ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF MEDICAL LABORATORY SCIENCES

PREVALENCE OF UNDIAGNOSED DIABETES MELLITUS AND ASSOCIATED FACTORS AMONG ADULT RESIDENTS OF THE WERABE TOWN, SILTIE ZONE, CENTRAL ETHIOPIA

By:-Mohammed Aliye Said

Advisors:

1. Mr. Samuel Kinde Birru (MSc, assit.prof, PhD candidate)
2. Mr. Gobena Dedafo Dekebo (MSc)
3. Mrs. Mekdes Alem(MSc)

A research thesis submitted to the Department of Medical Laboratory Sciences, College of Health Sciences, Addis Ababa University, in partial fulfillment Master of Science Degree in Clinical Laboratory Sciences (Clinical Chemistry Track)

May, 2025

Addis Ababa, Ethiopia.

Addis Ababa University

College of Health Sciences

Department of Medical Laboratory Sciences

This is to certify that the thesis prepared by Mohammed Aliye Said, entitled:

"Prevalence of undiagnosed diabetes mellitus and Associated factors among adult residents of the Werabe town, Siltie Zone, Central Ethiopia**"** and submitted in partial fulfillment of the requirements for Master of Science degree in Clinical Laboratory Sciences specialty in Medical Laboratory Sciences (Clinical Chemistry Track) complies with the regulations of the University and meets the accepted standards for originality and quality.

Signed by the Examining Committee:

External Examiner_____ Signature _____ Date _____

Internal Examiner _____ Signature _____ Date _____

Advisor_____ Signature _____ Date _____

Advisor_____ Signature _____ Date _____

Chairman of the Department or Graduate Program Coordinator _____

ACKNOWLEDGEMENT

First and foremost I thank the Almighty Allah, whose strength, courage, and guidance sustained me throughout this project. I also extend my deepest gratitude to my advisors, Mr.Samuel Kinde, Mr.Gobena Dedefo, and Mrs.Mekdes Alem, for their consistent support, insightful feedback, and expert guidance, which were the instrumental to successful completion of this study. The invaluable time and willingness of my study participants are gratefully acknowledged. Furthermore, I thank my supportive colleagues and friends for their unwavering assistance and encouragement during the research process.

Finally, I would like to express my sincere gratitude to the Department of Medical Laboratory, College of Health Sciences, Addis Ababa University, for providing the opportunity to conduct this enlightening research. I also acknowledge Werabe University for their generous sponsorship of my Master of Science degree and Werabe Comprehensive Specialized Hospital for their crucial support during data collection.

Table of Contents

List of figures

List of tables

ABBREVIATIONS AND ACRONYMS

ADA	American Diabetes Association
BMI	Body Mass Index
BP	Blood pressure
BFP	Body fat percentage
DM	Diabetes mellitus
DR	Democratic Republic of Congo
FBS	Fasting blood sugar
FHDM	Family history of diabetes mellitus
GDM	Gestational diabetes mellitus
IDF	International Diabetes Federation
IDDM	Insulin-dependent diabetes mellitus
MODY	Maturity-onset diabetes of youth
NHANES	National Health and Nutrition Examination Survey
NIDDM	Non–insulin-dependent diabetes mellitus
TC	Total Cholesterol
TG	Triglyceride
TyG-index	Triglyceride-glucose index
WCSH	Worabe Comprehensive Specialized Hospital
WHO	World Health Organization
UDM	Undiagnosed diabetes mellitus
WC	Waist circumference

Abstract

Background:-Diabetes mellitus is becoming a big public health concern, especially in developing nations like Ethiopia. As long as early screening and follow-up are done, the illness is manageable. However, given the paucity and disarray of Ethiopian studies, and limited studies in a specific setting, tools have been chosen for this study. For that reason, determining the magnitude of undiagnosed diabetes and identifying associated factors for prompt intervention to prevent potentially fatal complications is quite essential.

Objectives: -To assess the Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of the Worabe town, Siltie Zone, CentralRegion of Ethiopia.

Materials and methods:-A community-based cross-sectional study was conducted from May 10, 2024, to September 20, 2024, at Worabe town, Siltie Zone, Central Region of Ethiopia. A total of 212 healthy adults were selected. The required sample size was calculated using single calculation formula. Systematic and simple random sampling techniques were employed. Structured questionnaires were used to collect socio-demographic and clinical data. A blood sample after overnight fasting for (10–12 h) was collected and serum was tested for glucose, total cholesterol and triglycerides. Hexokinase, colorimetric and Triacylglycerol are laboratory assay methods to analyze FBS, TC and TG respectively. on-parametric statistical analysis was performed using SPSS version 25.

Results:-The prevalence of undiagnosed diabetes mellitus among adult residents of the Worabe town was 9.4%. Undiagnosed DM was higher in males than in females (12.1%vs 5.7%, P>0.05).factors like khat consumption, diastolic and systolic blood pressure, total cholesterol, triglyceride, TyG-index and body fat percentage were statistically significant independent predictors of undiagnosed diabetes mellitus.

Conclusion and recommendation:-The magnitude of the undiagnosed diabetes mellitus was high in the study setting. Therefore, creating awareness through activities targeting adults and identified factors should be devised and institutionalized in the health system in the study setting.

Keywords: Undiagnosed diabetes mellitus; Diabetes mellitus

1. Introduction

1.1Background

Diabetes mellitus (DM) is metabolic disorder which is brought on by different factors defined by persistent raised level of blood glucose due to impairments in insulin secretion, action or both(1).Some of the linked variables of diabetes mellitus are: Age, occupation, smoking habit, habit of alcohol use, lipid profile, body mass index, and physical activity(2).

The American Diabetes Association (ADA) and the World Health Organization (WHO) divided diabetes mellitus into different types: gestational diabetes mellitus (GDM), type 1 diabetes, type 2 diabetes, and various other unique forms of diabetes.

Insulin dependence, rapid onset, and a tendency toward ketosis are the hallmarks of type 1 diabetes, an immune system condition in which the immune system targets the pancreatic beta cells that secrete insulin.T2DM is the most common type of diabetes among all the types, accounting for around 90% of all diabetic patients. This kind of diabetes sometimes ignored for years and is associated with a strong inherited predisposition. Patients are more likely to develop it as they age, become obese, and stop exercising. The disease typically manifests as an adult and has minor symptoms than type 1, with ketoacidosis occurring rarely. But, these patients have a higher chance of facing macro vascular and micro vascular complications, as well as a higher chance of entering a hyperosmolar coma.*Pathophysiology of* Type 2 DM is characterized by insulin insensitivity as a result of insulin resistance, declining insulin production, and eventual pancreatic beta-cell failure(3).This leads to a decrease in glucose transport into the liver, muscle cells, and fat cells. There is an increase in the breakdown of fat with hyperglycemia. The involvement of impaired alpha-cell function has recently been recognized in the pathophysiology of type 2 DM(4).Smoking is one of the risk factor to develop disease such none communicable. Because nicotine, a key component of tobacco, can impair the body's ability to use insulin effectively, leading to insulin resistance and it is an alkaloid naturally produced by the tobacco plant that binds nicotinic acetylcholine receptors, found throughout neuronal and non-neuronal or visceral organs. These receptors participate in signaling within the central and peripheral nervous system and in a number of metabolic tissues, including pancreatic islets, adipose tissue, macrophages, liver, and skeletal muscle(5).Nicotine has been shown to directly alter glucose homeostasis(6).Chronic heavy alcohol consumption can impair the function of beta cells in the

pancreas, which are responsible for producing insulin. This can lead to reduced insulin secretion, making it harder for the body to regulate blood sugar levels. Alcohol can also reduce the sensitivity of cells to insulin, particularly in key metabolic tissues like skeletal muscle, liver, and adipose tissue. This means that even when insulin is present, cells may not respond effectively, leading to higher blood sugar levels(7).Khat chewing due to its adrenergic effect cathinone raises plasma catecholamines level and it counteract insulin action and thus resulting in glucagon secretion, activation of glycogenolysis in liver, (β-2 adrenoreceptor mediated response) adreno corticotropic hormone (ACTH) secretion, suppress insulin release from pancreatic Beta cells (α 2 adrenoreceptor mediated response) which generally leads to increased blood sugar level(8).

GDM is the word used to define any level of glucose metabolizing difficulty that begins or is initially identified during pregnancy(9).

Mature-onset diabetes of youth (MODY) is an unusual type of diabetes mellitus (DM) that is monogenic and non-autoimmune, distinguished by disturbance of insulin secretion and death of pancreatic β-cells. The illness mainly begins between adolescence and early adulthood, before twenty five years(10). These genes, the most common are HNF1A, HNF4A, HNF1B, and GCK genes, are mainly included into beta cells. These gene change result in β-cell dysfunction, which reduces insulin secretion and increases blood sugar levels.If a person has not yet received a diabetes mellitus tests, but their blood glucose level currently fulfills the requirements for the diagnosis of diabetes, they are said to have undiagnosed diabetes mellitus(11).Poor health systems, a lack of awareness among the general public and health experts, and the slow happening of type 2 diabetes symptoms are some of the causes contributing to cases of the disease going misdiagnosed for years(12).

The prevalence of the undiagnosed diabetes was found to differ greatly in the most of Ethiopian studies, and some of them recommend more study on related issues. Nothing has been done in the place selected for this study, and there is a shortage of community-based research on the distribution of undiagnosed diabetes and its related factor in resource-constrained settings. This study, therefore, assesses prevalence of undiagnosed Diabetes mellitus and associated factors among adults living in Worabe town.

