasing public health issues in growing nations is diabetes mellitus. Undiagnosed Diabetes Mellitus imposes significant consequences because patients are left untreated and face potential difficulties.

Objective: To assess the prevalence of undiagnosed Diabetes Mellitus and associated risk factors among adults in Arba Minch City, southern Ethiopia.

Materials and method: In this study, a community-based cross-sectional study was conducted among 484 individuals in Arba Minch city Gamo zone, Southern Ethiopia from **July 8, 2023, to Dec 9, 2024.** A standardized questionnaire was administered through a trained interviewer- to gather sociodemographic data and followed collections of anthropometric measurements from each study participant. Early morning (following 8 hours or more of fasting) blood samples were collected to measure the fasting blood glucose (FBG) level. FBS was determined by enzymatic method (glucose oxidase and ferricyanide) using VivaChek ™ Ino Blood Glucometer. To determine the predictors of undiagnosed diabetes mellitus, a multivariable logistic regression model was built. The strength of relationships was evaluated by calculating the 95% confidence interval (CI) for the adjusted odds ratio (AOR).

Result: The overall prevalence of undiagnosed DM in the study was 52(11.4% 95% CI: 8.6-14.7%).Though not statistically significant undiagnosed DM was higher in males (15.9% vs. 6.7%, P>0.05). Increased occurrence of undiagnosed DM was observed with increasing age but again not statistically significant (P>0.05). Multivariate analysis of logistic regression showed undiagnosed DM was highly associated (P<0.05) along with cigarette smoking status, alcohol consumption, poor knowledge of DM, body mass index, and history of hypertension. Predictors for undiagnosed DM in the study were smoke cigarette status(p=<0.001, OR: 4.44 95% CI: 2.08-9.48), poor knowledge on DM (P=0.001, OR:3.97 95%CI:1.74-9.06), alcohol consumption(p=0.011, OR: 2.54 95% CI: 1.24-5.22), history of hypertension (p=0.006, OR: 2.73 95% CI: 1.34-5.54) and overweight/BMI (p=0.042, OR:2.13 95%CI: 1.03-4.43).

Conclusion and recommendation : In general higher percentage of undiagnosed diabetes mellitus was noted in the current study and this call to strengthen the findings further large-scale study is recommended. Programs for urban health extension will focus on helping households adopt healthy eating and exercise habits that can lead to weight loss.

Key words: Undiagnosed Diabetes mellitus, prevalence, risk factors, fasting blood glucose test

Introduction

1.1 Background

Diabetic mellitus is an endocrine and chronic metabolic disease marked by insufficiencies in the hormone insulin released by pancreatic beta cells, either in its action or secretion (1). The etiology of diabetes mellitus is not defined; however, both environmental and genetic factors have been linked to the growth of it. Destroying the Langerhans islets of the pancreascells is known to be triggered by multiple factors, which include environmental factors like genetic variables and rubella infection like inheritance of Human Leukocyte Antigen – Death Receptor 3 and 4 (HLA-DR3 and DR4) genes. however, environmental factors like poor eating patterns and inactive lifestyles are known to influence the progression of the disease(2). Undiagnosed diabetes mellitus is individuals who did not know about their diabetes status but had elevated blood glucose levels during fasting (≥126 mg/dl).

The earliest classification by WHO divided the illness into two main groups: Insulin-dependent diabetes mellitus and type 1 diabetes (75% of cells disappear, leading to almost absolute insulin deficiency) and Type 2 Diabetes, also known as non-insulin-dependent Diabetes Mellitus. It is caused by insulin insufficiency as a result of pancreatic -cell secretory defects, insulin resistance in peripheral tissues, or receptors which result in insufficient glucose absorption into tissues (2).

Diabetes mellitus is a group of biochemical metabolic disorders/errors of carbohydrate (especially glucose), lipid, and protein metabolism) and regulation errors. hyperglycemia, a condition related to the metabolism of carbohydrates that is typically caused by either insufficient insulin production (type 1 diabetes) or an inefficient cell response to insulin (type 2 diabetes)(3).

Diabetes mellitus, has multiple causes that contribute to the onset of diabetes, none of which is now understood to be the only cause. These range from anomalies to autoimmune-mediated pancreatic damage beta cells, which leads to insulin insufficiency. Nowadays, a combination of biological, social, and economic factors such as increased physical inactivity, bad lifestyle choices, Genetic factors, obesity, dyslipidemia, and advanced age all play a major function in the growth of diabetes mellitus in the majority of population groups (4).

Rapid socio-economic development, urbanization, and associated lifestyle changes including a shift in eating habits have increasingly contributed to the disease (2). There is a correlation between

body mass index (BMI), family history, education level, and a history of other chronic conditions and undiagnosed diabetes mellitus (DM)(5). additionally, low health-seeking behavior, lack of regular health check-ups, also contributed to undiagnosed diabetes

Symptoms and signs of diabetes mellitus can be divided into three main categories namely (i) those related to the expression of physical symptoms e.g. polydipsia (increased thirst and consequently increased fluid intake), polyuria (Frequent urination), glycosuria (glucose in urine), polyphagia (extreme hunger or increased appetite). (ii) those arising from specific long-term lesions of diabetes mellitus e.g. microangiopathy, particularly in the eye known as retinopathy (sudden vision changes), in the kidney referred to as nephropathy, and in the nerves which show a tingling sensation or numbness in the hands or feet a condition called neuropathy (iii) those resulting from acceleration of increased predisposition to disease processes, example. atherosclerosis, frequent or recurrent skin and urinary tract infection (6).

Most of the morbidity and mortality linked to diabetes are caused by complications that impact several organ systems. These problems are divided into two categories: macrovascular (coronary heart disease, or CHD) and microvascular (retinopathy, neuropathy, and nephropathy)(6), cerebrovascular illness, as well as nonvascular consequences such as periodontal disease, hearing loss, and infections (PTB and UTI)(7).

There are Different laboratory diagnostic approaches to diagnose diabetic mellitus. By measuring the amounts of glucose or glycosylated hemoglobin in a blood sample in a lab, diabetes mellitus is diagnosed. During the test of oral glucose tolerance, it can be identified as either random blood sugar (RBS) concentration > 11.1 mmol > (200 mg/dl), fasting blood glucose (FBG) >7 mmol< (126 mg/dl), or 2-hour plasma glucose >11.1 mmol < (200 mg/d)(4).

1.2. Statement of the Problem

An international epidemic impacting people of all ages, in all nations, and on a worldwide basis, diabetes mellitus is among the most urgent public health concerns of the twenty-first century. With an estimated 6.7 million deaths worldwide in 2021, diabetes was rank among the top ten causes of death (8). In 2019, diabetes affects over 15.8% (20.4 million) of live births during pregnancy. Moreover, this fatal illness reduces life expectancy by 30% (9). The other study on morbidity and mortality of DM in the world, In 2014, 387 million individuals worldwide were estimated to have diabetes, and the disease was linked to 5.1 million fatalities(10).

In Africa morbidity and mortality of DM, in 2016, Diabetes had a lower prevalence (3%) in Sub-Sahara Africa, compared to the worldwide frequency of 8.5%. But the percentage of undiagnosed in Africa (67%) is nearly twice as high as the percentage in industrialized nations(37%) (11), which adds to the region's rising rates of illness and death.

In the past few years, Ethiopia has experienced rapid socio-economic development, along with increased urbanization and shifts in lifestyle and dietary structure. These changes are increasingly contributing to the prevalence of diabetes. The increasing magnitude of diabetes and related health complications will threaten the economy of the country through, for example, Direct medical costs as well as loss income and productivity. With limited infrastructure for diabetes care, Ethiopia is ill-equipped to handle this disease (12). In Ethiopia morbidity and mortality of DM, In Ethiopia in 2021, a systemic and meta-analysis study revealed that the combined prevalence of diabetes mellitus was 6.5%(13) According to the 2017 IDF, the amount of people with diabetes mellitusindividuals aged 18 to 99 years was 4.8%, and 31,536 people died as a result of the disease (14).

Globally a large Cross-sectional studies was conducted on the prevalence of undiagnosed DM and associated complications in Denmark indicated 35% of undiagnosed participants had complications at the time of diagnosis, of whom 12% had microvascular, 17% had macrovascular disease, and 6% had micro- and macrovascular complications (15). Among those who have microvascular complications, the most frequent was retinopathy (13%), followed by neuropathy (4%) and nephropathy (3%). The most frequent macrovascular consequence observed was ischemic heart disease (15%), which was followed by peripheral arterial disease (2%) and atherosclerotic cerebrovascular disease (5%). Due to variations in economic, social, and genetic

inequalities, the prevalence of undiagnosed diabetes mellitus varies among African nations. The previous study conducted on the magnitude of previosly undetected diabetes mellitus and risk factors inNorth Africa ranged from 18% to 75% of all diabetes cases (16) and For retinopathy, albuminuria, nephropathy, and neuropathy, the prevalence of long-term, undetected diabetic sequelae ranged from 8.1% to 41.5%, 21% to 22%, and 6.7% to 46.3%, respectively. Furthermore, the magnitude of previosly UDM in multiple African sites was shown to be as follows: Tanzania has 9%(17), 7.2% in Ethiopia 5.97% in North Sudan (18). The highest amount of undiagnosed diabetic mellitus were found in Africa, which accounts more than half (54%) (8). In developed nations, 37% of people have diabetes without a diagnosis. But compared to developed nations, the magnityde of previosly undiagnosed diabetes in Africa (67%) is nearly twice as high(11), which adds to the region's rising rates of morbidity and mortality. Overall risk factors are more related to age above 40 and educational levels (non-educated) and related to severe complications.

A study conducted on A comprehensive examination of risk factors and prevalence, and complications of undiagnosed Diabetes mellitus in Ethiopia concluded that the review result indicates that the range of diabetes prevalence in Ethiopia was 2.0% to 6.5%. of this, the most frequent complications linked to an undiagnosed diabetes mellitus are retinopathy (2.7%–25%), neuropathy (4.8%–35.0%), depression (13.0%–61.0%), kidney diseases (18.2%–23.8%), hypertension (23.0%–54.82%), anemia (19.0%) (19).

The research gap I have observed is that most studies in Ethiopia were institution-based cross-sectional and community-based cross-sectional studies but 80% of studies considered adults age 35 and above. Diabetic mellitus is a global epidemic that is impacting all ages, all economic conditions, and everywhere in the world. However, this study considered adults aged 18 and above years. Additionally, the previous literature about the frequency of unidentified diabetes classified the glucose level of study participants into two categories only (i.e. normal and above normal). Hence, they did not report pre-diabetic individuals. Furthermore, existing studies did not assess certain important factors in detail (i.e. knowledge of DM) linked to an undetected DM case but a single question was used to evaluate just the DM symptom. However,present research assess detail about DM(about DM symptom, cause of DM, and prevention and control mechanism of DM). Again different community-based cross-sectional studies conducted on prevalence of undiagnosed

DM and its associated factors measured blood glucose by random blood sugar but this study consider measuring blood glucose level by fasting blood sugar.

1.3 Significance of the study

Diabetes mellitus and its consequences are a principal causes of increase premature of death in the world including Ethiopia (8). By identifying those who are at-risk and launching primary prevention interventions in the study area, it will be possible to stop the diabetes epidemic. This study will be helpful in studying trends in the prevalence and risk factors for the disease because Arbaminch town has eating more fats in their life.

This study will benefit study participants and other stakeholders by increasing population awareness about diabetes mellitus to improve early illness detection and treatment prior to the disease's development to life-threatening complications and Clinicians/Nurses to provide valuable dietary and lifestyle advice to help people at risk of developing type 2 diabetes (especially in community level) to reduce their risk

Again this study is important for community/ people with diabetes to be diagnosed and treated as soon as possible, as high blood sugar levels can damage body organs and tissue. The government took NCDs including DM as a priority and mobilized health professionals to create awareness among the community/people to combat the burden and enhance early diagnosis and treatment onset but the health professionals did not create awareness in the real community so, at that time individuals which are physically inactive and more government servant are excluded from health mobilization.

To fill the aforementioned gaps, I will consider the following issues in my study: (i) considering age 18 and above, (ii) category of undiagnosed DM based on glucose level (normal, pre-diabetic, and diabetic); (iii) knowledge of the risk factors, management, and controls for diabetic mellitus; furthermore (iv) measuring glucose by fasting blood sugar. Thus, the purpose of this research is to evaluate the prevalence of adult undiagnosed diabetes mellitus and related risk factors in Arba Minch City Southern, Ethiopia.

In general, the results of this study will be important for policymakers, Developing successful treatments to prevent and control diabetes, undiagnosed DM, and its risk factors is a task for program managers and researchers. The result of this finding is used as a baseline for feuture study on undiagnosed diabetic mellitus in the Gamo zone, Arba Minch City, southern Ethiopia .

2. Literature Review

2.1. Overview and pathophysiology of diabetic mellitus.

Diabetic mellitus is an endocrine and long-term metabolic illness marked by insufficiencies in the hormone insulin secreted by the beta cells in the pancreas, either in its secretion or its effect (1). Any age may develop type 1 diabetes, however it usually starts in late childhood when the pancreas is unable to release enough insulin. Diabetes type 1 has a strong genetic connection, but most cases are the result of an autoimmune disorder, possibly set off by a viral infection, foreign protein, or environmental toxin. Type 2 diabetes results from insulin resistance and is the most prevalent form of diabetes covering for more than 90-95% of all diabetes cases. If early diagnosing type 2 diabetes can prevent it (7).

in the past decade, the magnitude of diabetes has increased more quickly in middle-class and lower-income nations than in wealthy nations. nowdays, the world magnitude of diabetes mellitus has more than increased by twofold since 1980, increasing 4.7% to 10.5% in 2021 among adults in the population age 20-79(8). Furthermore, the number of individuals living with diabetes rises with age, with a 19.9% prevalence (111.2 million) among those 65 to 79 years old in 2019(9).

2.1.1.Normal pathology of the human body.

The pancreas, an organ situated behind the stomach and liver, secretes digestive enzymes as well as the hormones glucagon and insulin into the bloodstream in healthy individuals to regulate blood glucose levels. Because insulin permits glucose to enter body cells where it is digested, blood glucose levels (simple sugars from diet) are reduced. Too low blood glucose levels cause the pancreas to produces glucagon to increase the liver's glucose synthesis. Following a meal, blood glucose levels rise fast as amino acids and glucose are directly absorbed into the bloodstream.

An increase in blood glucose levels triggers the release of insulin into the bloodstream from beta cells, which are vital in the pancreas. Insulin reaches its maximum level 20 minutes after a meal. Insulin promotes glucose absorption by body cells, especially those in the liver and muscles. Here, the decision of whether to burn glucose for energy or store it for later is made by insulin and other hormones. The liver stops generating glucose when insulin levels are high and saves it until the body needs it again. The pancreas decreases insulin synthesis when blood glucose reaches its maximum (insulin and blood glucose are at low levels approximately 2–4 hours after a meal).

2.1.2. Abnormal biochemical metabolism and regulation errors result in diabetic mellitus.

A collection of metabolic diseases affecting the metabolism of proteins, fats, and carbohydrates (particularly glucose) is known as diabetes mellitus. Hyperglycemia, or elevated blood sugar, is a hallmark of impaired glucose metabolism. This condition is typically caused by either insufficient insulin production (type 1 diabetes) or an inadequate cell response to insulin (type 2 diabetes).

Insulin is a very important hormone that plays a major role in fuel metabolism, thus this section elaborates on its effect on metabolism. Insulin hormone stimulates glucose uptake by cells as such its absence, insufficiency, or unresponsiveness by receptors consequently affects many metabolic processes. Insulin metabolically supports glycogenesis by increasing its rate, stimulates protein synthesis and inhibits glycogenolysis and lipolysis (20). It also stimulates the rate of glycolysis, which provides the precursors for the formation of fatty acids, and also decreases the rate of production of ketone bodies. Lack of insulin reduces the expression of multiple genes required for target tissues to react to insulin as intended, including glucokinase in the liver and the GLUT- 4 class of glucose transporters in adipose tissue. the major metabolic derangements that result from insulin deficiency in diabetes mellitus are impaired glucose, lipid, and protein metabolism

In those without any endocrine or metabolic disorders, glucose enters the bloodstream following the breakdown of carbohydrates and is later transported into cells for ATP to be generated through metabolic processes such as glycolysis, tricarboxylic acid (TCA) cycle, glycogenesis.

Normally, glucose is stored inside the cells and used as fuel later. The adipose, liver, and muscle cells of an individual when suffering with type 2 diabetes do not respond to insulin correctly when there is a regulation error or shift in blood glucose levels. Additionally, this leads to insulin resistance, which prevents blood sugar from entering these cells to be stored as energy.

Because there is less oxaloacetate available in untreated diabetes mellitus, the TCA cycle is suppressed and directed toward the gluconeogenic pathway. When such uncontrolled circumstances persist, the inability of blood glucose to be transported into cells for metabolism leads to a decrease in glucose utilization from the blood, which results in hyperglycemia. Diabetes mellitus also affects how well non-hepatic tissues use glucose, especially in adipose and skeletal muscle, where insulin promotes the uptake of glucose. Implicitly, there is a decreased condition of peripheral tissue uptake of glucose, which results in a decreased rate of glucose metabolism (20).

The metabolic pathways for utilization of lipids and carbohydrates are entwined. Considering insulin's metabolic effects on carbohydrates, it is not by chance that it also affects lipid metabolism. Insulin promotes the synthesis of the liver's fatty acids. It also stimulates the synthesis of the liver's glycogen. However, as glycogen accumulates to high levels, further synthesis is strongly suppressed. Any extra glucose that hepatocytes take up is diverted into pathways that lead to the creation of fats, which are exported from the liver as lipoproteins after the liver is saturated with glycogen. the lipoproteins are ripped apart in the circulation, providing free fatty acids for use in other tissues, including adipocytes, which use them to synthesize triglyceride. Insulin inhibits the breakdown of fat in adipose tissue by inhibiting the intracellular lipoprotein lipase (LPL) an enzyme found on the outside of the endothelial cells lining the vessels that hydrolyzes triglycerides to release fatty acids (20).

Aside due to the reality that insulin stimulates glycogen energy stores in hepatocytes and skeletal muscle, it also stimulates hepatocytes to synthesize triglycerides and store them in adipose tissue whilst inhibiting the process of lipolysis. Insulin facilitates the entry of glucose into adipocytes and within those cells, glucose can be used to synthesize glycerol. These glycerols, along with fatty acids delivered from the liver, are used to synthesize triglyceride within the adipocyte. This means that insulin is involved in the further accumulation of triglyceride in fat cells and thus has a fat-sparing effect. Not only does it drive most cells to preferentially oxidize carbohydrates instead of fatty acids for energy, but it indirectly stimulates the accumulation of fat in adipose tissue(20). Triglycerides (TG) make up the majority of lipids found in cells or circulating in the blood. Although TG is a neutral lipid in and of itself and is not poisonous, its derivatives, such as free fatty acids (FFA), ceramides, and diacylglycerol (DAG), are lipotoxic and have been linked to insulin resistance. The notion of ectopic lipid accumulation and the ensuing lipotoxicity has been known for a long time, but the significance of inflammatory signaling as a crucial connection between lipids and insulin resistance has gained recognition recently (21).

In uncontrolled type-1 diabetes mellitus, there is a rapid mobilization of triglycerides leading to increased levels of plasma-free fatty acids. The free fatty acids are taken up by numerous tissues except the brain and metabolized to produce ATP. The liver also takes up free fatty acids. Normally, the levels of malonyl-CoA are high in the presence of insulin. The presence of high levels of malonyl-CoA inhibits carnitine palmitoyltransferase I, the enzyme required for the

transport of fatty acyl-CoA's into the mitochondria where they are subjected to oxidation for energy production. Thus, in the absence of insulin, malonyl-CoA levels reduce and the rate of transport of fatty acyl-CoA into the mitochondria increases. Mitochondrial oxidation of fatty acids generates acetyl-CoA, which can further be oxidized in the TCA cycle. However, in hepatocytes majority of the acetyl-CoA is not oxidized by the TCA cycle but is metabolized into ketone bodies; acetone, acetoacetate, and -hydroxybutyrate. These ketone bodies leave the liver and are used for energy production by the brain, heart, and skeletal muscles. In type-1 diabetes mellitus, the greater accessibility of ketone molecules and free fatty acids exacerbates the reduced utilization of glucose thus promoting hyperglycemia. Ketone bodies are thus produced more than the body's ability to utilize leading to ketoacidosis (20).

Insulin regulates the synthesis of many genes, either positively or negatively that then affect the overall metabolic processes. In addition to insulin's effect on the entry of glucose into cells, it also stimulates the uptake of amino acids, thus contributing to its overall anabolic effect. When insulin levels are low, as in a fasting state, the balance is pushed toward intracellular protein degradation (catabolism). This implies insulin has a universal effect on protein metabolism, increasing the rate of protein synthesis and decreasing the rate of protein degradation. Implicitly the presence of type-1 diabetes mellitus due to absolute lack of insulin would lead to an increased rate of protein catabolism. The increased rate of proteolysis leads to elevated concentrations of plasma amino acids. These amino acids serve as precursors for hepatic and renal gluconeogenesis. In the liver, the increased gluconeogenesis further contributes to the hyperglycemia seen in type-1 diabetes mellitus. Additionally, insulin deficiency decreases the expression of several genes necessary for target tissues to respond normally to insulin such as glucokinase in the liver and GLUT-4 a class of glucose transporter in adipose tissue (20).

2.2. Global prevalence of undiagnosed diabetes mellitus

Globally, diabetes here and now ranks among the top ten main reasons for death in 2021, which will account for almost 6.7 million deaths(8). In 2019, diabetes affects over 15.8% (20.4 million) of live births during pregnancy. Moreover, this fatal illness reduces life expectancy by 30% (9). Glovally, the causes for losing life (before to becoming 70 years old) from diabetes a 5% increase, especially in lower-middle-income nations 2000 to 2016 (22). The greater rate of diabetic complications among UDM cases results in an additional annual cost to each individual of undiagnosed diabetes mellitus of 2864 USD. A number of causes contribute to type 2 diabetes

patients going misdiagnosed for years include inadequate health systems, a lack of knowledge among the general public and medical experts, and a delayed beginning or progression of the disease's symptoms(23).

Uncontrolled high blood glucose is a hallmark of previosly undetected diabetes mellitus, and it can cause micro- and macrovascular problems such as peripheral vascular disease, neuropathy, nephropathy, retinopathy, coronary artery disease, and stroke (24). A study done in the USA result showed that up to 41.7% of adults with newly diagnosed diabetes have developed chronic kidney disease.

Globally, In 2014, around 422 million adults had diabetes (12), Comparing the adult population, of in 1980, 108 million (an increase of 4.7% to 8.5%). That means its prevalence since 1980, roughly doubled(12). Among them, nearly half (46%) were undiagnosed for diabetes. Research conducted globally has revealed varying levels of undiagnosed diabetes mellitus prevalence. In general population surveys conducted in India, the magnitude of UDM was 7% (25), 4.1% in the USA (28.6% of all diabetes cases) (26), and 2.9% in Russia (53% of all diabetes cases) (27). So complications of each result are different in each country with different risk factors.

According to a study done in Thailand, the prevalence of DM is expected to rise from 6.5% in 2015 to 10.69% in 2035. In 2015, the proportion of undiagnosed DM cases out of all DM cases was 18.2%. The age group under 39 years old had the greatest rate of undiagnosed diabetes mellitus. Those without a diagnosis of diabetes died ten times more frequently than those who had (28).

A nationwide cross-sectional research carried out in Malaysia concluded that overall the frequency of diabetes mellitus was 17.5% even though the prevalence of undiagnosed DM was 9.2%. According to this result, associated factors with undiagnosed diabetes mellitus were the highest percentage of obesity (13.6%), second highest was respondent’s age 60 years and above (13.6%), ethnicity (Indians) 11.9%, educational level (no formal education) 12.9% and hypertension (12.8%) (29).

Once more, the results of another cross-sectional investigation of the prevalence of undetected diabetes and prediabetes among Kuwaiti adults indicated that the estimated prevalence of

prediabetes was 47.9%. Among them, 6.9% had an undiagnosed DM. Sex-related disparities in the magnitude of UDM and prediabetes were noted in this investigation. As age and BMI increased, prevalence estimates of undiagnosed undiagnosed diabetes and prediabetes exhibited rising trends. Results from the current study indicate that a significant fraction of Kuwaiti people have prediabetes, and a sizable component of the general population meets the criteria for undiagnosed diabetes mellitus. Moreover, prevalence estimates of prediabetes and undiagnosed DM demonstrated increasing trends as age and BMI increased. Hence, older and obese individuals are more vulnerable to DM-related complications (30).

2.3. Prevalence of undiagnosed Diabetes mellitus in Africa.

In 2014, about 179.2 million people lived with undiagnosed DM worldwide and the African region had the highest percentage compared with others. About 62.3% of the people with the disease do not know their being affected, and about 13.4 million have undiagnosed DM (31).

By 2021, 24 million adults in Africa are expected to have diabetes, or a 4.5% regional prevalence, according to IDF Africa. By 2045, a 129% increase is anticipated, reaching 55 million. Africa had more than half (54%) of the world's untreated cases of diabetes mellitus(8). Compared to the world magnitude of 8.5% in 2016, the magnitude of diabetes in Sub-Saharan Africa was lower at 3%. But compared to wealthy nations, the percentage of undiagnosed people in Africa (67%) is nearly twice as high 37% (11), wich adds to the region's rising rates of sickness and mortality.

Due to variations in social, economic, and genetic inequalities, the prevalence of undiagnosed diabetes mellitus varies widely between African nations. In North Africa, UDM accounted for between 18% and 75% of all cases of diabetes (16). Moreover, the prevalence of UDM in different regions of Africa was 9% in Tanzania (17), 7.2%, 11.5%, 5%, 2.3%, 3.8%, and 2.13% in different parts of Ethiopia (32, 33), and 2.6% and 5.97% in North Sudan(34) (East African studies); 3.19% in Guinea (35), 6.3% in Cameroon (36), 4.64% in Senegal (37), and 4.6% in Nigeria (38) (West African studies); and 4.2% in Egypt (North Africa) (39).In South Africa, the colored population has been disproportionately affected by this epidemic (40).

In South Africa, diabetes claimed the lives of at least 58 individuals every day in 2012. In South Africans, the crude type 2 diabetes magnitude, which includes those with pre-existing diagnoses, was 28.2% (age-adjusted 26.3% Confidence interval (CI) of 95% 22.0 - 30.3), and the magnitude

of type 2 diabetes cases that have not yet been diagnosed was 18.1% (age-adjusted 16.8% (13.3 - 20.4), and complications are linked to both of these rates. Heart-related conditions (41).

The combined prevalence of diabetes mellitus without a diagnosis in Africa was 5.37%, according to a meta-analysis and systematic review of the the cost of UDM in the Adult African Population. Undiagnosed diabetes mellitus is twice as common in urban populations (8.68%) as it is in rural ones (3.93%), according to the aggregated prevalence from subgroup analysis. According to this study, several African communities have higher than usual rates of Undetected diabetes mellitus(34).

2.4. Prevalence of undiagnosed diabetes mellitus in Ethiopia.

As a result, 4.3% of the adult population aged 20 to 79 is expected to have this incidence in 2019. Similarly, it has been shown that almost two-thirds of people in the nation do not have a diagnosis for diabetes mellitus(9). Meta-analysis and systematic research carried out in Ethiopia 2021 indicated that the combined magnitude of diabetes mellitus was 6.5%(13) According to the IDF study from 2017, there was a 4.8% prevalence of diabetes mellitus among people in the 18–99 age range, and 31,536 deaths were attributable to the disease overall(14).

The burden, prevalence, and threats of DM and risk factors are not well understood in Ethiopia. This is mainly because the efforts to halt the spread of the disease is a recent phenomenon and the existing few studies are often based on small data which is generated from hospital admissions. There is no comprehensive population-based information about the incidence of diabetes and key risk factors. However, all the studies conducted so far suggested the increasing prevalence of the disease – 3.32% to 5.2% (42, 43).

International Federation for Diabetes (IDF) estimated that in 2014 close to 5 million Ethiopian adults within the age range 20-79 were living with diabetes and around 2.9 million individuals of them have a reduced ability to metabolize glucose (44). According to the Ethiopian Diabetes Association, some 2%-3% of the population is estimated to live with diabetes. 1.4 million individuals were undetected and the magnitude of the disease is increased in urban areas compared to rural areas (42).

In Ethiopia, a research conducted in North West Ethiopia (in Bahirdar city), revealed the magnitude of undetected diabetic mellitus was 10.2%. in previos research the risk factors related

to a Family background of diabetes mellitus ever checked blood glucose level, not knowing about the symptoms of diabetes and overweight BMI were predictors of undiagnosed DM (45).

A community-based cross-sectional study carried out in western Ethiopia concluded the prevalence of undiagnosed DM was found to be 6.4% with a fasting blood glucose level ≥ 126 mg/dl and 15.8% of individuals were live with impaired fasting glucose. In the present investigation risk factors of undiagnosed diabetic mellitus are more related to BMI (6.02%) and More than half (69.26%) of the research subjects have central obesity(46).

In the northwest of Ethiopia, a study found that the magnitude of UDM was 2.1% in rural areas and 5.1% in urban areas (42).

A different study found that 5% of people in Bishoftu city, East Shoa, Ethiopia, had undiagnosed diabetes mellitus. In the current study, a significant relationship was discovered between body mass index, alcohol use, previous history of hypertension, and high triglyceride levels and undetected diabetes mellitus. The study found that history after age adjustment, body mass index, and DM in the family history were risk factors/predictors for undiagnosed DM. (47).
12.3% of adults in Mettu city, Southwest Ethiopia, participated in an investigation of community-based cross-sections that found a increased magnitude of undetected diabetes . Age range of 40 to 49, alcohol and ketamine usage, sedentariness, elevated diastolic blood pressure, and a history of diabetes mellitus in the family were the independent predictors of undiagnosed diabetes in this study (48).
An investigation that was cross-sectional and carried out in Mizan-Aman city, Southwest Ethiopia, found that the magnitude of DM was 6.5%. Before being diagnosed, 88.5% of people had diabetes mellitus without realizing it. This study discovered a strong relationship between diabetes mellitus and risk factors for total cholesterol, smoking, body mass index, and hypertension (49). Comparably, a study on modifiable risk factors in the same region reveals the prevalence of behavioral risk factors, including 14.1% chewing khat, 8.4% smoking, 35.9% alcohol use, 23.3% usage of vegetables and fruits below the recommended amount, 10.6% physical inactivity, and 23.3% fruit and vegetable consumption. Conversely, the frequency of biological risk factors is 4.0% obesity, 12.1% overweight, and 12.1% hypertension(50)

Undiagnosed diabetes mellitus was found to be 2.3% in a cross-sectional investigation conducted in the Koladiba community city, northwest Ethiopia. In this investigation, it was discovered that systolic hypertension (3.858%) and associated factors for overweight (4.25), obesity (5.26), hypertriglyceridemia (2.83%), and undiagnosed diabetes (DM) were independently linked to impaired fasting glucose. Hypertriglyceridemia was linked to undetected diabetes mellitus, and a family background of diabetes also exhibited a weak correlation with impaired fasting glucose(51).