1.2 Statement of the problem

Most frequent serious health complications could result from a delayed diabetes diagnosis are peripheral arterial disease and nerve damage. For women in particular, there is also chance of miscarriage(13).According to a report published by the International Diabetic Federation in 2021, the proportion of undiagnosed diabetes in sub Saharan Africa was 54%, a 4% increase from 2019, with the African region having the highest prevalence of when compared other regions(14).In the same year, the estimated mortality associated with DM in the African region was approximately 416,000, due to late diagnosis and failure to seek treatment(15).

In Ethiopia, among populations living with diabetes, according to IDF 2017 estimate; approximately 1.96 million (76%) of them are undiagnosed and unaware of their diabetes status(16).Evidence from studies conducted in Gondar, northwest Ethiopia, showed that 2.3% of the individuals lived with undiagnosed DM(17).

After cardiovascular disease, diabetes is presently the Ethiopia's second most prevalent non-communicable illness and its distribution is 4.8% in this nation, but 25% of people there have undiagnosed diabetes mellitus (DM), which increases the risk of numerous complications like heart collapse ,blood vessel problems, eye, kidney, and nerve damage (18).According to the systematic review and meta-analysis conducted showed that the combined prevalence of undiagnosed diabetes mellitus in Ethiopia was 5.75%(19).

Globally an estimated gross domestic product loss due to DM, including both the direct and indirect costs, will total US$ 1.7 trillion, while LMICs have a total loss of US$ 800 billion due to the unacceptably high burden of DM(20).In addition to the health burden, diabetes also impacts the individual’s economy, healthcare system and government spending by incurring high medical costs. Estimated global healthcare spending related to diabetes was approximately $376 billion in 2010, accounting for approximately 12% of total healthcare spending. For these UDM reasons, an additional cost of $2864 per year per person was associated with complications related to late diagnosis and treatment(21).

Behavioral risk factors which can raise chances of having diabetes mellitus include: being overweight, being physically inactive, using tobacco products and drinking alcohol (22).

As far as it is known, no prior published study has been done in the place which has been selected for this study. As a result, the present study will mainly focus at determining the burden of undiagnosed DM and to identify factors related to its happening.

1.3 Significance of the study

Undiagnosed diabetes mellitus increases the risk of numerous complications and results in high cost of managing the complications. Therefore this study will help to

- Determine burden and related factors
- Successfully provide care, policies must take diagnostic methods into account to enhance screening for instances of diabetes mellitus that are not yet identified.
- Promote intervention to prevent complications due to diabetes mellitus
- Reduce loss of costs to manage complications
- Serve as baseline data for the upcoming researchers.

.

2. Literature

The primary cause of T1DM pathophysiology is when the body's immune system is targeting the pancreatic cells that produce insulin caused by macrophages and T lymphocytes that invade the islet. Although reduced insulin production due to malfunctioning pancreatic beta cells is the primary result of non-insulin-dependent diabetes mellitus, insulin activity is also hampered by insulin resistance. When insulin resistance is high, beta cell mass has altered and can increase the supply of insulin in order to make up for the excessive and abnormal demand(23).

According to a study done in India by Bharatia et al. (2014), the primary predisposing factors for diabetes mellitus are high blood pressure, obesity, overweight, smoking, alcohol intake, tobacco use, and exercise habits(24).

Based on another study done in China by Hu et al. (2017), showed that predisposing variables of diabetes are: being older, having a increased body mass index, a larger waist circumference, getting married, eating badly, having less education, and, and having more Co morbidities(25).

According to the IDF Diabetes Atlas research, nearly half of people aged 20-79 years who have diabetes mellitus did not know they had the disease (44.7%; 239.7 million) in the world in 2021). Highest rates of undiagnosed diabetes were observed in South-East Asia (51.3%), the Western Pacific (52.8%), and Africa (53.6%). In North America and the Caribbean, The least proportion of undiagnosed diabetes was seen(24.2%)(14).

According to data in National Health and Nutrition Examination Survey (NHANES) done from period 2013 to 2016, the prevalence of diabetes among adult U.S. citizens was 9.7% for diabetes with a diagnosis, 4.3% for undiagnosed diabetes, and 14.0% for overall diabetes

A cross-sectional study carried out in South Chennai in 2018 on 1361 adult population; the distribution of undiagnosed diabetes mellitus was nearly 10.3%(26).

Based on 2022 cross-sectional survey of 11, 421 the adult population in Bangladesh, the prevalence of undiagnosed diabetes was 6.0% ,(6.1%) for men and 5.9% for women. Older age, having a raised body mass index (BMI), having raised blood pressure, and being male were predisposing factor linked to undetected diabetes(27).

According to systematic analysis on the prevalence and sub-regional distribution of the undiagnosed diabetes mellitus among adults in African countries, the prevalence of undiagnosed diabetes mellitus among adults was 3.85%,the prevalence of undiagnosed diabetes mellitus

geographically was 4.43% in Eastern Africa; 4.72% Western Africa; 4.27% in Northern Africa and 1.46% in southern Africa respectively(28)

In 2015, 1111 adult subjects participated in a cross-sectional research done in Sudan in 2015, in the rural areas of River Nile State; the incidence of undiagnosed diabetes was 2.6%. (29).

When it comes to Ethiopia, a lot of research has been done in various locations to determine the prevalence of undiagnosed diabetes mellitus. In Ethiopian adults, elevated blood sugar is prevalent 6 percent of the time(30).

A cross-sectional investigation was carried out on 422 volunteers in selected institutions at Bishoftu town, East Shoa, Ethiopia, from 2012 to 2013 showed that the prevalence of the undiagnosed diabetes mellitus was 5%(31).

In a rural koladiba town, northwest Ethiopia a community based cross-sectional study was conducted on 392 adults, in 2015, that showed the prevalence of Undiagnosed diabetes mellitus to be 2.3%(32).

A community based Cross-sectional study which was conducted on 757 adults in East Gojjam,northern Ethiopia in 2016 showed In the research region, the overall prevalence of undiagnosed diabetes mellitus was 11.5%.The frequency was 13.4% in cities compared to 10.3% in rural regions, and 11.3% in men compared to 11.8% in women. The burden of undetected diabetes mellitus was primarily associated with older age, family history of diabetes, and history of pregnancy-related diabetes(33).More over burden seems to be greater in urban areas when compared to rural ones. Yet, the burden in rural is really alarming.

The burden of undetected diabetes mellitus was 10.2% in a 2018, community-based cross-sectional study conducted on 607 healthy adults in Bahir Dar city, northwest Ethiopia(34).

A community-based cross-sectional study was conducted on 696 adults in Mettu Town, Southwest Ethiopia, in 2018 and the prevalence of undiagnosed diabetes mellitus was 12.3%, and the prevalence of undiagnosed diabetes mellitus was high among Sedentariness, raised diastolic blood pressure, alcohol consumption, khat use, and a family history of diabetes mellitus (35).This investigation was done in the same year with that of investigation done in Bahar Dar city. But the prevalence was slightly higher than that of the prevalence of undiagnosed diabetes in Bahar Dar town. This could be due to higher study subjects taken by the study conducted in Mettu town.

Again in Debra Tabor town, north central Ethiopia, a community-based cross-sectional study was conducted on 407 healthy adults in 2021 on the magnitude of undiagnosed diabetes mellitus and associated factors, and showed the prevalence of undiagnosed diabetes was 4.5% and significant correlation was found between Undiagnosed diabetes mellitus and a family history of the condition (36).

The prevalence of undiagnosed diabetes was 14.7% in 2021 in a community-based cross-sectional study conducted on 422 healthy adults in the Menja Communities, sheka zone in Southern nations, nationalities and people and Reduced vegetable intake, decreased physical activity, and a family history of diabetes mellitus were the independent factors predicting of diabetes risk in Menja communities(37).

In similar manner, Community based cross-sectional study which was conducted on 324 adults in the cityof Woreta, northwest Ethiopia, in 2021 revealed that the burden of the undetected diabetes mellitus was about 10.0%(38).Among the these three studies, prevalence of the undiagnosed diabetes in woreta town is lowest, due to it could be study subjects taken and life style related conditions.

Over all above studies conducted In Ethiopia, had showed different percentage of undetected diabetes mellitus, for instance, study carried out in Bishoftu,Koladiba, East Gojam,Bahr Dar, Mettu, Debre Tabor, Menja community, and Woreta, discovered that the number of people with undetected diabetes mellitus was 5, 2.3, 11.5, 10.2, 12.3, 4.5, 14.7and 10.0% respectively, with over all pooled average prevalence of 8.8%.In general above variations in prevalence was could be study subjects difference, this means as study subjects taken increases the prevalence will increase. In the above studies, habit of alcohol use, habit of khat use, physically inactiveness increased diastolic blood pressure, older age, family history of diabetes, history of gestational diabetes, less physical exercise. Lower vegetable consumption, abnormal body mass index, and increased systolic hypertension all are independent predictors of undiagnosed diabetes mellitus.

Despite the fact that these investigations have been done in different parts of Ethiopia, no published study has been carried out in the worabe town communities. So, the purpose of this investigation is to assess the prevalence of undiagnosed diabetes and its contributors among adults in worabe town communities. This enhances the implementation of evidence-based interventions for governmental and non-governmental groups as well as policymakers.

3. Objectives

3.1General objective: -

- To determine the prevalence of undiagnosed diabetes mellitus among adult residents in Worabe town, Siltie Zone, Central Ethiopia.

3.2 Specific objectives:-

- To determine prevalence
- To determine socio-demographic factors related with undiagnosed diabetes mellitus among adult residents in Worabe town,
- To determine the relation between lifestyle factors and undiagnosed diabetes mellitus among adult residents in Worabe town,
- To evaluate the relationship between anthropometric and undiagnosed diabetes mellitus among adult residents in Worabe town ,
- To evaluate the association between lipid profile and undiagnosed diabetes mellitus among adult residents in Worabe town.