The incidence of diabetes without a diagnosis was 11.5% in a cross-sectional study carried out in the community carried out in East Gojjam, North West Ethiopia; it was 11.3% among males compared to 11.8% among females and 13.4% in urban areas compared to 10.3% in rural regions. The age range of 35–44 years old and married individuals had the highest percentage of undiagnosed diabetes mellitus(33).

In the study conducted in Northeast Ethiopia's Dessie Town, the prevalence of diabetes mellitus was 6.8%. Of them, 72.5% had diabetes mellitus but had never received a diagnosis. 19.3% of subjects chewed khat, 54% engaged in physical inactivity, 22.3% drank alcohol, and 2.6% smoked(52).

2.5. Complications and risk factors associated with undiagnosed diabetes mellitus

2.5.1. Complications

Undetected DM and its complications are increasingly associated with the risk of untimely death and bring significant financial loss due to direct medical expenses, lost productivity and income, and health systems, for individuals with diabetes and their families, as well as for national economies (53). If DM is not well controlled, problems might arise that pose a risk to one's health and even death. Acute consequences play a major role in death and low life quality. blood sugar levels that are abnormally high can be fatal if they cause disorders like type 1 and type 2 diabetic ketoacidosis (DKA) or hyperosmolar coma. All forms of diabetes can cause abnormally low blood glucose, which might lead to seizures or unconsciousness.

Chronic problems can harm the heart, blood vessels, eyes, kidneys, nerves, and bring life-threatening consequences. This can result in incapacity and early death(54). During pregnancy, uncontrolled diabetes can increase the risks of death for both the mother and child (54). Hyperglycemia (even before diabetes) also exacerbates periodontal infection (gum disease) (IDF) (55).

2.5.2. Risk factors

Modifiable risk factors are associated with morbidity and mortality of non-communicable diseases (NCDs) including diabetes. It is reported elsewhere that undiagnosed DM and diabetes mellitus are made worse by certain risk factors, including poor eating practices, tobacco use, heavy drinking, high blood pressure, obesity, overweight, elevated body mass index, and a sedentary lifestyle (56, 57).

Being obese and overweight are widely recognized associated the causes concerning type 2 diabetes. Being overweight is highly in connection with diet practices and a inactive lifestyle. Undernutrition is also related with obesity in poor and less affluent areas of the world. Moreover, physical inactivity, family background of diabetes, ethnicity, unhealthy diet, and smoking tend to raise the chance concerning type 2 diabetes (58).

The prevalence of diabetes in newly industrialized nations and those who are in economic transition is comparable to the most advanced societies. WHO data, for example, showed that the obesity rate in Nigeria is increasing from time to time, which is more evident among women (35%), followed by men (8.3%) (55). In fact, over half of individuals in European nations are fat,

indicating a higher prevalence of obesity there. For instance, one in four adult British people are obese(54).

2.6. Preventing Diabetes mellitus

As indicated above, there is no known preventive measure for type 1 diabetes. Type 2 diabetes, however, can be prevented by promoting policies and practices that promote health such as exercising regularly, eating healthily, avoiding smoking, and controlling blood pressure and lipids. This, indeed, will not only prevent type 2 diabetes but also the complications and premature deaths that can result from all types of diabetes(41).

A study conducted in several countries such as Finland, Sweden, the US, China, India, and Japan has proven that lifestyle interventions can halt, or at least delay, the onset of diabetes in people who are identified as having high risk (54, 59). The study also reported that a shift in lifestyle such as losing weight for overweight people, increasing physical exercise, and making dietary modifications (reducing fat intake, increasing dietary fiber, etc.) are key factors that prevent or reduce the risks of developing diabetes. The higher their achievement in these lifestyle changes, the more their chances to avoid the risks of becoming diabetics (60).

Genetically, many people are not adapting well to the modern lifestyle, which increases the risk of developing diabetes. Most importantly, constant consumption of bulky food and beverages and inactive physical activity increase risks. There is sufficient evidence to suggest that dietary changes significantly prevent the risks of developing diabetes (61). This includes a diet rich in whole grains and fiber and choosing good fats, such as polyunsaturated fats found in nuts, vegetable oils, and fish. Limiting sugary beverages and eating less red meat and other sources of saturated fat can also help prevent diabetes (60). On the whole, much One can avoid type 2 diabetes as it results from modifiable risk factors that can be changed through promoting a healthy lifestyle. This could be achieved by creating favorable policies in the social and physical environment (41).

2.7. Conceptual framework of the study

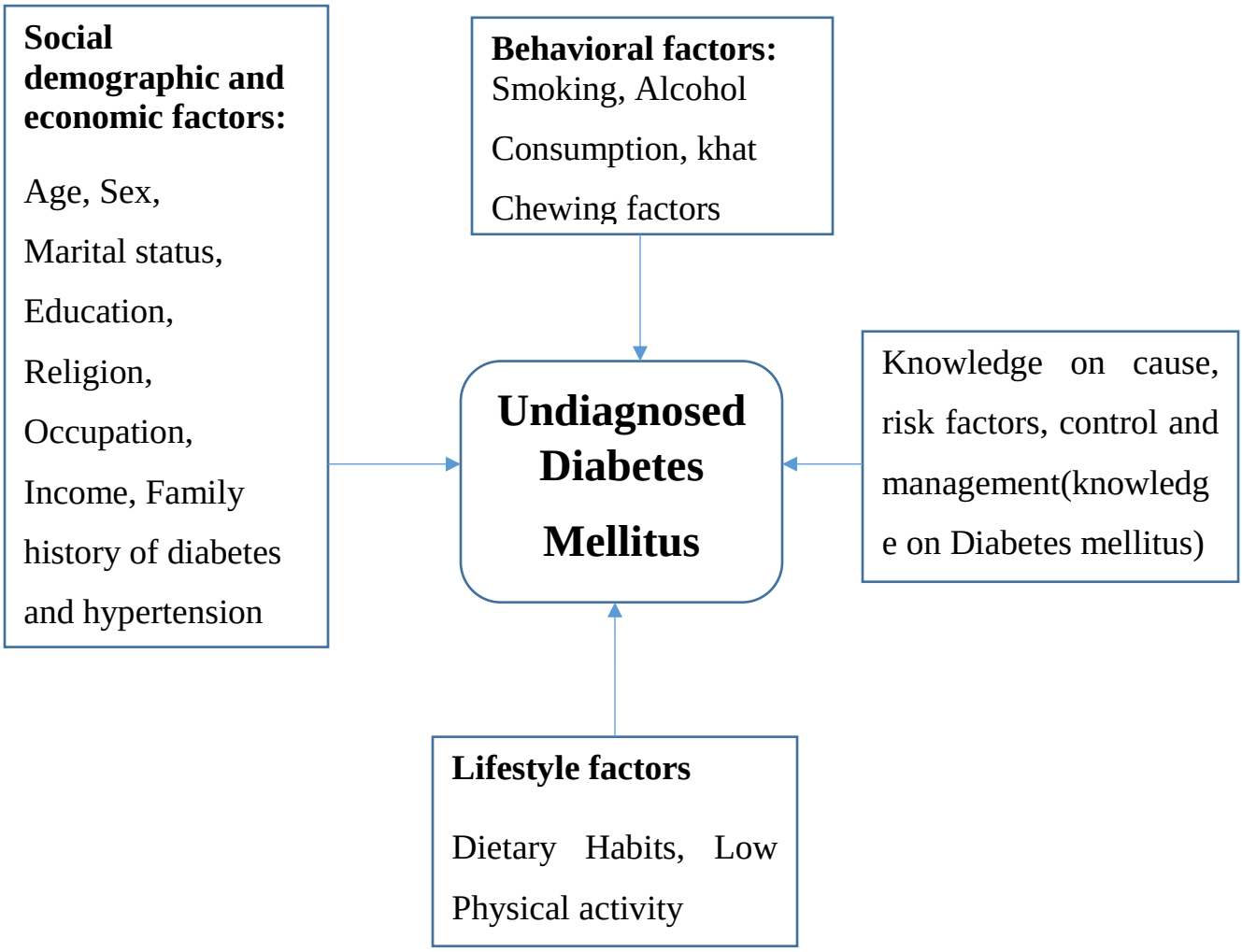


Figure 1: Conceptual framework of the study

3. Objective of the study

3.1. General Objective

- To assess the prevalence of undiagnosed Diabetes Mellitus and associated factors among adults in Arba Minch City Southern, Ethiopia, 2024

3.2. Specific Objective

- To determine the prevalence of undiagnosed Diabetes Mellitus among adults aged 18 years and above in Arba Minch city.
- To identify factors associated with undiagnosed diabetes mellitus among adults aged 18 years and above in Arba Minch City southern Ethiopia

4. Materials and method

4.1. Study Area

Investigation occurred in the southern Ethiopian city of Arba Minch. The Gamo zone's capital city is Arba Minch. Arba Minch, one of the administrative hubs of the South Ethiopia Region, is situated 505 kilometers from Addis Ababa, the Ethiopian capital. Arba Minch is situated 1285 meters above sea level and is bordered by the two biggest lakes in Ethiopia, Abaya and Chamo, as well as the Arba Minch Zuria woreda. Numerous fruits, including avocados, mangoes, bananas, and apples, are well-known in the town. Arba Minch is blessed with a diverse population that coexists peacefully.

The Central Statistical Agency (CSA) performed a census in 2007 that yielded 74,879 total population, of which 35,671 were female and 39,208 were male. 12 Kebeles with a total of 25624 homes (HH) make up the town. 12 kebeles (Doysa, Bere, wuhaminch, Chamo, Mehal-Ketama, Edgetber, Dilfana, Menaria, Gurba, Kulufo, Gidib, and Woze) make up the administrative division of the city. In Arba Minch city, there were thirteen drug stores serving the populace, one governmental general hospital, eleven health posts, two health centers, thirty-three private clinics, and on governmental primary hospital and 1 private hospital (62)

4.2. Study Design and Period

The A cross-sectional study with a community focus was carried out from July 8, 2023, to Dec 9, 2024

4.3. Population

4.3.1. Source population:

Was all adults who are eighteen years of age and above who are living in Arba Minch town.

4.3.2. Study population:

All randomly selected individuals aged 18 years and above who are living at least 6 months and above in the selected kebeles of Arba Minch City.

4.3.3. Sampling unit*:* targeted four kebeles were chosen by simple random sampling method by lottery method and households in the target Kebele's in Arba Minch City with Eligible adults

4.3.4. Study unit: Adults selected to participate in present research.

4.4. Inclusion and Exclusion Criteria

4.4.1. Inclusion Criteria.

All adults age 18 and above those who were living in selected Kebele living at least 6 months and above, and available when gathering data.

4.4.2. Exclusion criteria

- Individuals with diagnosed DM
- Pregnant women(during pregnancy, hormone levels change, making it harder for the body to process blood sugar efficiently)
- Individuals with chronic diseases, such as Tuberculosis and cancer
- Individuals currently taking any drugs with possible impact on glucose metabolism
- Adults who are severely ill/mentally ill
- Individuals not able to communicate

4.5. Study variables

4.5.1. Dependent variables

Undiagnosed diabetes mellitus.

4.5.2. Independent variables

- **Socio-demographic characteristics;** Gender,age, educational, Marital status, Religion, Occupation, Income, family history of DM
- **Antropometric measurement:** Height, weight,body mass index and Hypertension (systolic and diastolic pressures)
- **Behavioral factors or Lifestyle:** Chewing khat, smoking, drinking too much alcohol, poor dietary habits, and insufficient exercise.

4.6. Measurement and Data Collection

4.6.1 Sample Size Determination

The formula for a single population proportion was used to determine the sample size, by using the prevalence of undiagnosed diabetes mellitus that was reported in the Bahir Dar City, study at 10.2 % (p=0.102)(63). This presumption led to the sample size being determined as

$$n = \frac{(Z\alpha/2)2\ P\ (1 - P)}{w^2}$$

Then; n= the minimum sample size required p= proportion of diabetes mellitus, w= margin of error/absolute precision = 4% (0.04), and Zα/2 =1.96 at the confidence interval=95%.

Then n= $\frac{(1.96)^2(0.102)\ (1-0.102)}{(0.04)^2}$ =220

The design effect can be equivalent defined as the the actual sample size divided by the effective sample size. Thus, where the true sampling variance is twice that computed under the assumption of simple random sampling the design effect is 2.

so, iused design effect 2 and multiplying by 2, non-response rate i was used as 10% of the minimum sample size, then final sample size was 220x2=440, then I added 10% of 440 was 44,the total sample size was 440+44=484, participants.

4.6.2. Sampling method/sampling procedure

A Random sampling methodology was applied. Arba Minch City have 12 kebeles . Out of 12 kebeles, four kebeles were chosen by simple random sampling method by lottery method, the size of the sample was distributed to individual selected kebeles using proportional allocation using the formula: ni= n/N *Ni. Where; n=total sample size to be selected =484. N=total house hold=7329, Ni = total house hold of each kebeles Bere=2125, Wuhaminch = 2393, Kulufo=1265, and Gidib =1546. ni= sample size from each kebeles Bere=140, Wuhaminch =158, Kulufo=84 and Gidib=102.

After determining the interval (K value) by dividing the total household in each of the four selected kebeles by the sample assigned to each of the selected kebeles, the study subjects were chosen via systematic random sampling. Finally, from those households, a family member who met all eligibility requirements was selected from adults who were present during the data collection. If the chosen household does not have an eligible member or If a chosen household cannot be reached or does not meet the requirements for inclusion, the next house hold was included additionally, if more than one qualified participant in the chosen house hold in the study, one was chosen at random.