4. Materials and methods

4.1Study area

The study was carried out in Worabe Town, Silte Zone, Central Ethiopia, which is located 172 km south of Addis Ababa. The Zonal administrations are surrounded by the Oromia Regional State to the east, the Guragae Zone to the north, the West Hadia Zone to the west, and the Alaba Zone to the southeast.

Worabe town administration has a total number of ten dispersed kebeles (these are Fuge, Albazar, Datie wazir6, Germama, 01 kebele, 02 Kebele, Diledate, Alkeso, Anshebesso, and Agedele) with total population of (201778) and households (20305). Worabe city has one hospital, two health centers, 5 post offices and 12 private clinics.

4.2. Study design and period

Community based cross-sectional study design was conducted from May 10, 2024 to September 20, 2024.

4.3. Population

4.3.1. Source population

All adults aged 18 years and above residing in the worabe town

4.3.2. Study Population

Everyone who was 18 years of age or older and living in the selected houses throughout the research period who fulfilled the requirements for inclusion.

4.4. Eligibility criteria

4.4.1. Inclusion criteria

Persons who fulfill the following criteria were incorporated in this study:

- Apparently healthy Adults aged 18 years or older
- Permanent residents within the selected households in Worabe town for at least six months prior to beginning of the investigation.
- Individuals who gave written consent.

4.4.2. Exclusion criteria

- Participants taking drugs that significantly affect blood glucose levels, including corticosteroids, estrogens, diuretics, and antidepressants were excluded from the current study.
- Individuals with a prior diagnosis of diabetes mellitus, as self-reported or documented in medical records.
- Pregnant women (due to the potential for gestational diabetes).
- Individuals with known cognitive impairment or mental illness that would preclude their ability to provide informed consent or accurately participate in the data collection process.
- Individuals who were unable or unwilling to provide a blood sample for fasting blood glucose testing.

4.5. Study variables

4.5.1. Dependent variables

- Undiagnosed diabetes mellitus

4.5.2. Independent variable

- Socio-demographic factors:
  - ✓ Age (years), sex (male/female), occupation (categorized, e.g., farmer, merchant, Civil servant, House wife and Other),marital status (single, married, divorced, widowed), educational attainment (categorized, e.g., illiterate, semi-illiterate, primary, high school ,college or university) and family history of diabetes (yes/no)
- Lifestyle and Behavioral Factors:
  - ✓ Physical activity, tobacco use,alcohol consumption and khat chewing
- Anthropometric Measures:
  - ✓ Weight (kilograms), height (meters), waist circumference (centimeters) and blood pressure (systolic and diastolic, mmhg)
- Lipid Profile:
  - ✓ Total Cholesterol (mg/dL), and Triglycerides (mg/dL)

4.6. Sample size calculation and Sampling method

4.6.1. Sample size calculation

The sample size is calculated by taking 95% (1.96) confidence interval, 5 %(W=0.05) which is the marginal error and using the undetected diabetes mellitus percentage which is 14.7% from prior study done(37).

$$n = \frac{(z\,\alpha/2)^2 . P(1-p)}{d^2} = \frac{(1.96)^2 (0.147 \times 0.853)}{(0.05)^2} = 192.68 \sim 193$$

By increasing non-response proportion of 10% =212

4.6.2. Sampling Method

Houses from all of the houses in the research region were chosen using the systematic random sampling approach, and study participants were chosen using a simple random sample.

4.7. Measurement and Data collection

The data gathering tool in English was created following an examination of several types of literature. The Amharic version of the questionnaire was translated. Four categories made up the questionnaire: clinical or anthropometric characteristics, lifestyle or behavior, and socio-demographic. One laboratory employee and one seasoned nurse were hired by the principal investigator, who also instructed them on the purpose of the study and the proper way to draw blood samples. Data on socio-demographics and behavior were gathered through in-person interviews using a questionnaire given by the interviewer. The participants were told to fast for the next 10 to 12 hours following the nighttime interview. Venous blood was drawn the next morning in order to assess the lipid profile and fasting blood glucose levels. Two to three milliliters of venous blood were drawn using a standard serum separator tube. After clotting for approximately half an hour at room temperature, the blood sample was centrifuged for five minutes at 3000 rpm. The hexokinase technique was used to measure the serum glucose level in the Clinical Chemistry Laboratory of the Worabe Comprehensive Specialized Hospital using a Roche COBAS 311C chemistry analyzer. Diabetes was diagnosed when the fasting blood glucose (FBG) level was 126 mg/dl or above.

4.7.1 Demographic and behavioral information:-

Each participant was questioned about their age, sex, marital status, employment, level of educational level, physical activity, and family history of diabetes mellitus, alcohol use, and smoking habits.

4.7.2 Clinical data

4.7.2.1. Blood pressure measurement:-

Participants in the research were deemed to have positive hypertension when it was identified. The Omron digital blood pressure device was used to take the patient's blood pressure (BP) while they were seated on their right arm. The final blood pressure value was calculated by taking the mean of two readings obtained five minutes apart. A systolic blood pressure of 140 mmHg or a diastolic blood pressure of 90 mmHg is considered hypertension(39).

4.7.2.2 Anthropometric measurements:-

A meter was used to measure height when study subject was standing upright on a level surface. An adjustable scale was used to evaluate body weight while study subjects were dressed

comfortably. Body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared. Underweight >18.5 kg/m2, normal ≥ 18.5-24.9 kg/m2, and overweight or obese ≥ 25 kg/m2 are the three categories of BMI(40).Triglyceride-glucose index, and it's normal range is less than 10.7.The TyG index is calculated using the formula ln[FBS(mg/dl) × TG (mg/dl)/2].BFP was also measured and it's normal range is less or equal to 25% for women and less than or equal to 35% for men. BFP is calculated using the formula (1.2xBMI) + (0.23xAge)-16.2 for men and (1.2xBMI) +(0.23xAge)-5.4 for women.Using flexible plastic tape, the waist circumference (WC) was measured at the approximate halfway between the top of the iliac crest and the lower border of the last palpable rib. WC levels more than 94 cm were deemed high by the World Health Organization (WHO) for men and women, respectively (41).

4.7.2.3 Biochemical measurements:-

In the evening interview, the participants were told to fast for 10- 12 hours the next day.2-3 milliliters of venous blood were drawn the next morning. After being centrifuged for five minutes at 3000 rpm and allowed to clot for 15-30 minutes at room temperature, the blood sample was sent to the Clinical Chemistry Laboratory of the worabe comprehensive specialized hospital. Then the fasting blood glucose and lipid profile were tested there.According to WHO guidelines from 2006, a fasting blood glucose level of more than 126 mg/dl was considered a diagnostic marker for diabetes mellitus(42).

4.8. Data Quality Assurance

The data was collected by qualified nurses. Laboratory personnel received refresher training on appropriate sample collection before beginning blood collection. Serum was separated within 30 minutes of blood collection, and samples were stored at -20°C before analysis. Before running samples for testing, quality control samples of normal (Humatrol N) and pathological (Humatrol P) were run daily to calibrate the instrument COBAS 311 C chemical analyzer using a calibrator (Autocal).

4.9. Data analysis and interpretation

The statistical program SPSS version 25 was used to enter and evaluate the data once it had been cleaned and coded. For continuous variables, the data was displayed as the median and interquartile range; for categorical variables, the data was displayed as a percentage (%) and

frequency. and some non-parametric tools like kruskal-wallis, and mann-whitney U test were used for analysis.

4.10. Operational definitions

Undiagnosed DM:-person whose plasma glucose fulfills the WHO categorization criteria for diabetes but whose diabetes has not been detected by a doctor.

Fasting Blood Glucose: Serum glucose level after overnight fasting (10-12 hours)

Body mass index (BMI):-is determined by dividing the square of an individual's height in meters by their weight in kilos.

Non-smoker:- An individual who has no habit of smoking

Family history of DM:-is considered positive if one or both of their parents or siblings have been confirmed with the diabetes mellitus.

Non-drinker:- individual who have no drink any kind of alcohol

Khat use: -khat chewing habit or Self-administration of khat

4.11. Ethical considerations

The Institutional Review Board (IRB) of Addis Ababa University gave ethical approval. Data collection was carried out after A formal letter of authorization was acquired from worabe town Administrative Office and WCSH Chief Executive Officer. Language experts translated the questionnaire from English to Amharic. After obtaining each participant's written consent, information was collected after the chosen responders had been fully informed of the study's objectives. Throughout the research period, confidentiality and beneficence were guaranteed, and information was recorded anonymously. Data confidentiality was ensured by employing codes to identify research participants, preventing unauthorized individuals from accessing the collected data, and developing an interventional strategy for those with a diabetes diagnosis.

4.12. Dissemination of the result

The result of this research was disseminated to Addis Ababa University, College of the Health Sciences, and Department of the Medical Laboratory Sciences, Worabe town health office and Worabe Comprehensive Specialized Hospital. Researchers may use the completed investigation as a baseline and source of reference for future research. Additionally, the outcome was shared by being presented at pertinent workshops and seminars and published in peer-reviewed national and international publications.