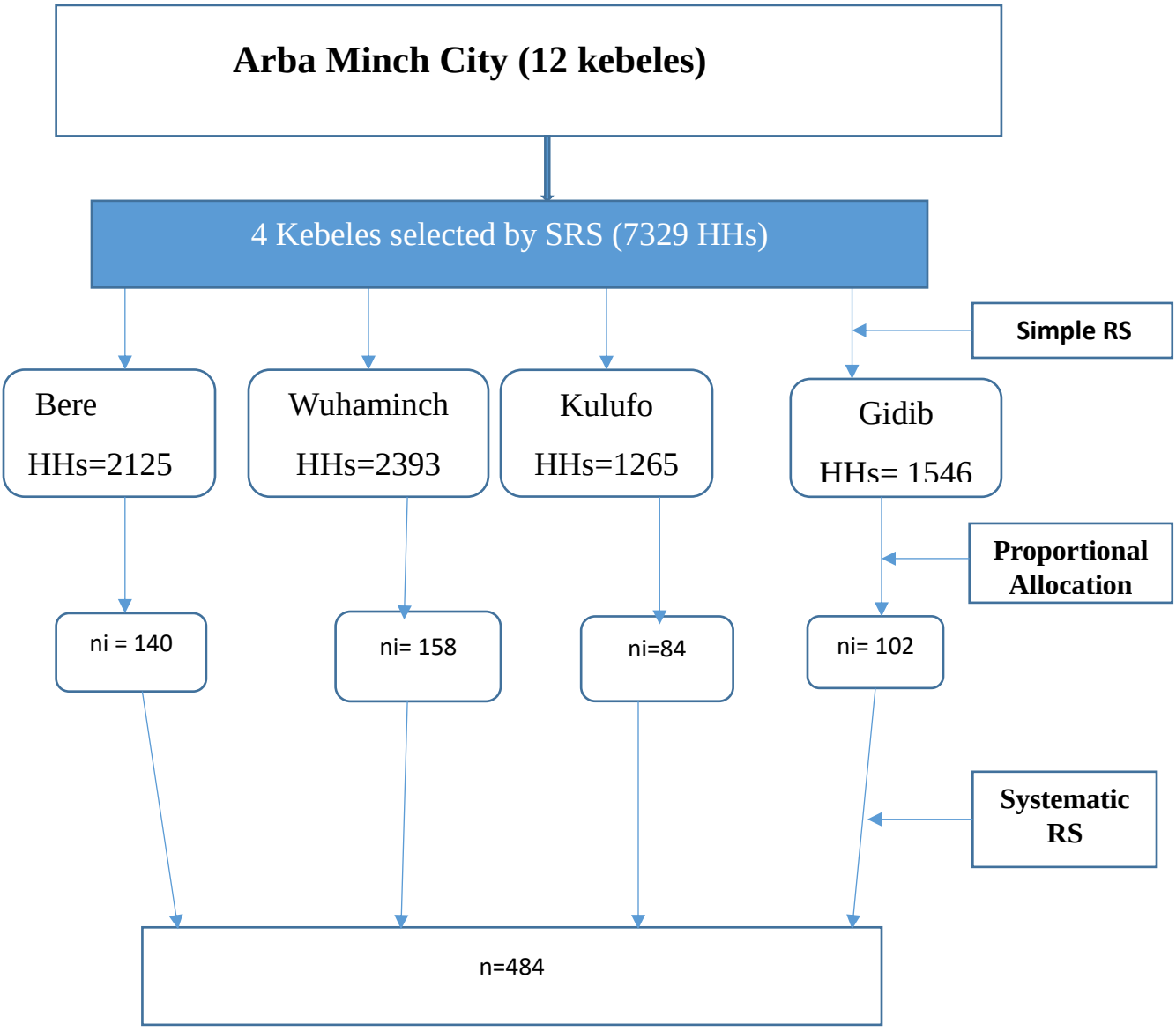


Fig 2: Schematic diagram of sampling procedure and technique

4.6.3. Data collection instruments

To prevent ambiguity, the structured survey was first created translated from English into Amharic using clear and concise methods. Using a typical zero mercury sphygmomanometer, the blood pressure was measured. A stadiometer was used, along with standing straight on a level surface, to measure height. A modified scale was used to assess body weight while the subject was dressed comfortably. The formula used to determine (BMI) was kilos of weight divided by square meters of height(wt. /ht2).

4.7 Data Collection Procedure and Measurements

A pretested structured survey given out by an interviewer was used to gather data from study participants in in-person interviews. This questionnaire was developed from the World Health Organization's systematic method for non-communicable disease surveillance of risks. We proceeded step-by-step through those sociodemographic data, behavioral traits and medically associated variables, physical assessments (blood pressure and anthropometric measurements), and biochemical testing(64).

4.7.1 Demographic and Behavioral Characteristics

On the first day face to face-to-face interview technique was employed after the written consent of each participant and four trained nurses collected the socio-demographic factors, like marital status, sex, age, and educational level, religion, family's total average monthly income, and occupational status.

Behavioral features include things like alcohol drinking habit, cigarettes smoking habit, dietary habit like, eating a diet high in fruits and vegetables, chewing khat habit, taking knowledge tests about diabetes mellitus, and exercising. health-related variables, such a family background of diabetes. The WHO's global recommendation for physical activity was used to quantify physical activity. Physically active adults (achieved 600 minutes per week) are defined as having engaged in 150 minutes or more of moderate-to-intense exercise, a minimum of 75 minutes of strenuous exercise, or a combination of both estimated to accumulate at least 600 MET-minutes per week. This is in contrast to physically inactive adults (achieved less than 600 MET-minutes per week). Conversely, a sedentary lifestyle was assessed by determining how much time was spent sitting over the course of a normal week (65, 66). The CDC's definition of alcohol and tobacco use as current, former, and never was used to measure these behaviors. The recorded variable's three criteria were used to classify a smoker's status according to multiple questions regarding cigarette

smoking: never smoked, former smoker, and current smoker. An adult (over the age of eighteen) who has smoked cigarettes for the preceding thirty days, either continuously or in part, is considered a current smoker. A former smoker is an adult (over the age of eighteen) who smoked some or all of their lifetime supply of cigarettes but had either completely quit or was not smoking at the time of the interview. Any adult (over the age of eighteen) who claims never to have smoked(67)**.** The American Heart Association's assessment of alcohol suggests a healthy drink limit of 2 cap of alcoholic drinks for men and 1 cap of alcoholic drink for women per day(50).

4.7.2 Physical Measurement

In addition to the behavioral and sociodemographic data, physical measures were made of the height and weight required to determine the body mass index and blood pressure. Weight divided by height squared (kg/m2) yielded the body mass index (BMI). With the subjects positioned at the Frankfurt Plane and the four points (heel, calf, buttocks, and shoulder) touching the vertical stand, the study participants' heights were determined to the closest 0.1 cm by a stadiometer. The individual also had their shoes removed. The stadiometer was calibrated before the measurements were started. The subjects were stripped of their light clothing and shoes before their weights were measured to the nearest 0.1 kg on a digital scale. In order to minimize intra- and inter-observer bias, the validity of the scale was tested using an object with a known weight every morning and in between measurements. The World Health Organization's BMI cut-off points classify BMI as follows: obesity (BMI >30 kg/m2), overweight (BMI ≥ 25–29.9 kg/m2), normal (18.5-24.9 kg/m2), and underweight (BMI < 18.5 kg/m2) (66). Using a digital sphygmomanometer Riester ri-champion, blood pressure (BP) was measured while the patient was seated and supported by the right arm. Three minutes passed between the two readings. The mean systolic and diastolic blood pressures were taken into consideration as the final BP result, in accordance with the WHO standard. When blood pressure is measured, prehypertension is defined as 120–139 mmHg systolic and 80–89 mmHg diastolic, whereas hypertension is defined as 140 mmHg or higher systolic and 90 mmHg or higher diastolic blood pressure (68)**.** Then the participant was to fast overnight for at least 8-10 hours. Then glucose was tested twise and the average was obtained to increase precission and taken following the WHO recommendation (28).

4.7.3 Biochemical Measurements

The second day's laboratory parameters were established using the usual operating procedure. As a result, a laboratory technologist who is unaware of the measurements or subject history of the

study conducted all of the laboratory results. during the first contact of the face-to-face interview on socio-demographic and behavioral characteristics were informed to the individuals to not consume any type of food overnight, and FBS was done on the next day at morning. VivaChek ™ Ino The blood glucose levels were measured using a blood glucose meter and NON-CODING Blood Glucose Test Strips (manufactured in Taiwan, expiration date: 2024/07). based on the IDF and American diabetic Association's classification standards for diabetic mellitus Test for fasting blood sugar (FBG): checks blood sugar following an 8-hour minimum overnight fast (without eating). FBG level 100 < FBS < 126 mg/dl was classified as prediabetes, FBG level 126 mg/dl or higher suggests diabetes, and any level of FBG below 100 mg/dl was considered normal(69, 70). In general, study participants who tested positive for prediabetes (impaired glucose tolerance) and diabetes for the first time were sent to local healthcare institutions for additional monitoring and treatment.

4.7.4. Principles of Laboratory analysis, procedures, and interpretation of results.

Principle of operation of glucometer using glucose oxidase technique:

When the enzyme glucose oxidase, which is included in the test strip, combines with the glucose in the sample's blood, it creates gluconic acid. A little drop of blood sample is deposited on a disposable test strip or reaction cuvette. Then, gluconic acid, another chemical, and ferricyanide from the testing strip react. The subsequent reaction of ferricyanide with gluconic acid yields ferrocyanide. After ferrocyanide is created, the device runs an electrical current across the blood sample on the strip. This current then reads the ferrocyanide and glucose levels on the testing strip from the blood sample. That figure is thereafter shown on the glucose testing meter's screen.

4.8. Data quality management

The data gathering tool was first created by English, then converted into Amharic, then translated to local language gamogna and then back translated into English to make sure accuracy and reliability. In order to check for potential issues with the questionnaire's flow, length of time needed for interviews, feasibility, and clarity, a 5% pretest was conducted in Woze, Dilfana, one of the town's non-selected kebeles, prior to the administration of the questionnaire. This was done before applying it to the final data collection. Based on their credentials, prior data collecting experience, and ability to communicate in the local languages, two nurses and two laboratory technologists were hired. In addition to this, individuals who collected the data received two days

of refresher training on interviewing techniques, appropriate sampling procedures with labeling, universal safety precautions, anthropometric measurement, and data recording before the actual gathering of data. Measurement and recording was closely monitored by both investigator and supervisors. Additionally, ensured that all of the data was gathered was accurate, consistent, and complete every day. Physical measures were taken twice, and in certain situations three times, in order to reduce the bias of the observers. Data collectors also rotated in order to compare the results. Periodically, the glucometer apparatus and strips were examined to ensure consistency in test and reference values. Every day, a calibrator was used to calibrate the Glucometer before samples were taken for testing, and quality control samples were normal.

4.9. Data analysis and interpretation

For additional analysis, The data that were coded were imported into Epi-data version 3.1 while exported to the version 26 SPSS software . The entered was cleaned before analysis. Descriptive statistics mean with standard deviation shown for data that is normally distributed for continuous variables, thereafter, the information was summarized using the median. For categorical variables, percentages and frequencies were provided. Pie charts and bars were used as visual aids to display the findings of categorical variables. An estimate of the prevalence was made along with its 95% confidence interval. adjusted and crude odds ratios were calculated with confidence intervals of 95% to investigate relationships between independent and dependent factors. After conducting a bivariate analysis, all variables with a cut-of-point the value of P less than 0.25 were added to a multiple variate logistic regression model for biologically significant variables that did not account for collinearity. Model fitness was evaluated by examining the results of the Hosmer-Lemeshow and Omnibus tests of model coefficients. In the course of the logistic regression analysis, variables that had a value of P< than 0.05 were deemed statistically considerable.

4.10. Ethical Considerations

Ethical approval was acquired from the Council for Research and Ethics of the School of Medical Laboratory Science, College of Health Science, Department of Medical Laboratory Sciences of Addis Ababa University (AAU) with Ref.No: MLS/031,23, Date: 31/03/23. Written permission was taken from the health of the Gamo zone office and respective kebeles administrative in the research area. During data collection, each respondents were made aware of the goal, the study's objectives, scope, and expected results, and the respondents' adequate, informed verbal consent was obtained. Anyone who was eliminated from the study since they refused to participate;

additionally, participants were free to skip any questions they didn't want to answer or end the interview at any time. To ensure that create an anonymous connection, the questionnaire simply recorded the codes—not the names of the responders.

An essential part of the research process was teaching supervisors and data collectors about ethical considerations. Abnormally high(above reference value) and extremely low results of laboratory findings and abnormally high blood pressure were immediately informed to the study participants and immediately referred to the nearest health facility for rechecking and medical attention

4.11. Result dissemination plan

Lastly, outcome of finding will be disseminated to the Addis Ababa University College of Health Sciences, school of medical laboratory science in hard and soft copies and will disseminated for Gamo Zone health birou and the finding also will be published on peer revied journals.

4.12 Operational Definition

According to the American Diabetes Association: Diabetes and prediabetes

Normal blood glucose level: Blood glucose after an overnight fasting for at least 8 hours, blood glucose concentration between 70 mg/dl and 100 mg/dl

Diabetes: (Elevated blood sugar levels): adults above the age of 18, those who have just been diagnosed, and those who fasting blood glucose (Fasting blood glucose) levels>126 mg/dl(70)

Prediabetes – Fasting blood sugar level 100-125 mg/dl.

Newly diagnosed/undiagnosed DM: comprised individuals with FBG >126 mg/dl, who had never had their blood glucose checked previously, had not taken diabetes medication at the time of data collection, and were not on any diabetic mellitus drugs (44).

Hypertension: Any adult who is at least eighteen years old, whose systolic and diastolic blood pressure is at least 140/90 mmHg, and who is taking an antihypertensive medication, or who has previously been diagnosed with hypertension (59).

Family background of diabetes: was a research participant considered positive if they had diabetes mellitus in one or more of their parents, sisters, or brothers.

Good knowledge: Individuals who responded to the mean and above of the total knowledge questions had good knowledge about diabetes mellitus.

Poor knowledge: Individuals who responded below the mean of the total knowledge questions had poor knowledge about diabetes mellitus.

Body Mass Index (BMI) was defined by WHO criteria (54).

- Underweight : body mass index less than 18.5

- Normal : body mass index 18.5 to 24.9
- Overweight: body mass index ≥25.0 and <29.9
- Obese: body mass index ≥30.0

Low fruit and vegetable intake: A person's self-reported consumption of less fruits and vegetables was considered an insufficient intake or individuals who didn't eat vegetables and fruits daily (14).

A smoker: was defined as an individual who, during the previous 30 days, smoked at least one cigarette every day.

Heavy Alcohol Consumption: WHO criteria high to excessive consumption (>21alcoholic beverages a week) or over 3 standard alcoholic drinks (about 30 grams of alcohol) for males or over 2 standard alcoholic drinks (roughly 20 grams of alcohol) for women every day(55).

A standard alcoholic drink is the equivalent of one glass/can/bottle (330ml) of regular beer (with 3% ethanol), and one glass (100ml) of wine (10% ethanol). Each of It results in roughly 10g of ethanol per drink

Physically active: was defined as participants engaging in either moderate physical activity (defined as > 10 minutes at a time for activities like gardening, hand washing clothes, drawing water, cycling, or a combination of both) or vigorous physical activity (defined as > 10 minutes at a time for activities like sawing hardwood, playing football, or plowing).

Physically inactive: was characterized as those engaging in low physical activity, which is equivalent to their resting metabolic rate. Low physical activity includes jobs like secretarial or office work, TV watching, card games, shopping, and leading a sedentary lifestyle

Sedentary lifestyle: The response to always engaged in light or most of the week spent in leisure activities, or This study examines the reaction to occasionally or never participating in moderate-to-intense physical activity for the most of the week outside of work. This would result in a minimum of three hours of moderate-to-intense physical activity each week(59).

5. Result

5.1 Socio-demographic and characteristics of study participants

In present research, the total sample size was 484 but 456 Participants contributed the data needed for the analysis at the end, with a response rate of 94.2%. Using a structured questionnaire, a face-to-face interview was administered with a 5.8% non-response rate. Among the study participants, 232(50.9 percent) were males and the rest 224(49.1%) females. Participants' average age was 36.73 ±11.84 Standard deviotion with range of age 18-79 years. Most of , 175 (38.4%) were within the age range of 25-34 years. Most research participants were Orthodox Christian 234 (51.3%), and married 274 (60.1%). In addition, the majority of study participants were college level and above 174 (38.2%) followed by grade 1-8 were 130 (28.5%).