5. Result

5. 1. Socio-demographic and behavioral characteristics of the study participants

A total of 212 subjects were included in this study. Among the research participants, 58.5% (n=124) were males and 41.5% (n=88) females, indicating sex ratio of 1.4:1.Study Participants in the investigation were between the ages of 18 and 79.A larger proportion of research participants are between the ages of 18 and 34 years with 54.7 %(n=116). Relative to educational levels of the research participants, the majority of them were categorized under college or university, who showed a response of 40.1 %(n=85).Again, concerning the marital status of study participants, the most of them were married, who showed a response of 62.7% (n=133). In the occupational status of study participants, the most of them were civil servants, who responded by about 28 %(n=61). Regarding behavioral characteristics of the study participants, about 36.8 %(n=78), 9 %(n=19), 5.2 %(n=11) and 16%(n=34)of the study participants had habit of khat use, history of smoking cigarette, consuming alcohol and physically activity respectively. In similar manner, when we considered the Anthropometric, and biochemical characteristics of the study participants, about 80.7% of the total participants had a BMI of18.5-24.9 25 kg/m2 followed by 25 kg/m2 or higher (12.3%).And 4.2% had higher waist circumference Relative to obesity indices about (1%) of higher TyG-index, and 23.6% of higher body fat percentage. Again13.7% and 15.1% had an abnormal systolic and diastolic blood pressure respectively and 11.3% had a family history of DM. The study participants also showed abnormally high levels of cholesterol (17%) ,triglyceride (23.1%)and fasting blood glucose (9.4%) (see table1).

Table 1:-Socio demographic ,behavioral, Anthropometric, and biochemical characteristics of the study participants from May 10, 2024 to September 20, 2024 in Werabe town, Siltie Zone,Central region of Ethiopia(N=212).

variable	Category	Frequency(percent)
sex	Male Female	124(58.5) 88(41.5)
Age	18-34 35-54 ≥55	116(54.7) 42(19.8) 54(25.5)

Educational status	Illiteracy	17(8)
	Semi-literate	42(19.8)
	Primary school	40(18.9)
	High school	28(13.2)
	College and university	85(40.1)
Marital status	Single	63(29.7)
	Married	133(62.7)
	Divorced	9(4.2)
	Widowed	7(3.3)
Occupational status	Civil servant	61(28.8)
	House wife	38(17.9)
	Merchant	38(17.9)
	Farmer	41(19.3)
	Other	34(16)
Family history of DM	Yes	24(11.3)
	No	188(88.7)
Chewing khat	Yes	78(36.8)
	No	134(63.2)
Physical exercise	Yes	34(16)
	No	178(84)
Smoking cigarette	Yes	19(9)
	No	193(91)
Drinking alcohol	Yes	11(5.2)
	No	201(94.8)
BMI(kg/m^2)	<18.5	15(7.1)
	18.5-24.9	171(80.7)
	≥25	26(12.3)
WC(cm)	<94	203(95.8)
	≥ 94	9(4.2)

TyG-index	≤10.7 >10.7	210(99) 2(1)
BFB	Normal High	162(76.4) 50(23.6)
DBP(mmhg)	<90 ≥90	180(84.9) 32(15.1)
SBP(mmhg)	<140 ≥140	183(86.3) 29(13.7)
TC(mg/dl)	<200 ≥200	176(83) 36(17)
TG(mg/dl)	<150 ≥150	163(76.9) 49(23.1)
FBS(mg/dl)	<126 ≥126	192(90.6) 20(9.4)

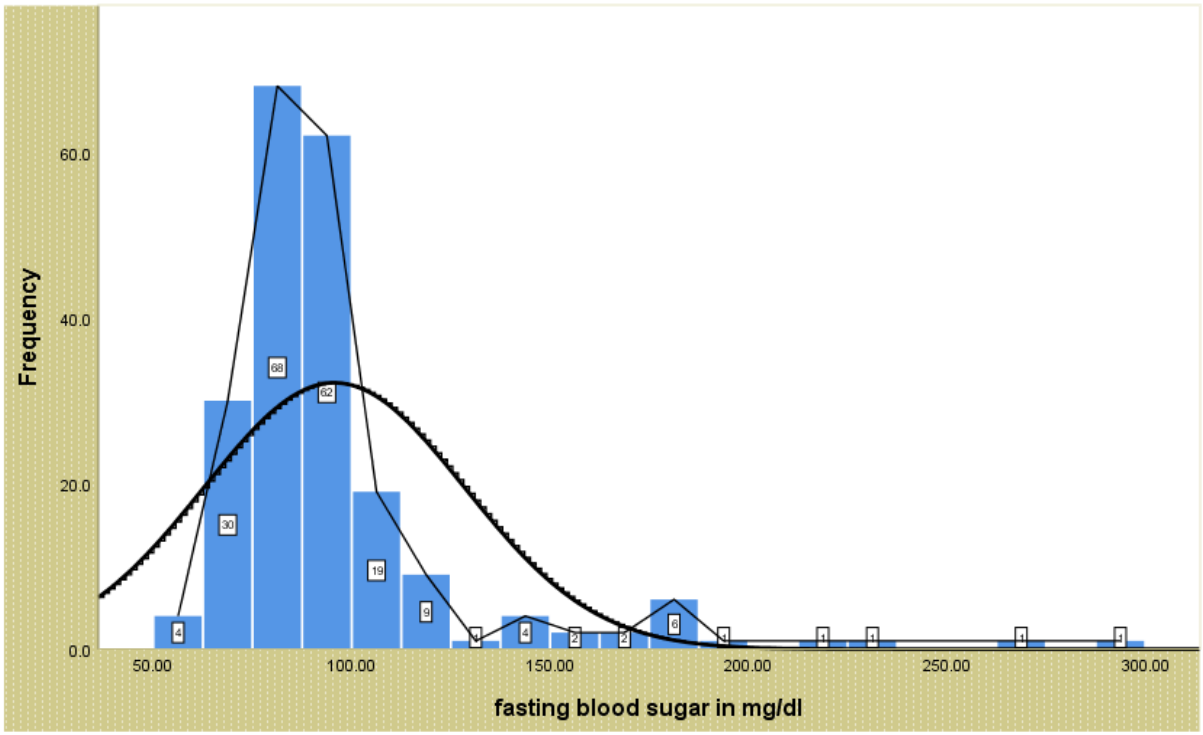

Figure 1:-The distribution of the fasting blood sugar among all the study participants

Prevalence of the undiagnosed diabetes mellitus and its relation to socio-demographic, behavioral, clinical and biochemical characteristics of the study participants

In the investigation out of 212 research subjects tested, 9.4 %(n=20) were confirmed to have undetected diabetes mellitus. The remaining 90.6% (n=192) were none-diabetic. Different proportions of undiagnosed diabetes mellitus were found across different independent variables.

Accordingly prevalence of sex wise, undetected diabetes mellitus was confirmed to be 12.1 %(n=15/124) for males and 5.7%(n=5/88) for females. Similarly age related prevalence of undiagnosed diabetes mellitus was assessed and prevalence was higher among for those participants whose age category ≥ 55 years, when compared to other categories (Fig 3).

Prevalence was also assessed regarding occupational status, educational status, marital status, and family history of DM. Based on this prevalence was higher among others (23.8%), married (13.5%), illiterates (17.6%), and participants having family history of DM(25%) respectively.

Again in regarding behavioral characteristics of the study participants, the prevalence of undiagnosed diabetes mellitus was found in 18.2 %(n=2/11) of individuals who drank alcohol regularly and 9% (n=18/201) of people who didn't use alcohol regularly. in similar manner, the prevalence of undiagnosed diabetes mellitus was found in 10.5 %(n=2/19) of subjects who had history of smoking and 9.3%(n=18/193) of subjects who had no history of smoking. Again prevalence of undiagnosed diabetes mellitus was found to be 17.9 %(n=14/78) in khat chewers and 4.5%(n=6/134) in non-chewers. Prevalence of undiagnosed diabetes mellitus was found to be 5.9 %(n=2/34) in physically active subjects and 10.1 %(n=18/178) in physically inactive subjects. In similar manner,the prevalence of undiagnosed diabetes mellitus was assessed in relation to anthropometric and biochemical factors. Based on this, Among research participants, the incidence of undiagnosed DM with raised WC had 22.2 %(n=2/9), BMI≥25 kg/m2 had 19.2%.The TyG-index abnormal was 100%, the abnormal body fat percentage was 16%,diastolic blood pressure of ≥90 was 37.5%,systolic blood pressure of ≥140mmhghad 34.5%,total cholesterol ≥200 mg/dlhad36.1%, and triglyceride of ≥150 mg/dl had 30.6% (table 2).