Government personnel made up the majority of research participants (113, or 24.8%), followed by private employees (101, or 22.1%). The average monthly income of the respondents (226, or 49.6%) was greater than 4126 ET Birr. Of the study participants, 59 individuals (12.9%) declared a history of diabetes in their family, 358 (78.5%) reported no history of the disease, and approximately 39 (8.6%) reported not knowing.

Table 1: Socio-demographic characteristics of adult study participants at Arba Minch City, Gamo Zone, South Ethiopia, 2024 (n=456)

Variables	**Category**	**Frequency (n)**	**Percent (%)**
Sex	Male	232	50.9
	Female	224	49.1
Age	18-24	50	11.0
	25-34	175	38.4
	35-44	126	27.6
	≥45	105	23.0
Religion	Orthodox Christian	234	51.3
	Protestant	177	38.8
	Catholic	28	6.1
	Muslim	17	3.7
Marital status	Single	106	23.2
	Married	274	60.1
	Divorced	31	6.8
	Widowed	45	9.9
Educational status	Unable to read and write	38	8.3
	Grade 1-8	130	28.5
	Grade 9-12	114	25.0
	College level and above	174	38.2
Occupational status	Merchant	87	19.1
	Daily labour	37	8.1
	Governmental Employee	113	24.8
	Private Employee	101	22.1
	Housewife	80	17.5
	Student	25	5.5
	Driver	13	2.9
Family monthly income (in birr)	1124 - 2124	10	2.2
	2125 - 3125	17	3.7
	3126 - 4126	43	9.4
	>4126	226	49.6
	I do not know	160	35.1
Family history of diabetes mellitus	Yes	59	12.9
	NO	358	78.5
	Don't know	39	8.6

5.2 Behavioral characteristics and knowledge of participants on diabetes mellitus

Of the total study participants, about 67 (14.7%) had smoked cigarettes in the last 12 months, of these respondents 45 were males and 22 were females. Of 67 smokers, 22 (32.8%) respondents were daily smokers, and 45 (67.2%) smoked every other day.

Of the total participants, about 47 (10.3) were chewed chat and the rest 409 (89.7) were not chewed chat. Of 47 chat chewers, 41 respondents were males and 6 respondents were females. Of the total chat chewers, 20 respondents were daily chewers and 27 respondents were chewed sometimes.

Of a total of 456 participants 358 (78.5%) have never consumed alcohol in their lifetime, 76 (16.7%) of respondents did so, while 22(4.8%) respondents have not consumed alcohol in the past 12 months. Of 76 alcohol consumed respondents, 61 were males and 15 respondents were females. Of 76 alcohol consumed respondents, 43 (56.6%) respondents had 1-3 drinks per day, 31(40.8) respondents had 4-6 drinks per day and nearly 2 (2.6 %) had seven or more drinks a week.

Overall 70 (15.4%) participants do not eat fruits in their life time and 276 (60.5%) of participants do not eat fruits each day. 7 (1.5%) of participants do not eat vegetables in their life time and 422 (92.5%) of participants do not eat vegetables every day.

Overall, 260 (57%) of the study participants were physically inactive or mostly sitting or standing with a little work (mild exercise), 148 (32.5%) with moderate exercises or activity that required some effort and 48 (10.5%) with activity that requires heavy efforts (heavy exercises). In addition to these outside working hours physical activity Overall, 212 (46.5%) of the study participants were physically inactive or mild exercise, 163 (35.7%) with moderate exercises or activity that required some effort, 81 (17.8%) with activity that requires heavy efforts or heavy exercises.

Among the total participants, 218 (47.8%) respondents have good knowledge(according to mentioned in operational definition,above mean) of diabetes mellitus, and 238 (52.2%) have poor knowledge(according to mentioned in operational defition) of diabetes mellitus. Of these 218 respondents had good knowledge of DM, 120 respondents were males and 98 respondents were females.

Table 2: Behavioral characteristics and knowledge of participants on diabetes mellitus among adults in Arba Minch City, Gamo Zone, South Ethiopia, 2024 (n=456)

Variables	**Category**	**Frequency (%)**	**Sex**	
			Male	**Female**
Smoke cigarette in the last 12 months	Yes	67 (14.7)	45	22
	No	389 (85.3)	197	192
If smoking, how often (n=67)	Daily	22 (32.8)	9	13
	Every other day	45(67.2)	26	19
Chew khat	Yes	47 (10.3)	41	6
	No	409(89.7)	191	218
If yes to chewing khat habit,how often (n=47)	Yes, daily	20 (42.6)	18	2
	Yes, sometimes	27 (57.4)	23	4
Drinking habit any type of alcoholic drink in the last 12 months	Yes	76 (16.7)	61	15
	Yes, but not in the past 12 month	22 (4.8)	13	9
	No, I have never	358 (78.5)	158	200
On average, how often do you usually drink alcohol (n=76)	One to three drinks a week	43 (56.6)	31	12
	Four to six drinks a week	31 (40.8)	28	3
	Seven or more drinks a week	2 (2.6)	2	0
Frequency of fruits taken per day	Don't eat fruits their life time	70 (15.4)	31	39
	Don't eat fruit every day	276 (60.5)	147	129
	I take fruits once a day	109 (23.9)	54	55
	I take fruits 2-4 times per day	1 (0.2)	0	1
Frequency of eating vegetables per day	Don't eat vegetables their life time	7 (1.5)	2	5
	Don't eat vegetables every day	422 (92.5)	213	209
	I take vegetables once a day	27 (5.9)	17	10
Habit of exercise physical during working hours	Mild exercise	260(57.0)	123	137
	Moderate exercise	148 (32.5)	79	69
	Heavy exercise	48 (10.5)	30	18
Outside the working hours or transportation time physical activity	Mild exercise	212 (46.5)	90	122
	Moderate exercise	163 (35.7)	83	80
	Heavy exercise	81 (17.8)	59	22
Knowledge of diabetes mellitus	Good knowledge	218 (47.8)	120	98
	Poor knowledge	238 (52.2)	112	126

5.3 Anthropometric measurements of the subjects of the research

The respondents' body mass indexes varied from 15.6 to 39.7 kg m-2. Overall, 7(1.5 %) of subjects had underweight weight (lower body weight), 306 (67.1%) of respondents had normal body mass index, 104 (22.8%) participants were overweight, additionally 39 (8.6%) respondents obese. Again an increased proportion of male respondents than females were overweight (55.8% versus 44.2 %), Lower rate of males than females were obese (41% of males and 59% of females). Out of 456 participants, 363 (79.6%) of participants possessed a systolic blood pressure of under 140 mmHg and the rest 93 (20.4%) participants had systolic hypertensive. 321 (70.4%) participants had blood pressure at the diastolic level below 90mmHg and the rest 135 (29.6%) participants had diastolic hypertension. Of the total systolic hypertensive 93 participants, 57 (61.3%) participants were males and 36 (38.7%) of participants were females. Of diastolic hypertensive 135 participants, 78 (57.8%) participants were males and 57 (42.2%) of participants were females. In general, 151 (33.1%) study subjects had high blood pressure. Of 151 high blood pressure participants, lower proportion of females 62 (41.1%) and increased rate of males 89(58.9%).

Table 3: Anthropometric and clinical measurements of study participants among adults in Arba Minch City, Gamo Zone, South Ethiopia, 2024 (n=456)

Variables	**Category**	**Frequency**	**Percent**	**Sex**	
				Male	**Female**
BMI	<18.5	7	1.5	2	5
	18.5-24.9	306	67.1	156	150
	25-29.9	104	22.8	58	46
	≥30	39	8.6	16	23
Systolic hypertension	No	363	79.6	175	188
	Yes	93	20.4	57	36
Diastolic hypertension	No	321	70.4	154	167
	Yes	135	29.6	78	57
Hypertension	No	305	66.9	143	162
	Yes	151	33.1	89	62

5.4 Undiagnosed diabetes mellitus among adults

In this study, out of the total number of participants, 456 According to diabetic classification creteria 52(11.4%) participants were classified as having diabetic mellitus. So in this study, the magnitude of undiagnosed diabetes mellitus was found to be 52 (11.4%) (95%CI: 8.6%, 14.7%) while 17 (3.7%) were found to be present in the prediabetes stage (**figure 3**).

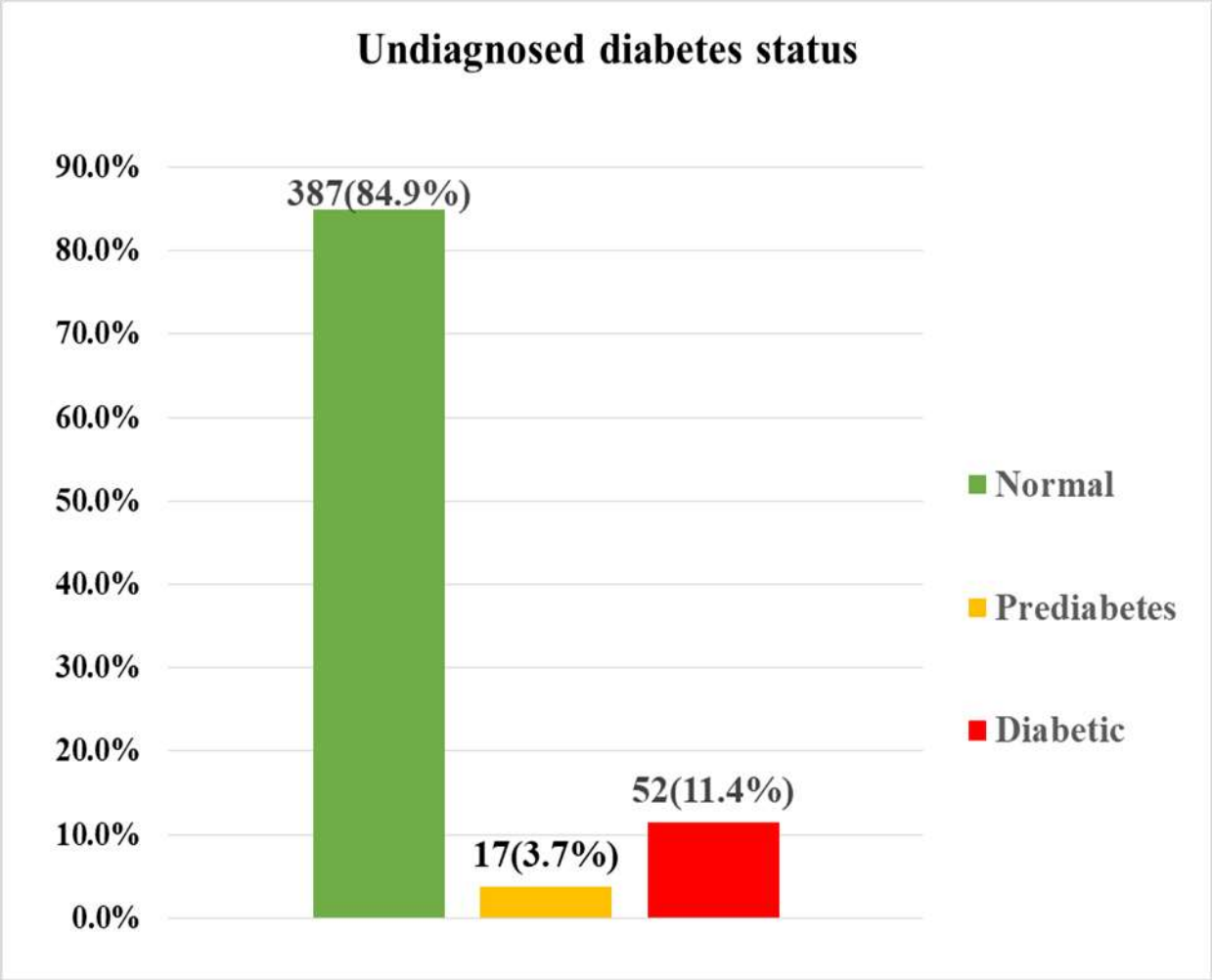


Figure: 3: Undiagnosed diabetic status among adults in Arba Minch City, Gamo Zone, South Ethiopia, 2024

The prevalence of undetected diabetes Mellitus among males was 15.9% (n=37/232) and females was 6.7% (n=15/224). The magnitude of undiagnosed DM in the age division ≥ 35 was 17.3%. Furthermore, in respect to the participants' educational background, the magnitude of undetected diabetes mellitus was 16.2% among primary(1-8) and 10.3% among college level and above.

Of all the individuals involved in the study, the magnitude of undetected diabetes mellitus was 26.9% among participants smoked cigarettes in past 12 months and 31.9% were among participants chew khat. In addition to these, regarding consumed any type of alcoholic drink, the magnitude of undiagnosed diabetic was 27.6%.

Of the whole study participants, mild exercise was the most prevalent and the frequency of undiagnosed diabetic mellitus was 13.8%, and outside the working hours, 14.6% (mild exercise) was the most prevalent. In addition to this poor knowledge of undiagnosed diabetic mellitus was 9.1%

Among all study participants, the frequency of undiagnosed diabetic mellitus 23.8% was overweight/obese and 22.5% was hypertension (**Table 5**)

5.5 Factors associated with undiagnosed diabetes mellitus among adults

A bivariate logistic regression model was used to assess any association between dependent and independent variables.

In this study factors associated with undiagnosed diabetes mellitus were assessed by bivariate analysis, was determined, along with the variables' p-values lessthan 0.25 were Sex, Age, Educational level, persons with hypertension, BMI, history of alcohol, physical activity outside working hours, cigarette smoking status, chew chat and knowledge on undiagnosed diabetes mellitus were found to be significantly connected to undiagnosed diabetes and this variables were added to a multiple variate logistic regression model for biologically significant variables that did not account for collinearity.

Ahead of bivariate factor analysis, sex male [COR=2.64, 95% CI (1.41, 4.97)]s being male is a risk for the development of diabetes mellitus, Age group ≥35 [COR=3.72, 95% CI (1.90, 7.29) rise with aging in order to facilitate the growth of undiagnosed diabetes mellitus. Additionally, based on educational level grade 1-8 [COR=1.67, 95% CI (0.85, 3.28)]s. This result indicates that smokers as compared to nonsmokers had 3.84-time likelihood of acquiring diabetes mellitus [COR=3.84, 95% CI (2.01, 7.301)], khat chewers as compared to non-chewers had 4.71 times likelihood of acquiring undiagnosed diabetes mellites [COR= 4.71, 95% CI (2.34, 9.49)], Alcohol drinkers had 5.07 times likely hood of developing undiagnosed diabetes mellitus than the non-alcohol drinkers [COR= 5.07, 95% CI (2.78, 9.24)], physical activity outside working hours, mild exercise [COR= 2.60, 95% CI (0.98, 6.95)], moderate exercise [COR= 1.65, 95% CI (0.58, 4.69)] low or decrease in physical exercise is risk for developing undiagnosed diabetes mellitus. In addition to these Knowledge on diabetes mellitus, poor knowledge [COR= 5.12, 95% CI (2.43, 10.78)] increases for the development of diabetes mellitus, body mass index (BMI), overweight/obese [COR= 5.11, 95% CI (2.77, 9.43)] increase body mass index is a risk for developing diabetes mellitus, Hypertension [COR= 4.63, 95% CI (2.52, 8.53)] increase in systolic or diastolic pressure increase DM or risk for developing diabetes mellitus **[Table 4**].

Table 4: Bivariable logistic regression analysis for factors associated with undiagnosed diabetes among adults in Arba Minch City, Gamo Zone, South Ethiopia, 2024

Variable	Category	Undiagnosed diabetes		COR (95% CI)	P-value
		Present	Absent		
Sex	Male Female	37(15.9) 15 (6.7)	195(84.1) 209(93.3)	1 2.64(1.4,4.97	 0.003*
Age (in years)	<35 ≥35	12 (5.4) 40(17.3)	213(94.6) 191(82.7)	1 3.72 (1.90, 7.29)	 <0.001*
Educational level	Unable to read and write Grade 1-8 Grade 9-12 College level and above	2(5.3) 21(16.2) 11(9.7) 18(10.3)	36 (94.7) 109(83.8) 103(90.3) 156(89.7)	0.48 (0.11, 2.17) 1.67 (0.85, 3.28) 0.93 (0.42, 2.04) 1	0.34 0.14* 0.85
Smoke cigarette in the last 12 months	Yes No	18(26.9) 34(8.7)	49(73.1) 355(91.3)	3.84(2.01,7.301) 1	<0.001*
Chew khat	Yes No	15(31.9) 37(9)	32(68.1) 372(91)	4.71 (2.34, 9.49) 1	<0.001*
Consumed any type of Alcohol in the last 12 months	Yes No	27(27.6) 25(7)	71(82.4) 333(93	5.07 (2.78, 9.24) 1	<0.001*
Work-related physical activity during working hours	Mild exercise Moderate exercise Heavy exercise	36(13.8) 12(8.1) 4(8.3)	224(86.2) 136(91.9) 44(91.7)	1.77 (0.60, 5.22) 0.97 (0.30, 3.161) 1	0.30 0.96
Outside the working hours or transportation time physical activity	Mild exercise Moderate exercise Heavy exercise	31(14.6) 16(9.8) 5(6.2)	181(85.4) 147(90.2) 76(93.8)	2.60 (0.98, 6.95) 1.65 (0.58, 4.69) 1	0.056* 0.34
Knowledge of diabetes mellitus	Good knowledge Poor knowledge	9(4.1) 43(9.1)	209(95.9) 195(81.9)	1 5.12(2.43,10.78)	 <0.001*
BMI	Not overweight/obese Overweight/obese	18(5.8) 34(23.8)	295(94.2) 109(76.2)	1 5.11 (2.77, 9.43)	 <0.001*
Hypertension	No Yes	18(5.9) 34(22.5)	287(94.1) 117(77.5)	1 4.63 (2.52, 8.53)	 <0.001*
*Significant at p-value <0.25					

When multivariable logistic regression analysis was conducted the factor associated with diabetes mellitus bivariate analysis was determined, along with the variables' p-values of ≤ 0.25 was taken to multivariable and the model using backward stepwise method was employed to select the best fitting model. The overall goodness of fit was assessed using the Lemeshow and Hosmer the goodness of fit examination. The final model predicts the data well. The P-value of Lemeshow and Hosmer goodness of fit examination P = 0.132. A statistically significant p-value was defined as one that was less than 0.05.

According to these, in the multivariable logistic regression model, p-value ($p< 0.05$), ever-smoke cigarette or cigarette smoking status, alcohol consumption, knowledge of diabetes mellitus, body mass index (BMI), and hypertension were discovered to have a strong association with diabetes mellitus.

According to the adjusted odd ratio study, smokers had a 4.44 (95%CI; 2.08-9.48) time likelihood of developing unrecognized diabetes mellitus compared to non-smokers. Apart from this corrected odd ratio, the results showed that the likelihood of undiagnosed diabetes mellitus was 2.54 [95%CI; 1.24-5.22] times higher in alcohol users compared to non-drinkers. Additionally, In the adjusted odd ratio analysis, low knowledge on DM individuals had a 3.97 [AOR=3.97, 95% CI (1.74, 9.06)] times likelihood of developing diabetes mellitus than with good knowledge on Diabetes mellitus .

In the multivariable analysis, overweight study participants had a 2.13 [95%CI; 1.03-4.43] time likelihood of developing undiagnosed diabetes mellitus than the normal weight study participant.

Moreover, participant with hypertension had a 2.71 [95%CI; 1.34-5.54] time likelihood of developing undiagnosed diabetes mellitus than the non-hypertensive study participants (**Table 5**).

Table 5: Bivariable and multivariable logistic regression analysis for factors associated with undiagnosed diabetes among adults in Arba Minch City, Gamo Zone, South Ethiopia, 2024

Variable	Category	Undiagnosed diabetes		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Present	Absent				
Sex	Male Female	37 (15.9) 15 (6.7)	195 (84.1) 209 (93.3)	2.64 (1.41, 4.97) 1	0.003	1.94 (0.92, 4.05) 1	0.08
Age (in years)	<35 ≥35	12 (5.4) 40 (17.3)	213 (94.6) 191 (82.7)	1 3.72 (1.90, 7.29)	<0.001	1 2.11 (0.98, 4.55)	0.057
Educational status	Unable to read and write Grade 1-8 Grade 9-12 College level and above	2 (5.3) 21 (16.2) 11 (9.7) 18 (10.3)	36 (94.7) 109 (83.8) 103 (90.3) 156 (89.7)	0.48 (0.11, 2.17) 1.67 (0.85, 3.28) 0.93 (0.42, 2.04) 1	0.34 0.14 0.85	0.22 (0.04, 1.15) 0.77 (0.32, 1.85) 0.46 (0.18, 1.22) 1	0.07 0.56 0.12
Smoke cigarette in the last 12 months	Yes No	18 (26.9) 34 (8.7)	49 (73.1) 355 (91.3)	3.84 (2.01, 7.30) 1	<0.001	4.44 (2.08, 9.48) 1	<0.001*
Chew khat	Yes No	15 (31.9) 37 (9)	32 (68.1) 372 (91)	4.71 (2.34, 9.49) 1	<0.001	1.29 (0.48, 3.46) 1	0.61
Consumed any type of alcoholic drink in the last 12 months	Yes No	27 (27.6) 25 (7)	71 (82.4) 333 (93)	5.07 (2.78, 9.24) 1	<0.001	2.54 (1.24, 5.22) 1	0.011*
Outside the working hours or transportation time physical activity	Mild exercise Moderate exercise Heavy exercise	31 (14.6) 16 (9.8) 5 (6.2)	181 (85.4) 147 (90.2) 76 (93.8)	2.60 (0.98, 6.95) 1.65 (0.58, 4.69) 1	0.056 0.34	0.54 (0.15, 1.98) 0.84 (0.24, 2.90) 1	0.35 0.78
Knowledge of diabetes mellitus	Good knowledge Poor knowledge	9 (4.1) 43 (9.1)	209 (95.9)	1		1	

			195 (81.9)	5.12 (2.43,10.78)	<0.001	3.97 (1.74, 9.06)	0.001*
BMI	Not obese Overweight/obese	18 (5.8) 34 (23.8)	295 (94.2) 109 (76.2)	1 5.11 (2.77, 9.43)	<0.001	1 2.13 (1.03, 4.43)	0.042*
Hypertension	No Yes	18 (5.9) 34 (22.5)	287 (94.1) 117 (77.5)	1 4.63 (2.52, 8.53)	<0.001	1 2.73 (1.34, 5.54)	0.006*
*Significant at p-value <0.05; Hosmer and Lemeshow test was satisfied (P-value= 0.132)							

6. Discussion

The present study aimed to assess the Prevalence of Undiagnosed DM and Associated Risk Factors among Adults aged 18 and above in Arba Minch City, Southern Ethiopia. In this study, the result showed an 11.4 % magnitude of undiagnosed DM. In this study cigarette smoking status, alcohol consumption, low knowledge on diabetes mellitus, hypertension and body mass index were discovered to be considerably associated with undiagnosed diabetes mellitus.

In this study, the magnitude of UDM in individuals who are at least 18 and above was 11.4%. the frequency of undiagnosed DM observed in this study was comparable to those of studies conducted in Malaysia (8.9%) (71), study conducted in USA 11.5% (72), study conducted in Italy (73). Also, the proportion of people with undetected DM in the study was consistent with the result of study conducted from the subgroup analysis of African urban population 8.68% (34), this study was also comparable with studies conducted in northwest Ethiopia,East Gojjam zone, 11.5%(33), studies carried out in Bahir Dar town, northwest Ethiopia 10.2% (63) and the magnitude of UDM in Tanzania was 9% (9). Mostly magnitude of UDM in this research was in line with the study carried out in Southwest Ethiopia, Mettu town a Community-Based Cross-Sectional Study on adults 12.3%(74).

However, magnitude of undetected DM was less in our study thanfrom study done in Nigeria 18.9% (75) and in South Africa 18.1%(41), in Kanungu District 18.7% (65), and Konso, southern Ethiopia 54.5% (50). Again the result of different studies compared with this result, this result was lower than those of patients with UDM and hypertension in Kenya (14%) and India (15%) (76).

However, The study's outcome is compared along with other research, this discovery was strictly less- than that of a research carried out in Denmark 27.1% (77), and the result of a study conducted in Bukittinggi, Indonesia 32% (78). The possible explanations might be sociodemographics of living habit variations. The study was conducted among dental patients in Denmark whose diabetes was often associated with complication, like gingival ulcer.

Overall this diffrence might be explained partly due to seasonal variation(seasonal variation is considered that means every person can not get all food derivatives in the same day and moth, so month to or 3 month defference each person get different types of foods, socioeconomic differences, feeding habits of the study population, different recent changes in lifestyle and

urbanization have resulted in a decrease in physical activity and an increase in obesity. Other factors that affect health-seeking behavior include screening practices for diabetes and other health problems, age differences in studies conducted in Kanungu, China (age ranging from 45 to 80 years), genetic factors, and sample size

However, this result greater than that of a research conducted in the northwest Ethiopian town of Koladiba(51). East Shewa study, 2.3% of people in East Shoa, Ethiopia's Bishoftu town, had undiagnosed diabetes mellitus (79) in west Ethiopia, 5.1% (47), the same study done in Adis Ababa tells the magnitude was 6.6% (43), in Gonder, North West Ethiopia, 5.1%(42), in western Ethiopia 6.4% (46) and in west Ethiopia, 7.14%(46), Dessie Town, northeast Ethiopia, 6.8% (80), and Mizan-Aman Town, south Ethiopia, 6.5% (81). This Variations could be due to locations, such as rural settings, age differences, study design, sample size, study period, and facility-based study, could be the cause of this. Different studies conducted on age difference, study carried out in West Ethiopia age 41-64 years (46), and in East Gojjam (NW Ethiopia aged ≥25 years (33).

In general, Low-quality health-seeking behavior, low awareness raising, and subpar community screening programs may account for the largest percentage of undiagnosed diabetes. It is important to pay close attention to this because, although there may be variations depending on the study sites, study periods, and diagnosis techniques employed, overall the difference is quite high. If not discovered and screened early, this greater risk becomes diabetes mellitus in the future.

In this study Males had a greater rate of undiagnosed DM when it came to the magnitude of UDM by sex. Which was consistent with study findings from Yemen(82), the study result conducted near the East Shoa town of Bishoftu, in Ethiopia (47), and the study result conducted in Mettu town, southwest Ethiopia(74). However, women's vulnerability is additionally observed in additional reports such as the study results in West Ethiopia, Nekemt (46), and East Gojjam(NW Ethiopia (33). The gender disparity discovered in this investigation was probably just a result of women's lower participation rates. Furthermore, simultaneous risk factors in men could be the cause

Various research investigations have indicated that as people age, the prevalence of diabetes rises. Even while the link between age and the magnitude of UDM was not statistically significant, the current investigation also showed an increasing tendency in this regard. The results of this study agree with those of Bishoftu Town in Ethiopia(47), and they discovered that as people age, there is a larger incidence of undiagnosed DM in Bahir Dar, northwest Ethiopia(63). Responsible

mechanisms of age-related glucose intolerance include decreased insulin sensitivity and decreased β-cell function (83). Sarcopenia, or decreasing muscle mass, overweight, and a decline in physical activity are all results of aging in older adults. Insulin resistance develops as a result as people age. Moreover, aging impairs the function of islet cells by lowering insulin production, which results in insulin resistance(50)

According to this research finding, there wasn't any statistically significant association between undiagnosed DM and marital status. The lack of association between a person's marital status and undiagnosed DM was also observed in a study conducted in Bishoftu town (47) and results show in west Ethiopia (46). However, some findings suggest that single, divorced, and widowed statuses increase the risk of DM (84) and the other finding (85). The fact that there were more other groups in this study than married people could account for the lack of relationship.

Although the causes of diabetes are not fully understood it has a strong link with obesity/body mass index, hypertension, alcohol consumption, poor knowledge of DM, and cigarette smoking status. This statement is supported by different studies, including the present study.

Obesity/ BMI was associated with undiagnosed DM in the current study. The present study observed that overweight study participants had a 2.13 time likelihood of developing undiagnosed diabetes mellitus than the normal weight study participants. The study supports the findings of the current investigation is, in west Ethiopia, Nekemt (46), in Bishoftu Town, East Shoa, Ethiopia(47), and Bahir Dar city, northwest Ethiopia (63). Being obese has been linked to β-cell malfunction and insulin resistance, which are two main risk factors for type 2 diabetes and prediabetes. This is especially true when it comes to increased intra-abdominal fat, the accumulation of an excessive amount of body fat distribution, and increased intrahepatic and intramuscular triglyceride content (86).

This study declared that hypertension with undiagnosed diabetes mellitus were statistically significant associations.

The present study observed that hypertensive study participants had a 2.71 time likelihood of developing undiagnosed diabetes mellitus than the non-hypertensive study participants.The current study is supported, in Konso southern, Ethiopia (50), and in Mettu town (74). In addition,

This study agrees with one conducted in China(87), Brazilian (88), Dessie town northeast Ethiopia (52), additionally to Koladiba Town in Northwest Ethiopia(51). A common origin and multiple risk factors, including obesity, dyslipidemia, insulin resistance, and genetic susceptibility, are shared by both disorders, although the mechanism of either is unknown and does not cause diabetes directly. Atheroclerosis, vascular inflammation, fibrosis, endothelial dysfunction, and arterial remodeling are all associated with this. Cardiovascular conditions including macrovascular and microvascular problems follow this. In addition to this, the transport of insulin and glucose to skeletal muscle cells is altered by hypertension, which leads to decreased glucose uptake and, ultimately, hyperglycemia. Both of these effects result in insulin resistance(50). This indicates that screening for DM should be targeted to patients with hypertension in Ethiopia.

We found that, undiagnosed DM and alcohol consumption were associated. The result of this study concluded in adjusted odd ratio findings, that alcohol drinkers had 2.54 times to develop diabetes mellitus than non-alcohol drinkers. The result of the current study finding aligns with the results of a nationwide cohort study (89), in Bishoftu town east Shewa, Ethiopia(47) and Mettu town (74). The hypothesized diabetogenic effects of alcohol include its contribution to inadequate insulin release, reduced insulin binding, and inhibition of intracellular signaling with the eventual development of insulin resistance.

In other words, in the current study, Undiagnosed DM and smoking cigarettes were associated. In the adjusted ratio analysis, smokers as compared to non-smokers had a 4.44 time likelihood of acquiring diabetes mellitus than the non-smokers. The finding agreed with the current result (74). Insulin helps blood sugar enter cells, but nicotine changes cells so they don't respond to insulin, which increases blood sugar levels. Chemicals in cigarettes harm cells in your body and cause inflammation. This also makes cells stop responding to insulin.