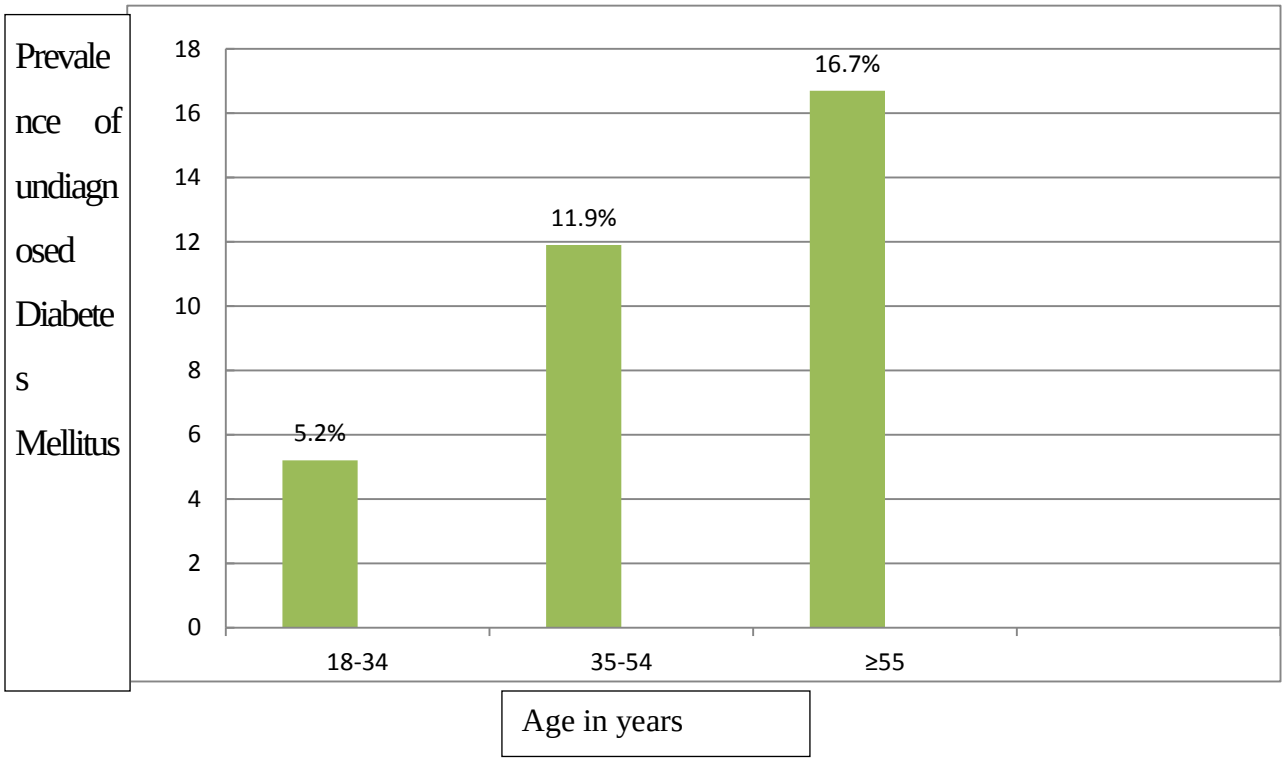

Figure 2:-Age specific prevalence of undiagnosed diabetes mellitus among study subjects in Worabe town, Siltie Zone, and Central region of Ethiopia.

Table 2:-Prevalence of the undiagnosed diabetes mellitus and its relation to independent predictors of study participants from May 10, 2024 to September 20, 2024 in Worabe town, Siltie Zone, Central region of Ethiopia(N=212).

		Undiagnosed DM	
Variable	Category	YES(FBS≥126 mg/dl) n(%)	NO(FBS<126 mg/dl) n (%)
Sex	Male	15(12.1)	109(87.9)
	Female	5(5.7)	83(94.3)
Marital status	Single	2(3.2)	61(96.8)
	Married	18(13.5)	115(86.5)
	Divorced	9(0)	9(100)
	Widowed	7(0)	7(0)
Educational status	Illiterate	3(17.6)	14(82.4)
	Semi-literate	4(9.5)	38(90.5)
	Primary school	6(15)	34(85)
	High school	2(7.1)	26(92.9)
	College and university	5(5.9)	80(94.1)
Occupational status	Civil servant	5(8.2)	56(91.8)
	House wife	3(7.9)	35(92.1)
	Merchant	4(10.5)	34(89.5)
	Farmer	5(12.2)	36(87.8)
	Other	3(23.8)	31(76.2)
Family history of DM	Yes	6(25)	18(75)
	No	14(7.4)	174(92.6)
Smoking habit	Yes	2(10.5)	17(89.5)
	No	18(9.3)	175(90.7)
Physical exercise	Yes	2(5.9)	32(94.1)
	No	18(10.1)	160(89.9)
Khat consumption	Yes	14(7.9)	64(82.1)
	No	6(4.5)	128(95.5)
History of alcohol	Yes	2(18.2)	9(81.8)

consumption	No	18(9)	183(91)
BMI(kg/m^2)	<18.5 18.5-24.9 ≥25	1(6.7%) 14(8.2%) 5(19.2%)	14(93.3%) 157(91.8%) 21(80.8%)
Waist(cm)	<94 ≥ 94	18(8.9%) 2(22.2%)	185(91.1%) 7(77.8%)
TyG-index	≤10.7 >10.7	18(8.6) 2(100)	192(91.4) 0(0)
BFP	Normal High	11(6.8) 8(16)	151(93.2) 42(84)
Diastolic blood pressure(mmhg)	<90 ≥ 90	8(4.4%) 12(37.5%)	172(95.6%) 20(62.5%)
Systolic blood pressure(mmhg)	<140 ≥140	10(5.5%) 10(34.5%)	173(94.5%) 19(65.5%)
TC(mg/dl)	<200 ≥200	7(4%) 13(36.1%)	169(96%) 23(63.9)
TG(mg/dl)	<150 ≥150	5(3.1%) 15(30.6%)	158(96.9%) 34(69.4%)

The respective value of median and interquartile range differences of fasting blood glucose were assessed among different socio-demographic variables. Fasting blood glucose levels were highly fluctuated among semi-literate groups and educational level has significant relationships with the prevalence of undiagnosed DM (P value 0.048). In addition, marital status and occupational status were found to have a significant relationship with the prevalence of undiagnosed DM with P values of 0.008 and 0.032, respectively. Again the respective value of Median and interquartile range difference of fasting blood glucose was assessed among different none modifiable factors. Accordingly there was no significant difference in fasting blood between male and female (P=0.224).But males tended to have highly fluctuated fasting blood sugar relative to females. In similar manner, there was no statistical significance difference between the family history of DM and no family history of DM(P=0.133).But fasting blood sugar in participants who had family

history of DM had higher fasting blood sugar values when compared to participants who had no family history of DM. On contrarily there is statistically significant differences among age categories (P=0.000). Study participants whose Age category ≥55 revealed significantly higher fluctuating fasting blood sugar levels relative to other age categories. In similar manner, The respective value of median and interquartile range differences of fasting blood glucose were assessed among different modifiable factors. Accordingly, there were no statistically significant differences in fasting blood glucose levels between physically active and inactive subjects (P=0.316). But being inactive revealed higher fasting sugar levels when compared to physically active subjects. In a similar manner, statistically there was no discernible difference between smokers and non-smokers (P=0.453).In addition, statistically no significant differences were observed between alcohol drinkers and non-alcohol drinkers (P=0.862), normal waist circumferences and abnormal waist circumferences (P=0.967), and among categories of BMI (P=0.137). Despite the lack of statistically significant variationsamong those independent predictors, higher fasting sugar levels were shown among smokers, alcohol drinkers, participants having normal waist circumferences and study participants whose BMI was greater than or equal to 25 kg/m2. Unexpectedly, higher fasting blood sugar levels were shown in study participants whose waist circumference was normal and study participants who did not consume alcohol. This could be a smaller number of the study individuals that took part in the research setting. In contrast, statistically significant differences in fasting blood glucose levels were revealed between khat chewers and non-chewers (P=0.000) with higher fluctuating of fasting sugar levels in khat consumers, between diastolic blood pressure of above or equal to 90 mmgh and diastolic pressure of less 90 mmgh(P=0.000) with higher fluctuating of fasting sugar level in study participants whose diastolic blood pressure above or equal to 90 mmgh, between systolic blood pressure of above or equal to 140mmgh and systolic blood pressure of less than 140mmgh(P=0.000) with higher fluctuating of fasting sugar level in study participants whose systolic blood pressure of above or equal to 140mmgh. In addition, median and interquartile with tests of differences in fasting sugar levels were assessed among lipid indices and biochemical factors. Accordingly, statistically significant differences in fasting blood glucose levels were shown between normal and abnormal TyG-index(P=0.015) with higher glucose levels in abnormal TyG-index, between normal and abnormal BFP(P=0.001) with higher glucose level in abnormal BFP, between normal and abnormal TC level(P=0.000) with higher fluctuating fasting

blood sugar level in abnormal TC level, and between normal and abnormal TG (P=0.002) with higher fluctuating fasting blood sugar level was revealed in abnormal TG (Table 3).

Table 3:-Median and interquartile range difference of fasting blood glucose among socio-demographic characteristics of study participants (N=212).

Variables	Category	Median(interquartile range)(n)	p-value
Educational status	Illiterate	90.3(16.8)(17)	0.048*[a]
	Semi-literate	92.3(32.95)(42)	
	Primary school	91.15(24.35)(40)	
	High school	87.55(16)(28)	
	College and university	85.2(11.6) (85)	
Marital status	Single	82.9(13.4)(63)	0.008*[a]
	Married	89.6(27.15)(133)	
	Divorced	85.8(27)(9)	
	widowed	86.2(24.5)(7)	
Occupational status	Civil servant	85.6(15.6)(61)	0.032*[a]
	House wife	86.05(25)(38)	
	Merchant	91.7(23.7)(38)	
	Private worker	82.3(27.7)(6)	
	Farmer	89.1(24.9)(41)	

	Other	85.5(12.9)(28)	
Sex	Male female	88.45(17.6)(124) 86.8(16.2)(88)	0.244*[b]
Age	18-34 35-54 ≥55	83.75(13)(116) 91.25(26.6)(42) 93.35(28.5)(54)	0.000*[a]
Family history of dm	Yes No	88.5(76.6)(24) 88.05(15.9)(188)	0.133*[b]
smoke	Yes No	91(36.8)(58) 88(15.6)(193)	0.453[b]
Physical exercise	Yes No	86(10.7)(34) 88.1(19.5)(178)	0.316[b]
Chew khat	Yes No	91.9(33.4)(78) 85.85(13.7)(134)	0.000[b]
Drink alcohols	Yes No	85.6(17) (11) 88.1(18)(201)	0.862[b]
Waist circumference	<94 ≥ 94	88.1(17.2)(203) 85.6(16.7)(9)	0.967[b]
TyG-index	≤10.7 >10.7	88(17.2)(210) 280(34)(2)	0.015*[b]
BFP	Normal High	85.9(14.7)(162) 92.5(23.4)(50)	0.001*[b]
BMI	<18.5 kg/m^2 18.5-24.9 kg/m^2 ≥25 kg/m^2	80.7(20.7)(15) 88.1(18.3)(171) 89.3(19.6)(26)	0.137[a]