This investigation indicated that poor knowledge was a substantial risk element associated with the onset of diabetes mellitus as well as undiagnosed diabetes mellitus. Participants who had poor knowledge of DM were 3.97 times more probable to have undiagnosed diabetes mellitus

(AOR=3.97, 95% CI (1.74, 9.06) than compared with good knowledge. The current result is related with the finding at University of Ambo Referral Hospital, Ethiopia (90) and Lebanon (91).

Overall, our finding observed no important association between undetected diabetes with gender, education status, occupation, income, and family history of DM.

7. Strengthen and limitation of the study

Strength of this finding is baseline information on undiagnosed DM in Arba Minch City. This study's findings are applicable to the local community because it was conducted in a community, and it may be incorporated into a diabetes screening program for high-risk individuals. Those research participants who tested positive for prediabetes (impaired glucose tolerance) and diabetes recently were directed to local healthcare facilities for additional monitoring and care.

In this study, respondents' information bias about income and age. Second, the fast blood glucose (FBG) test, which was the sole measure employed in this study's primary laboratory measurement, underestimated the prevalence. Thirdly, the cross-sectional structure makes it challenging to determine a causal relationship link. Fourth, the type of diabetes was not identified in this investigation. Lastly, self-reported factors like physical activity, alcohol use, and smoking habit contributed to recall bias.

8. Conclusion

In general, this research finding indicated that high prevalence of UDM and pre-diabetes, among the adults in Arba Minch town in Gamo Zone. The associated risk factors identified for the increased development of undetected diabetes mellitus were cigarette smoking states, Alcohol consumption, knowledge of DM (especially poor knowledge), overweight, and hypertension. In general this finding reveals that prevalence of diabetic mellitus in Arbaminch is high(that means,of 456 participants,52 participants has detected undiagnosed diabetes mellitus calls from 100 participants, 1o participants can affected).

9. Recommendation.

- South Ethiopia Regional Health Bureau, Gamo Zone Health Bureau, and Arba Minch Town administrative health unit have to strengthen the effort to raise undiagnosed diabetes mellitus-related issues through promoting health information dissemination.
- The zonal health department should improve and fortify the delivery of health education programs and counseling for adequate physical activity, diet, weight control, and general awareness about diabetes mellitus (DM), including its causes, prevention, and treatment mechanisms), and advise the communities for widespread diabetes screening. Since early detection and behavioral changes to one's lifestyle may lessen the impact of diabetes
- The health professionals who serve in primary health centers and hospitals should provide health education for the clients or patients on risk factors of diabetes mellitus, smoking cigarette behavior, the risk of alcohol consumption and DM, give enough information on diabetic mellitus, prevention and control mechanisms of diabetes mellitus
- Health extension workers should spread health awareness throughout the community about altering lifestyle choices such eating a healthy diet, exercising, giving up smoking, and abstaining from alcohol to lower the chance of acquiring diabetes mellitus.
- Urban health extension programs shall target households to implement dietary and physical activity practices that help reduce weight.
- Additionally,available of materials screening of high-risk groups aged >35 years is recommended to early detect and prevention.
- In order to strengthen the findings more extensive or use wider sample size for such research is advised

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Annex:

Annex one: Information sheet

The main aim of this research and the information sheet is to assess the prevalence of undiagnosed DM and Associated factors among adults in Arba Minch town, Gamo zone.

Name of Principal Investigator: Woshke Worade (BSc MLT)

Name of Advisor: Dr. Mistire Wolde (BSc, MSc, Ph.D. Associate professor) and

Gobena Dedefo (BSc, MSc, Clinical chemistry unit head)

Name of Organization: Addis Ababa University College of Health Sciences School of Medical Laboratory Science.

Purpose: The purpose of this research is to assess the prevalence of undiagnosed DM and Associated factors among adults in Arba Minch City, in Gamo Zone, Southern Ethiopia, 2023. This study is primarily designed to find out the prevalence of undiagnosed DM and to identify the associated factors influencing diabetes to improve the health status of communities. Results from this study were used to assist in making recommendations for those who are responsible for designing effective and appropriate measures to improve the health of the adult population. This study used a community-based cross-sectional study design. Blood samples were collected for glucose to determine whether diabetes or not, and anthropometric measurements of adults such as height, weight, and blood pressure and population data were collected using a structured questionnaire. Ethical clearance was taken from Addis Ababa University and a Permission letter was processed from Gamo zone, Arba Minch city administration health department

Risk and/or Discomfort: There is no risk or discomfort that you face by participating in this research except dedication of time for blood collection, anthropometric measurements, and responding to the questionnaires. Any personal information given to the data collector was not informed and transferred to other bodies. Every piece of information was kept confidential.

Benefits: There are benefits for the Gam Zone Health department and Arba Minch town administrative in participating in this research. The findings of the study are no doubt to implement the intervention and make them aware of the problem, improve the health status of the population by creating awareness about associated factors with diabetes. Based on the findings of the research, generally, it helps to design effective and appropriate measures for the prevention and control of diabetes among the adult population.

Incentives/Payment for Participating: There is no incentive or payment to be gained by taking part in this research but any adults categorized as DM according to WHO criteria were incorporated into the follow-up and revived treatment.

Confidentiality: The information collected from this research project was kept confidential. Information was accessed by the researcher and research assistant only.

Persons to contact: This research was reviewed and approved by the ethical committee of Addis Ababa University. If you want to know more information you can contact the principal investigator through the address below. Woshke Worade: **Tel No: +251925651623.**

Annex two: Confidentiality and Consent Form

A structured Questionnaire prepared an assessment of the prevalence of Undiagnosed Diabetes Mellitus and Risk Factors, among adults18 years and above in Arba Minch City, Southern Ethiopia; March 30, 2023

Are you a known diabetes patient?	1. yes→ Discontinue the data collection 2. No →Continue the data collection

Respondent's code number_____

My name is_____. I am one of the data collectors. The study aims to assess the prevalence of undiagnosed diabetes and associated factors among adults in Arba Minch town, Gamo Zone, southern Ethiopia, 2023, and you are chosen to participate in this study by chance. The purpose of this study is to generate information about the prevalence of DM and associated factors among adults in selected Kebeles of the town which may help responsible bodies in the health, stakeholders, and significant others to take action based on the findings. The study will involve individual life questions, anthropometric measurements (height, weight, blood pressure), and laboratory tests. To effectively attain the objective of the research, we are requesting your help. There are questions related to diabetes and associated factors for you to respond to.

Your responses will be completely confidential. It is your full right to refuse to respond to any question or show your willingness for measurement. If you don't want to participate in any stage you can stop. However, your honest answers to these questions will help us better understand of associated factors with undiagnosed DM. we are requesting you to give your honest responses and

keep participating. It will take a maximum of 25-30 minutes to answer these questions, the Whole test will take about two days and the test done before a meal in the morning. In case you have any questions, you can contact the principal investigator, Ato Woshke Worade: Tel: +251925651623

Would you be willing to participate, please?

Yes, ____Continue to interview and take measurements, and No_____Thank her/him and quit.

Participate Signature---------- Date of interview----------

Name of the data collector ----------Signature ----------date ----------

Name of the supervisor ----------Signature ---------- date ----------

Annex three: English Questionnaire

This questionnaire will help the researcher to find out the prevalence and factors associated with undiagnosed diabetes mellitus. All information given in the questionnaire will be handled confidentially. Please, circle the letter of the respondent's choice or write the information space provided below

Participant Information

Name of kebeles_____

Unique ID for specific kebeles_____

Respondent's code number_____

Step 1. Socio-Demographic Information of Respondent

No	Questions	Choices for response	Code
SD 001	Sex	Male 1 Female 2	
SD 002	Age (enter number)	_____ years	
SD 003	Religion	1. Orthodox Christian 2. Protestant 3. Catholic 4. Muslim Other, specific _____	
SD 004	Marital status	1. Never married (single) 2. Currently married 3. Divorced 4. Widowed	

SD 005	Which educational level did you attain?	1. Unable to read and write 2. Grade 1-8 3. Grade 9-12 4. College level and above	

SD 006	What is your Occupational Status	1. Farmer 2. Merchant 3. Daily labor 4. Governmental Employee 5. Private Employee 6. Housewife 7. Student 8. Driver	
SD 007	What is your family's total average monthly Income?	1. _____ birr 2. Don't know	
SD 008	Do you have any first-degree relatives or family with a history of diabetes?	1. Yes 2. NO 3. Don't know	
SD 009	Do you have smoked cigarette in the last 12 months?	1. Yes 2. No →skip to Q012	
SD 010	If yes, to Q No 009, How often?	1. Daily 2. Every other day 3. Weekly Others, specify-------	

SD 011	When did you start smoking daily?	1. Since the last _____years 2. Since the last _____months 3. Since the last _____weeks	
SD 012	Do you chew Khat?	1. Yes 2. No	
SD 013	If yes, to Q No12, How often?	1. Yes, daily 2. Yes, sometimes 3. No, not at	
SD 014	Have you taken any type of alcoholic drink in the last 12 months? (beer, wine, local 'areke', 'Tella' and 'tej')	1. Yes 2. Yes, but not in the past 12 months 3. No, I have never → skip to Q No. 016	
SD 015	On average, how often do you usually drink alcohol * A standard alcoholic drink is the equivalent of one glass/can/bottle (330ml) of regular beer (with 3% ethanol), and one glass (100ml) of wine (10% ethanol).	1. Less than one drink a week 2. One to three drinks a week 3. Four to six drinks a week 4. Seven or more drinks a week 5. Don't Know	
SD 016	How many times per day do you usually take fruits? (Select one response).	1. Don't eat fruits at all 2. Don't eat fruit every day 3. I take fruits once a day 4. I take fruits 2-4 times per day 5. I take fruits 5 or more times per day	

SD 017	How many times per day do you usually eat vegetables? (Select one response).	1. Don't eat vegetables at all 2. Don't eat vegetables every day 3. I take vegetables once a day 4. I take vegetables 2-4 times per day 5. I take vegetables 5 or more times per day	
SD 018	Work-related physical activity: firstly, how many hours do you typically spend at work each day?	_____ Hours.	
SD 019	Work-related physical activity during working hours. A. Mostly sitting or standing with only a short walking distance ----(mild exercise) B. Activities that require the same physical effort as walking long distances or backyard gardening -----(moderate exercise) C. Activities that require the same effort as lifting heavy weights or heavy construction work ---(heavy exercise).	1. Mild exercise 2. Moderate exercise 3. Heavy exercise	
SD 020	Outside the working hours or transportation time physical activity. A. Mostly sitting or standing with only a little walking B. Activities that require the same effort as walking long distances, backyard gardening, or climbing upstairs	1. Mild exercise 2. Moderate exercise 3. Heavy exercise	

	C. Activities that require the same effort as lifting heavy weights or strenuous exercise.		

Note;

- A first-degree relative refers to: your actual father/mother (not step)-), full brother/sister, and full child
- A standard alcoholic drink is the equivalent of one glass/can/bottle (330ml) of regular beer (with 3% ethanol), and one glass (100ml) of wine (10% ethanol).
- One serving of fruit includes one banana, one orange, one apple one slice of pineapple, etc.

Step 2: Knowledge questions related to diabetes mellitus

S.No	Questions	Response options			
		Yes =1	**No= 2**	**I don't know = 3**	**Remark**
	What is/are DM				
200	DM is a condition of insufficient insulin production				
201	DM is a condition of the body which not respond to insulin				
202	DM is a condition of high level of sugar in the blood				
203	DM is not curable				
	What are the risk factors of DM?				
204	Older age				
205	Genetic or family history of diabetes mellitus				
206	Being overweight /Obesity				
207	Sedentary life /Poor dietary habits				
	Control and management of DM				
208	Insulin injection is available for the control and management of DM				
209	Tablets & capsules are available for the control and management of DM				
210	Regular Exercise				
211	Practices healthy diet				
212	Weight reduction				

Step 3: Physical Measurements

PM 101	Blood pressure (measured 2 times)	1st----------mmHg(systolic/diastolic) 2nd----------mmHg(systolic/diastolic)	☐
PM 102	Weight in kg	----------kg	☐
PM 103	Height in cm (measured 2 times)	1st----------cm 2nd ----------cm	☐

PM 104	Body Mass Index (BMI)	Result: _____	☐

Step 4: Blood Glucose Tests

BST 201	Blood glucose analysis: Fasting blood sugar level (in mg/dl)	Result: _____ mg/dl

Annex four: - Amharic version questionnaire:

አዲስ አበባ ዩኒቨርሲቲ፣ የጤና ሳይንስ ኮሌጅ፣ የሕክምና ላቦራቶሪ ትምህርት ክፍል

የስምምነት ቅጽ

የመላሽ ኮድ ቁጥር_____

እኔ አቶ/ወ/ሮ ----------የመጣሁት ከ---------- ነዉ። የመጣሁበት ምክንያት አቶ ወሸኬ ወራዴ በአዲሰ አበባ ዩንቨርስቲ የሕክምናና ጤና ሳይንስ ኮሌጅ የህኪምና ላቦራቶሪ ትምህርት ቤት የክሊኒካል ከምስትር 2ኛ ድግሪ/የማስተርስ ድግሪ መመረቂያ ጥናት ሥነ-ጹሁፍ ያዘጋጁትን መጠይቅ ለመሙላት ሲሆን እርሶዎም ደግሞ እንደአጋጣሚ ከተጠያቂ ሰዎች መካከል አንዱ ሆኔዉ ተመርጠዋል። ጥናቱ የሚያተኩራዉ በጋሞ ዞን በአርባምንጭ ከተማ ያሉ አዋቂ ሰዎች ለስኪር በሽታ የመጋለጥ ዕድላቸው ምን ያህል እንደሆነና ለዚህም አስተዋጾ የሚያበረክቱ ዋና ዋና ምክንያቶች ምን ምን እንደ ሆኑ መለየት ነዉ። ዓላማዉ መረጃዉ ከተሰበሰበ በኃላ በተገኘዉ ዉጤት ለዉሳኔ ሰጪ አካላት ፣ በዘርፉ የሚሠሩ አጋር ድርጅቶችና ለወደ ፊት በተመሳሳይ ርዕስ ጥናት የሚያደረጉ ሰዎች ግብዓት የሚሆናቸዉን ነጥቦች በማግኘት የህብረተሰቡ የጤና

አገልግሎት ለማሻሻል ይረዳል ተብሎ ይታሰባል ። መጠይቁ የተለያዩ የግል መረጃን ጨምሮ አዋቂ ሰዎች ክብደት፣ ቁሜት ልኬት እና የናሙና ምርመራ ወዘተ ያካትታል። የጥናቱ ዓላማ ግቡን ይመታ ዘንድ እርሶዎ የሚሰጡት መረጃ ወሳኝ ስለሆነ ትክክለኛዉን መረጃ በመስጠት እድተባበሩን በአክብሮት እንጠይቃለን። ይህ መጠይቅ በርሶዎ በጎ ፈቃድ ላይ የተመሰረተ የመመለስም ሆነ ያለመመለስ መብትዎ የተጠበቀ ነዉ። ጀምረዉ ቅር የሚያሰኝ ነገር እንኳ ብኖር ማስቆም ይችላሉ ፤ ሆኖም ምስጥራዊነቱ በጠያቂዉና በተጠያቂዉ መሐል ብቻ

የሚቆይ ሲሆን የግል መረጃዎን ያለርሶ ፍቃድ ለ2ኛ ወገን ማስተላለፍ ፈጽሞ የተከለከለ ነዉ።ስለዚህ ከርሶዎ የሚናገኘዉ መረጃ አዋቂ ሰዎች ለስኪር በሽታ ጋር የተያያዙ ዋና ዋና

ምክንያቶችን ለመረዳት ስለሚያስችለን በቅንነትና በታማኝነት የጥናቱ ተሳታፊ ሆነዉ መጠይቁን በመመለስ እንድተባበሩን በአክብሮት እንጠይቃለን። መጠይቁን ለማጠናቀቅ ከ25-35 ደቅቃ ሊፈጅ ይችላል። ሙሉ ምርመራው ለሁለት ቀናት ያህል የሚቆይ ሲሆን ጥዋት ከምግብ በፊት ይከናወናል። ማንኛውም ጥያቄ ቢኖርዎት፣ ዋናውን መርማሪ ማነጋገር ይችላሉ፣ አቶ ወሸኬ ወራዴ፡ ስልክ፡ +251925651623

እባክህ ለመሳተፍ ፈቃደኛ ትሆናለህ?

አዎ ____ቃለ መጠይቁን ቀጥል እና መለኪያዎችን ወስደህ አይ_____አመሰግናት እና ተወው።

ተሳተፍ ፊርማ _____የቃለ መጠይቁ ቀን _____

የመረጃ ሰብሳቢው ስም _____ፊርማ _____ ቀን _____

የሱፐርቫይዘሩ ስም _____ፊርማ _____ቀን _____

የጥናቱ ተሳታፊዎች መረጃ

ተ.ቁ	ቦታ ና ቀን	ምላሽ	አስተያየት
1	ቀቤሌ መለያ ቁጥር	╚═╩═╩═╝	
2	ቀቤሌ ስም		
3	የመረጃ ሰብሳቢ መለያ ቁጥር	╚═╩═╩═╝	
4	ቀን	ቀን ╚═╩═╝ ወር ╚═╩═╝ ዓም ╚═╩═╩═╩═╝	
5	የጥናቱ ተሳታፊዎች መለያ ቁጥር	╚═╩═╩═╝	

ክፍል 1፡-ማህበራዊና ስነህዝባዊ መረጃዎችን በተመለከተ የተዘጋጀ ቃለ መጠይቅ

ተራ ቁጥር	ጥያቄ	የመልስ ምርጫ	ወደ ጥያቄዎች ዝለል
A1	ጾታ	1. ወንድ 2. ሴት	
A2	እድሜ	---------- ዓመት	
A3	ሐይማኖት	1. ኦርቶዶክስ ክርስቲያን 2. ሙስሊም 3. ፕሮቴስታንት 4. 4. ካቶሊክ ሌላ ከሆነ ይግለጹ _____	

A4	የጋብቻ ሁኔታ	1. ያላገባ/ች 2. ያገባ/ች 3. የፈታ/ች 4. የሞተበት/ባት ሌላ ከሆነ ይግለጹ--------	
A5	የትምህርት ደረጃ	1. ማንበብ እና መጻፍ የማይችል 2. ከ1 -8ኛ ክፍል 3. ከ9-12ኛ ክፍል 4. ኮሌጅ እና ከዚያ በላይ የማይችል	
A6	የስራ ሁኔታ	1. አርሶ አደር 2. ነጋዴ 3. የቀን ሰራተኛ 4. የመንግስት ሰራተኛ 5. የግል ሰራተኛ 6. የቤት እመቤት ሌላ ካለ ይግለጹ----------	
A7	የቤተሰብዎ አጠቃላይ አማካይ ወርሃዊ ገቢ ምን ያህል ነው?	1. _____ ብር 2. አላዉቅም	

A8	የመጀመሪያ ደረጃ ዝምድና ያላቸው ዘመዶችዎ በስኳር በሽታ የተጠቃ አለ ?	1. አዎ 2. አይደለም 3. አላውቅም	
A9	ባለፉት 12 ወራት ውስጥ ሲጋራ አጨስሃል?	1. አዎ 2. አይደለም	አይደለም ከሆነ ወደ ጥያቄ 12 ይሂዱ
A10	ጥያቄ 9 መልሱ አዎ ከሆነ ለምን ያህል ጊዜ?	1. በየቀኑ 2. ከሦስት ቀን አንድ ቀን 3. በሳምንት አንድ ቀን 4. ሌላ	
A11	መቼ ነዉ በየቀኑ ማጨሰ የጀመሩት?	1. ባለፈዉ----------ዓመት 2. ባለፈዉ----------ወር	

		3. ባለፈዉ----------ሳምንት	
A12	ጫት ይቅማሉ?	1. አዎ 2. አይደለም	አይደለም ከሆነ ወደ ጥያቀ 14 ይሂዱ
A13	ጫት የሚቅሙ ከሆነ ለምን ያህል ጊዜ	1. አዎ በየቀኑ 2. አዎ አልፎ አልፎ 3. አይደለም በጭራ	
A14	ማናቸውም የአልኮል መጠጦችን ወስደው ያውቃለ? (ቢራ፣ አረቂ፣ ወይን ፣ ጠላ እና ጠጅ)	1. አዎ 2. አዎ ግን ባለፈው 12 ወራ አይደለም 3. አይደለም በጭራሽ	መልሱ አይደለም ከሆነ ወደ አመጋገብ ክፍል ይሂዱ 16
A15	ጥያቄ 14 መልሱ አዎ ከሆነ፤ ባለፉት 12 ወራት ቢያንስ አንድ መለኪያ በምን ያክል በተደጋጋሚ ወስደዋል?	1. በሳምንት ከአንድ ጊዜ ያነሰ መጠጥ 2. በሳምንት ከአንድ እስከ ሶስት ይጠጣሉ 3. በሳምንት ከአራት እስከ ስድስት መጠጦች 4. በሳምንት ሰባት ወይም ከዚያ በላይ መጠጦች 5. አያውቁም	
A16	በአብዛኛው ጊዜ በቀን ውስጥ ፍራፍሬዎች ለምን ያክል ጊዜ ይጠቀማሉ?(አንድ ምላሽ ይምረጡ)	1. ፍራፍሬ በጭራሽ አልበላም 2. በየቀኑ ፍራፍሬ አልበላም 3. ፍራፍሬዎችን በቀን አንዴ እወስዳለሁ 4. በእያንዳንዱ ቀን 2-4 ጊዜ ፍራፍሬ እወስዳለሁ 5. በእያንዳንዱ ቀን ከ 5 ወይም በላይ ጊዜ ፍራፍሬ እወስዳለሁ	
A17	በአብዛኛው ጊዜ በቀን ውስጥ አትክልት ለምን ያክል ጊዜ ይጠቀማሉ?(አንድ ምላሽ ይምረጡ)	1. አትክልት በጭራሽ አልበላም 2. በየቀኑ አትክልት አልበላም 3. በቀን አንዴ አትክልት እበላለሁ 4. በየቀኑ 2-4 ጊዜ አትክልት እበላለሁ 5. በየቀኑ ከ 5 ወይም በላይ ጊዜ አክልት እወስዳለሁ	
A18	መደበኛ ወይም የለመደው የስራ ጊዜዎት በቀን ምን ያህል ነው?	_____ ሰዓት	

A19	በመደበኛ ስራ ሰዓት ያለዎት እንቅስቃሴ ምን ይመስላል? (ከ 1-4 ከተገለጡት ዉስጥ አንድ ምላሽ ይምረጡ) A. ስራዎት መቆም ወይስ መቀመጥ ይበዛበታል፣ በአንድ ጊዜ ከ 10 ደቂቃ ለማይበልጥ ጊዜ መራመድን አካቶ? (mild exercise) B. ስራዎት መካከለኛ የሆነ ጫና ያለበት ስራን ያካትታል ማለትም ፈጠን ያለ እርምጃ ወይም ቀለል ያለ እቃዎችን በአንድ ጊዜ ከ 10 ደቂቃ ለማያንስ ጊዜ መሸከምን? (moderate exercise) C. ስራዎት ከባባድ እንቅስቃሴዎችን፣ እንደ ከባድ እቃዎችን ማንሳት፣ መቆፈር ወይም የግንባታ ስራ ቢያን ስ 10 ደቂቃ በአንድ ጊዜ የሚፈጅ ነው? (heavy exercise)	1. ሁል ጊዜ 2. ብዙ ጊዜ 3. አልፎ አልፎ 4. አይደለም
A20	ከመደበኛ ስራ ሰዓት ውጭ ያለዎት እንቅስቃሴ ምን ይመስላል (ከ 1-4 ከተገለጡት ዉስጥ አንድ ምላሽ ይምረጡ) A. ትርፍ ጊዜዎት መቀመጥ፣ ጋደም ማለት ወይም መቆምን ማናቸውም አካላዊ እንቅስቃሴ ሳያደርጉ ከ 10 ደቂቃ የበለጠ ጊዜ ይደርሳል? B. በትርፍ ጊዜዎት በመካከለኛ ደረጃ ጫና ያለበት ስራ እንደፈጣን እርምጃ ፣ ሳይክል መጋለብ ወይም ዋና ቢያንስ ለ 10 ደቂቃ በአንድ ጊዜ ያደርጋሉ? C. በትርፍ ጊዜዎት ከባድ እንቅስቃሴዎችን ማለትም ሩጫ ወይም አስቸጋሪ ስፖርት ፣ ክብደት ማንሳት ቢያንስ ለ 10 ደቂቃ ይቆያሉ?	1. ሁልጊዜ 2. ብዙ ጊዜ 3. አልፎ አልፎ 4. አይደለም

ክፍል 2: የስኪር በሽታ እዉቀትን የሚመለከቱ ጥያቄዎች

ተ.ቁ	ጥያቄዎች	የመልስ አማራጮች			
		አዎ =1	አይደለም =2	አርግጠኛ አደለሁም = 3	ምርመራ
	የስኪር በሽታ ማለት ምን ማለት ነው ?				
B1	የስኪር በሽታ ማለት ከቆሽት የሚመነጨው ኢንሱሊን የተባለው ሆርሞን (ንጥረ ነገር) ጭራሽ መጥፋቱ/አለመመንጨቱ ወይም መጠኑ መቀነሱ				
B2	የስኪር በሽታ ማለት ከቆሽት የሚመነጨው ኢንሱሊን የተባለው ሆርሞን (ንጥረ ነገር) የሚያከናውነው ሥራ ሲሰናከል የሚመጣ ነዉ።				
B3	የስኪር በሽታ ማለት ስኪር ወይም ጉሉኮስ በደም ውስጥ ከመጠን በላይ ሆኖ ሲገኝ የሚከሰት ነው።				
B4	የስኪር በሽታ መዳን የማይችል ነዉ።				
	ለስኪር በሽታ መከሰት ምክንያት ሊሆኑ የሚችሉ ጠንቆች				
B5	የዕድሜ መጨመር (በእድሜ መግፋት)				
B6	ዘር ወይም በቤተሰብ ውስጥ ሕመሙ ቀደም ብሎ መታየቱ				
B7	ዉፍረት(ውፋሬ) ወይም ክብደት ከሚገባ በላይ መጨመር				
B8	የልተስተካከል የኑሮ ሁኔታ/የአመጋገብ ሁኔታ				
	የስኪር በሽታንና ጠንቆቹን እንዴት መከላከል ወይም እንዳይባባሱ ማድረግ ይቻላል?				
B9	በመርፌ መልክ በሚወሰዱ የተለያዩ የኢንሱሊን ዝግጅቶች የስኪር በሽታን መቆጣጠር ይቻላል				
B10	በአፍ በሚወሰዱ በክኒን እና በጥቅል መልክ ባሉ መድሀኒቶች የስኪር በሽታን መቆጣጠር ይቻላል				

B11	አዘውትሮ የሰውነት እንቅስቃሴ (ስፖርት) መሥራት። ለምሳሌ ያህል በየቀኑ ግማሽ ስዓት በመውሰድ በሳምንት ውስጥ ለአምስት ቀናት ያህል መሮጥ				
B12	ጤነኛ የሆነ ምግብ መመገብ(ይህ ምግብ አትክልትና ፍራፍሬ በብዛት የያዘ)				
B13	ተገቢ በሆነ የሰውነት ክብደት ወይም ውፋሬ ላይ መገኘት				

ክፍል 3: የአካል ልኬት

ተራ.ቁ	መለኪያ	የልኬት ዉጤት	
C1	የደም ግፊት (ሁለት ጊዜ የተለካ) በሚሊ ሜትር መርኩሪ	1. ልኬት አንድ ሲስቶሊክ/ዲያስቶሊክ---------- 2. ልኬት ሁለት ሲስቶሊክ /ዲያስቶሊክ----------	
C2	ክብደት በኬ.ግ.	ልኬት አንድ ---------- ልኬት ሁለት ----------	
C3	ቁመት በሴ.ሜ	ልኬት አንድ ---------- ልኬት ሁለት ----------	.
C4	የክብደት /ቁመት ንጽጽር (ክብደት/((ቁመት)^2)	----------	

ክፍል 4: የደም ምርመራ

D1	ምግብ ከመዉሰዶ በፍት የሚደረግ ምርመራ የደም ስኳር መጠን (በሚሊ ግራም/ደስ ሊትር)	----------(በሚሊ ግራም/ደስ ሊትር)	

Annex five: Procedure for blood glucose determination

1. Have the participant wash hands with soap and warm water.
2. Wash hands with soap and warm water.
3. Use appropriate personal protective equipment (PPE).
4. Choose a clean, dry work surface, and make sure you have the glucose meter, unused sterile lancet, and test strip.
5. Press the power button. When the code number appears, it must match the code number on the bottle of test strips.
6. Use of lancet:
    - Insert a new, sterile lancet into the lancet holder if applicable.
    - Hold the lancet firmly and gently twist and pull off the cap.
7. Obtaining a drop of blood:
    - Hold the lancet firmly against the side of the finger to engage or press the top of the pellet if applicable.
    - Squeeze the finger gently while holding the hand down; knead the palm if blood does not flow easily.
8. Apply a drop of blood to the test strip as directed (read the manufacturer's instructions before use as test strip insertion and blood application may vary).
9. Note the allotted time interval given for testing as indicated by the digital clock or count-down phase on the glucose meter screen
10. The meter displays your result in ≤ 30 seconds.
11. Press the power button to turn off the meter.
12. Appropriately dispose of sharps and bio-hazard materials
13. Wash hands.
14. Document the result in the appropriate form in the participant's chart.
15. Report results.

Interpretation of results

Normal value up to 70-100mg/dl

Prediabetes result 110-125mg/dl

Diabetes or Hyperglycemia ≥ 126mg/dl

Alerts results /needs Referrals

Alert levels requiring immediate notification of PI/Co-I or his designee to evaluate participant and discharge from CTRC:

- Blood glucose level ≤ 50mg/dl
- Blood glucose level ≥ 400mg/dl

Declaration

I, the undersigned, declare that this M.Sc. thesis is my original work, has not been presented for a degree in this area, and that all sources of materials used for the thesis have been duly acknowledged.

M.Sc. candidate: Woshke Worade (B.Sc.)

Signature: _____

Date of submission: _____

This proposal has been submitted with our approval as advisors.

Advisor:

Dr. Mistire Wolde (BSc, MSc, Ph.D. Associate professor

Signature: _____

Date: _____

Place: Addis Ababa, Ethiopia.

Advisor: Gobena Dedefo (BSc, MSc, Clinical chemistry unit head)

Signature: _____

Date: _____

Place: Addis Ababa, Ethiopia.