Diastolic blood pressure	<90 mmhg ≥90 mmhg	86(13.9)(180) 113.8(76)(32)	0.000*[b]
Systolic blood pressure	<140 mmhg ≥140 mmhg	86(13.9)(183) 111(59.6)(29)	0.000*[b]
TC	<200 mg/dl ≥200 mg/dl	85.95(14.6)(176) 97.4(79.9)(36)	0.000*[b]
TG	<150 mg/dl ≥150 mg/dl	86.5(14.2)(163) 92.4(65.8)(49)	0.002*[b]

- [a]):- kruskal-wallis test
- ([b]):-mann-whitney U test
- (*):-statistically significant

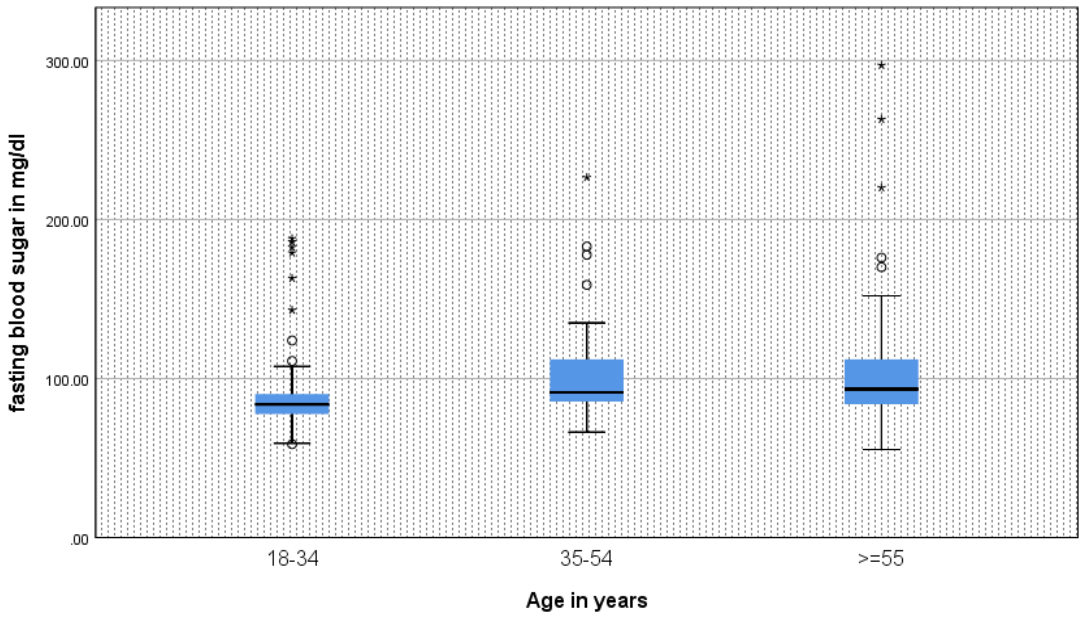

Figure 3:-Simple Box-whisker of fasting blood sugar by age category.

Based on the ordinal, nominal (categorical) and scale of measurement of independent variables, Chi-square and spearman rank correlation were used to assess the strength of association between independent and dependent variables. Based on this, the association of dependent variables with independent variables such as sex and khat consumption was assessed by using the chi-square method. Although significant association was not shown in sex, the risk of developing undiagnosed diabetes mellitus in males was higher than in females. But khat consumption showed a significant association with fasting blood sugar levels and the risk of developing undiagnosed diabetes mellitus among khat chewers was 4.5 times higher than that of non-chewers. In a similar manner, educational status revealed significant associations. Among independent variables, marital status, occupational status, smoking cigarettes, physical exercise, and family history of DM did not fit the chi-square assumption, since there were cells with an expected count of less than five. Spearman rank correlation was used to assess association of fasting blood sugar with continuous independent predictors such as BMI (P-value=0.000), TyG-index(P value=0.000), BFP(P value=0.000), waist circumference (P-value=0.001), diastolic blood pressure (P-value=0.000), systolic blood pressure (P-value=0.000), total cholesterol(P-value=0.002) and triglyceride (P-value=0.008) (table 4).

Table 4:-Correlation analysis result of independent variables with fasting blood sugar among study participants.

No	Variables	X^2	P-value	Relative risk
1	Sex	2.479	0.115[a]	
2	Chewing khat	10.472	0.001*[a]	(yes/no)=4.5
		ρ (rho)		
1	Age	0.363	0.000*[b]	
2	Educational status	-0.198	0.004*[b]	
3	BMI	0.239	0.000*[b]	
4	TyG-index	0.547	0.000*[b]	
5	BFP	0.336	0.000*[b]	
7	WC	0.226	0.001*[b]	
8	DBP	0.403	0.000*[b]	
9	SBP	0.362	0.000*[b]	
10	Total cholesterol	0.213	0.002*[b]	
11	Triglyceride	0.183	0.008*[b]	

- ([a]):-chi-square
- ([b]):-spearman rank correlation
- (*):-statistically significant

The reference intervals for FBS (70-125mg/dl), TyG-index (6.98-10.71) and BFP (>25% for men, >35% for women) were put based on the WHO criteria. Again, the median and interquartile ranges were assessed. Based on this, the respective values of the median and interquartile ranges for FBS 88(79-97mg/dl), TyG-index 8.6(8.3-8.9) and BFP 18.6(14.7-24.4). The prevalence of the abnormal value or high risk of diabetics for FBS, TyG-index and BFP were also assessed. Accordingly, the respective values for these predictors were 9.4%, 0.94% and 23.6%. Relative to the test of differences between gender (P value) for FBS and lipid indices (TyG-index and BFP) were 0.244, 0.005 and 0.001 respectively. In a similar manner, a test of differences between FBS and lipid indices (TyG-index and BFP) among khat chewers was assessed and the P value became 0.000. Tests of correlations with age were done between FBS and lipid indices (TyG-index and BFP) using Spearman's correlation coefficient (rho). Therefore, the respective values of rho and p values were rho= 0.363,P=0.000 for FBS, rho=0.504,P=0.000 for TyG-index and (rho)=0.89(P=0.000 for BFP(table 5)

Table 5:-Assessment of prevalence of abnormal values, Test of difference among gender,khat chewers and correlations with Age in FBS and lipid indices(TyG-index,and BFP)

	Reference interval	Median (IQR)	Prevalence of abnormally value or high risk of diabetics; according to the definition, %(n/N)	Test of difference among gender (p value	Test of difference among khat chewers(p value)	Test of correlations with Age
FBS	70-125mg/dl	88(79-97mg/dl)	9.4% (9/100)	P=0.244	P=0.000	P=0.000 and ρ (rho)= 0.363
TyG-index	6.98-10.71	8.6(8.3-8.9)	0.94%(0.94/100)	P=0.005	P=0.000	P value=0.000 And ρ (rho)=0.504
WHO BFP	≤25% for men,≤35% for women	18.6(14.7-24.4)	23.6%(23.6/100)	0.001	0.000	P value=0.000 And ρ (rho)=0.89

6. Discussion

This study addressed the prevalence of undiagnosed diabetes mellitus among adult residents of Worabe town. Accordingly, over all, the prevalence of undiagnosed diabetes mellitus in the study area was 9.4%. This result was aligned with the studies that were carried out in Bahir Dar, north-west Ethiopia (10.2%)(34).

But this outcome was greater than those found in investigations done at Hosanna, central Ethiopia(2.1%)(43),Koladiba,north-west,Ethiopia(2.3%)(17),diredawa,eastern,Ethiopia (6.2%)(44).This difference may result from numerous reasons, Incorporating differences in the research participants and the socio-demographic characteristics of research participants**.** However, the result was lower than that of reports carried out in menja-community(14.7%)(37),and east-Gojam(11.5%)(33).Variations in socio-demographic traits, behavioral habits, health-seeking actions, sample size, and the prevalence of routine diabetes and health screenings are anticipated to be the reasons for the disparity. Directly comparing prevalence rates is difficult due to the various methodologies used and the differing characteristics of the research groups.

With regard to the proportion of undiagnosed diabetes mellitus by sex, males revealed a more proportion of the undetected diabetes mellitus than females, but no statistically significant correlation was found. The gender difference in this investigation was probably just the result of women's lower participation rate.

In this study, the prevalence of undiagnosed DM was higher among study subjects who were Semi-illiterates or had no formal education. In contrast to this research finding, among research participants with just a primary education or no formal education, the prevalence of undiagnosed diabetes mellitus was lower in reports of Dire Dawa, Eastern Ethiopia. This might be due to lack of awareness among the study participants in this study. Moreover, we got higher occurrence of undiagnosed DM among married study subjects, which is also consistent with the earlier report done in the Iranian urban population(45).However, this result contrasts with another investigation conducted in Iran(46).In a similar manner, the recent investigation found a link between undetected diabetes and advanced age. This is similar to the study carried out in East Gojam (33),

Debre Tabor town(36),and Dire Dawa(44). Due to the frequent reduction in physical activity, getting older is recognized to be linked to higher fat accumulation and lower muscle mass. These changes are believed to lower insulin sensitivity, making individuals more susceptible to metabolic syndrome or diabetes(47). Moreover, getting older is associated with a reduction in B-cell proliferative capacity and an elevation in sensitivity to apoptosis(47).

In the present study, it was found that undiagnosed DM was higher among study participants whose BMI was ≥25 kg/m2; but, it was not statistically significant association. However, there was a significant association between higher BMI and UDM in study conducted in Bishoftu(31). Lack of the association in this study could be low proportion of study participants whose BMI ≥25 kg/m^2.

Additionally, this investigation did not find a statistically significant association between WC and undetected DM. However, significant associations were found in studies done in Bishoftu(31).Which could be due to the variation in study participants included in this investigation.

Again, in this investigation, although it was not statistically significant, research participants with a family history of DM had higher levels of DM. In contrast, a statistically significant association between the family history of DM and DM occurrence was reported in other investigation carried out in Mettu town(48),and Debre Tabor city (36).This is mainly attributed to participants lacking information on the DM status of their parents, resulting in a low number of participants who had a history of DM

In this study, participants who drank alcohol had a greater percentage of undiagnosed diabetes mellitus. However, it did not reach statistical significance. Conversely, investigations conducted in Bishoftu found a strong and positive correlation between alcohol use and undiagnosed diabetes mellitus(31).The lack of association in this study might be explained by the limited involvement of a smaller percentage of alcohol consumers in this study setting. On the other hand, in this study, undiagnosed diabetes mellitus was higher among smokers. Although it was not statistically significant. This could be from limited involvement of a smaller proportion of smokers in the study area.

The observations of the study did not reveal a significant association between physical activity and undiagnosed DM, which is similar to studies done in an urban sub-Saharan African population(49). However, reports done in Menja, community,(37)and East Gojam(50) showed significant association between physical activity and undiagnosed diabetes mellitus. Lack of association in this study could be low number of study participants who had habit of physically activity in study setting.

The investigation's other conclusion was that there was a significant statistical correlation between khat use and UDM. This could be attributed to the habit of spending extended periods chewing Khat and the inadequate glycemic regulation linked to Khat use(51).In a similar manner, there was a significant association between increased diastolic blood pressure and UDM. No investigations have been conducted to date that found increased DBP to be independently linked with UDM. This may be attributed to the well-known effect of extended vasoconstriction on increasing insulin resistance.

The current investigation found a strong correlation between undetected diabetes mellitus and systolic hypertension. This outcome was in line with previous research in Dessie Town, Northeast Ethiopia(52),and southern Ethiopia(53).Elevated blood pressure has been associated with microvascular and endothelial impairment, which may result in insulin resistance(54). Similarly, there was also a significant association between high TG levels and undiagnosed DM. It has been proposed that elevated FFA,possibly originating from TG, impairs insulin sensitivity(55).Again the current study showed significant association between TC and undiagnosed DM which aligns. However studies conducted in Bishoftu(31) did not show significant association.

This study also revealed lipid indices (TyG-index and BFP) as high risk of diabetics and prevalence of their abnormal values were also assessed with respective values of 0.94% and 23.6%.In similar manner this study showed strong correlation association of TyG-index and BFP with age(P =0.000) for both indices.

7. Strength and limitation

7. 1 .strength

This study's community-based approach was one of its advantages. The results may serve as a foundation for screening in the community initiatives for populations at high risk. The results might be useful as a beginning point for a screening in the neighborhood program for high-risk populations. Included were a few risk markers, such as triglycerides and cholesterol levels that show strong correlations with undiagnosed DM.

7. 2. Limitation

Patients having a diagnosis of diabetes mellitus were excluded from this study. Consequently, the precise prevalence of diabetes mellitus in the population cannot be determined only by undiagnosed cases. Relative to other similar studies, the participant count was limited (due to budget constraints we could not add more participants), which could either underestimate or overestimate the prevalence of undiagnosed diabetes mellitus. Indeed, since it was carried out only in urban areas, it may be challenging to apply to rural environments. This research, furthermore, relied on a single test of fasting blood glucose; OGTT and HbA1c were not employed, possibly causing misclassification as a result of fluctuations in blood glucose levels.

8. Conclusion and recommendation

According to this study, 9.4% of people had undiagnosed diabetes mellitus. This is more than the projected prevalence of DM by the IDF (3.32%).It is important to highlight that this outcome is quite concerning since forecasts indicate that a significant portion of the worldwide rise in DM is expected to occur in developing nations, including Ethiopia. In this study, undiagnosed diabetes mellitus was significantly associated with marital status, educational status, occupational status, advanced age, consuming khat, lipid accumulation product, triglyceride glucose-index, body fat percentage, systolic blood pressure, diastolic blood pressure, as well as total cholesterol and triglyceride levels. Consequently, focusing prevention specifically on these Risk factors that are changeable and those that are not may lower the rates of undiagnosed DM. Thus, efforts to raise awareness through initiatives aimed at adults and identified factors ought to be developed and integrated into the health system within the study area. Campaigns and community initiatives aimed at informing the public, regarding preventative measures and early screening measures addressing predisposing factors should be utilized to decrease the distribution of DM. Moreover, a comprehensive community-based research is suggested to develop rules and a policy aimed at reducing the potentially harmful consequences of undiagnosed DM.

9. References

1. Group IDA. Update of mortality attributable to diabetes for the IDF Diabetes Atlas: Estimates for the year 2013. Diabetes research and clinical practice. 2015;109(3):461-5.
2. Sahile AT, Bekele GE. Prevalence of diabetes mellitus and associated factors in Addis Ababa public health facilities, Addis Ababa, Ethiopia, 2016. Diabetes, Metabolic Syndrome and Obesity. 2020:501-8.
3. Kahn CR. Insulin action, diabetogenes, and the cause of type II diabetes. Diabetes. 1994;43(8):1066-85.
4. Fujioka K. Pathophysiology of type 2 diabetes and the role of incretin hormones and beta-cell dysfunction. Jaapa. 2007;20(12):3-8.
5. Kimura K, Tanida M, Nagata N, Inaba Y, Watanabe H, Nagashimada M, et al. Central insulin action activates Kupffer cells by suppressing hepatic vagal activation via the nicotinic alpha 7 acetylcholine receptor. Cell Reports. 2016;14(10):2362-74.
6. Epifano L, Di Vincenzo A, Fanelli C, Porcellati E, Perriello G, De Feo P, et al. Effect of cigarette smoking and of a transdermal nicotine delivery system on glucoregulation in type 2 diabetes mellitus. European journal of clinical pharmacology. 1992;43:257-63.
7. Kim JY, Lee DY, Lee YJ, Park KJ, Kim KH, Kim JW, et al. Chronic alcohol consumption potentiates the development of diabetes through pancreatic β-cell dysfunction. World journal of biological chemistry. 2015;6(1):1.
8. Barth E, Albuszies G, Baumgart K, Matejovic M, Wachter U, Vogt J, et al. Glucose metabolism and catecholamines. Critical care medicine. 2007;35(9):S508-S18.
9. Huffman FG, Exebio JC, Zarini GG, Exebio C. Use of HbA 1c in screening for Cuban-Americans with undiagnosed type 2 diabetes. Journal of Immigrant and Minority Health. 2011;13:541-5.
10. Yahaya TO, Ufuoma SB. Genetics and pathophysiology of maturity-onset diabetes of the young (MODY): A Review of current trends. Oman Medical Journal. 2020;35(3):e126.
11. Association AD. Diagnosis and classification of diabetes mellitus. Diabetes care. 2013;36(Supplement_1):S67-S74.
12. Beagley J, Guariguata L, Weil C, Motala AA. Global estimates of undiagnosed diabetes in adults. Diabetes research and clinical practice. 2014;103(2):150-60.

13. Soyoye DO, Abiodun OO, Ikem RT, Kolawole BA, Akintomide AO. Diabetes and peripheral artery disease: A review. World journal of diabetes. 2021;12(6):827.

14. Ogurtsova K, Guariguata L, Barengo NC, Ruiz PL-D, Sacre JW, Karuranga S, et al. IDF diabetes Atlas: Global estimates of undiagnosed diabetes in adults for 2021. Diabetes research and clinical practice. 2022;183:109118.

15. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. Diabetes research and clinical practice. 2019;157:107843.

16. Atrese T, Fekadu L, Kune G, Shita A, Woldemikael K. Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of Mizan Aman town, Southwest Ethiopia: Community-based cross-sectional study. Plos one. 2024;19(5):e0302167.

17. Worede A, Alemu S, Gelaw YA, Abebe M. The prevalence of impaired fasting glucose and undiagnosed diabetes mellitus and associated risk factors among adults living in a rural Koladiba town, northwest Ethiopia. BMC research notes. 2017;10:1-7.

18. Bishu KG, Jenkins C, Yebyo HG, Atsbha M, Wubayehu T, Gebregziabher M. Diabetes in Ethiopia: a systematic review of prevalence, risk factors, complications, and cost. Obesity Medicine. 2019;15:100132.

19. Yitbarek GY, Ayehu GW, Asnakew S, Chanie ES, Bayih WA, Feleke DG, et al. Undiagnosed diabetes mellitus and associated factors among adults in Ethiopia: a systematic review and meta-analysis. Scientific Reports. 2021;11(1):24231.

20. Seuring T, Archangelidi O, Suhrcke M. The economic costs of type 2 diabetes: a global systematic review. Pharmacoeconomics. 2015;33:811-31.

21. Asmelash D, Asmelash Y. The burden of undiagnosed diabetes mellitus in adult African population: a systematic review and meta-analysis. Journal of diabetes research. 2019;2019(1):4134937.

22. Issaka A, Paradies Y, Stevenson C. Modifiable and emerging risk factors for type 2 diabetes in Africa: a systematic review and meta-analysis protocol. Systematic reviews. 2018;7(1):1-10.

23. Burrack AL, Martinov T, Fife BT. T cell-mediated beta cell destruction: autoimmunity and alloimmunity in the context of type 1 diabetes. Frontiers in endocrinology. 2017;8:343.

24. Bhadoria AS, Kasar PK, Toppo NA, Bhadoria P, Pradhan S, Kabirpanthi V. Prevalence of hypertension and associated cardiovascular risk factors in Central India. Journal of family & community medicine. 2014;21(1):29.

25. Hu M, Wan Y, Yu L, Yuan J, Ma Y, Hou B, et al. Prevalence, awareness and associated risk factors of diabetes among adults in Xi'an, China. Scientific reports. 2017;7(1):10472.

26. Anusuya GS, Ravi R, Gopalakrishnan S, Abiselvi A, Stephen T. Prevalence of undiagnosed and uncontrolled diabetes mellitus among adults in South Chennai. Int J Community Med Public Health. 2018;5(12):5200-4.

27. Islam RM, Magliano DJ, Khan MN, Hossain MB, Rana J, Oldroyd JC. Prevalence of undiagnosed diabetes and the relative importance of its risk factors among adults in Bangladesh: findings from a nationwide survey. Diabetes Research and Clinical Practice. 2022;185:109228.

28. Dessie G, Mulugeta H, Amare D, Negesse A, Wagnew F, Getaneh T, et al. A systematic analysis on prevalence and sub-regional distribution of undiagnosed diabetes mellitus among adults in African countries. Journal of Diabetes & Metabolic Disorders. 2020;19:1931-41.

29. Noor S, Bushara S, Sulaiman A, Elmadhoun W, Ahmed M. Undiagnosed diabetes mellitus in rural communities in Sudan: prevalence and risk factors. Eastern Mediterranean Health Journal. 2015;21(3).

30. Shiferaw F, Letebo M, Feleke Y, Gelibo T, Getachew T, Defar A, et al. Non-communicable diseases in Ethiopia: policy and strategy gaps in the reduction of behavioral risk factors. Ethiopian Journal of Health Development. 2019;33(4).

31. Megerssa Y, Gebre M, Birru S, Goshu A, Tesfaye D. Prevalence of undiagnosed diabetes mellitus and its risk factors in selected institutions at Bishoftu Town, East Shoa, Ethiopia. J Diabetes Metab S. 2013;12:008.

32. Worede A, Alemu S, Gelaw YA, Abebe M. The prevalence of impaired fasting glucose and undiagnosed diabetes mellitus and associated risk factors among adults living in a rural Koladiba town, northwest Ethiopia. BMC research notes. 2017;10(1):1-7.

33. Wondemagegn AT, Bizuayehu HM, Abie DD, Ayalneh GM, Tiruye TY, Tessema MT. Undiagnosed diabetes mellitus and related factors in East Gojjam (NW Ethiopia) in 2016: a community-based study. Journal of public health research. 2017;6(1).

34. Bantie GM, Wondaye AA, Arike EB, Melaku MT, Ejigu ST, Lule A, et al. Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of Bahir Dar city, northwest Ethiopia: a community-based cross-sectional study. BMJ open. 2019;9(10):e030158.

35. Zenu S, Reshad M. Prevalence of Undiagnosed Diabetes Mellitus and Associated Factors in Adults in Mettu Town, Southwest Ethiopia: Community Based Cross Sectional Study. Open J Public Health 2022; 4 (2).1031.

36. Damtie S, Workineh L, Berhan A, Tiruneh T, Legese B, Getie B, et al. The magnitude of undiagnosed diabetes mellitus, prediabetes, and associated factors among adults living in Debre Tabor town, northcentral Ethiopia: A community-based cross-sectional study. Heliyon. 2023;9(7).

37. Assefa A, Shifera N. Undiagnosed diabetes mellitus and its predictors among socially marginalized menja communities in southwest Ethiopia. Frontiers in Public Health. 2022;10:861627.

38. Teshome AA, Baih SZ, Wolie AK, Mengstie MA, Muche ZT, Amare SN, et al. Magnitude of impaired fasting glucose and undiagnosed diabetic mellitus and associated risk factors among adults living in Woreta town, northwest Ethiopia: a community-based cross-sectional study, 2021. BMC Endocrine Disorders. 2022;22(1):243.

39. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo Jr JL, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. Jama. 2003;289(19):2560-71.

40. Identification EPot, Overweight To, Adults Oi, Heart N, Lung, Institute B, et al. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report: National Institutes of Health, National Heart, Lung, and Blood Institute; 1998.

41. Organization WH. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008. 2011.

42. Organization WH. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: report of a WHO/IDF consultation. 1. Diabetes mellitus—diagnosis. 2. Diabetes mellitus–classification. 3. Hyperglycemia. 4. Glucose tolerance test. I World Health Organization II International Diabetes Federation Geneva: Printed by the WHO Document

Production Services (WHO Press), 2006: 46 Available from: http://www who int/diabetes/publications/diagnosis_diabetes2006/en. 2006.

43. Dereje N, Earsido A, Temam L, Abebe A. Prevalence and associated factors of diabetes mellitus in Hosanna Town, Southern Ethiopia. Annals of global health. 2020;86(1).

44. Ayele BH, Roba HS, Beyene AS, Mengesha MM. Prevalent, uncontrolled, and undiagnosed diabetes mellitus among urban adults in Dire Dawa, Eastern Ethiopia: A population-based cross-sectional study. SAGE open medicine. 2020;8:2050312120975235.

45. Rahmanian K, Shojaei M, Jahromi AS. Relation of type 2 diabetes mellitus with gender, education, and marital status in an Iranian urban population. Reports of biochemistry & molecular biology. 2013;1(2):64.

46. Azimi-Nezhad M, Ghayour-Mobarhan M. Pariza-30. deh MR, Safarian M, Esmaeili H, Parizadeh SM et al. Prevalence of type 2 diabetes mellitus in Iran and its relationship with gender, urbanisation, education, marital status and occupation. Singapore Med J. 2008;49:571-6.

47. Bahijri SM, Jambi HA, Al Raddadi RM, Ferns G, Tuomilehto J. The prevalence of diabetes and prediabetes in the adult population of Jeddah, Saudi Arabia-a community-based survey. PloS one. 2016;11(4):e0152559.

48. Zenu S, Reshad M. Prevalence of undiagnosed diabetes mellitus and associated factors in adults in mettu town, Southwest Ethiopia: community based cross sectional study. Prevalence of Undiagnosed Diabetes Mellitus and Associated Factors in Adults in Mettu Town, Southwest Ethiopia: Community Based Cross Sectional Study. 2022;4(2).

49. Echouffo-Tcheugui JB, Dzudie A, Epacka ME, Choukem SP, Doualla MS, Luma H, et al. Prevalence and determinants of undiagnosed diabetes in an urban sub-Saharan African population. Primary care diabetes. 2012;6(3):229-34.

50. Wondemagegn AT, Bizuayehu HM, Abie DD, Ayalneh GM, Tiruye TY, Tessema MT. Undiagnosed diabetes mellitus and related factors in East Gojjam (NW Ethiopia) in 2016: a community-based study. Journal of public health research. 2017;6(1):834.

51. Al-Sharafi BA, Gunaid AA. Effect of habitual khat chewing on glycemic control, body mass index, and age at diagnosis of diabetes in patients with type 2 diabetes mellitus in Yemen. Clinical Medicine Insights: Endocrinology and Diabetes. 2015;8:CMED. S26045.

52. Endris T, Worede A, Asmelash D. Prevalence of diabetes mellitus, prediabetes and its associated factors in Dessie Town, Northeast Ethiopia: a community-based study. Diabetes, metabolic syndrome and obesity: targets and therapy. 2019:2799-809.

53. Zekewos A, Loha E, Egeno T, Wubshet K, Merga Z. Prevalence of diabetes mellitus and associated factors in Southern Ethiopia: a community based study. Ethiopian journal of health sciences. 2018;28(4).

54. Kim M-J, Lim N-K, Choi S-J, Park H-Y. Hypertension is an independent risk factor for type 2 diabetes: the Korean genome and epidemiology study. Hypertension Research. 2015;38(11):783-9.

55. Boden G, Shulman G. Free fatty acids in obesity and type 2 diabetes: defining their role in the development of insulin resistance and β-cell dysfunction. European journal of clinical investigation. 2002;32:14-23.

ANNEX I: Participant information sheet

Title of the Research: Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of the worabe town, SiltieZzone, Southern Ethiopia

Name of Principal Investigator: Mohammed Aliye

Advisors:

I. Mr. Samuel Kinde (MSc, Assit.Prof,Phd candidate)
II. Mr. GobenaDedafo (MSc in clinical chemistry)
III. Mrs. MekdesAlem (MSc in clinical chemistry)

Name of the organization:-Addis Ababa university, college the health sciences and department of the medical laboratory science

Introduction: This information sheet is prepared for the aim of explaining the research that you are asked to join with research participant. This information sheet describes about the research.

Aim of the study: To determine the Prevalence of undiagnosed diabetes mellitus and associated factors among adult residents of the worabe town, siltie zone, southern Ethiopia.

Procedure: If the participants are agreed to take part in the study, clinical nurse will be given verbal and/or written information about the study and participants will signed on consent form. Participants are kindly requested to give the correct information about them and the necessary measurements will be performed by the assigned nurse. And 3ml of an overnight (10-12) hour fasting blood samples will be collected.

Risk and discomfort: Participating in this research will not cause more discomfort than is required you could go through for routine examination. If there is any discomfort, we shall offer you necessary medical treatment freely. The amount of blood taken from each volunteer throughout the study period is 3ml which will not affect your health.

Benefits: If you are participating in this study, there may not be direct benefit to you but your participation is likely to help us an important input to find the Prevalence of undiagnosed

diabetes mellitus and associated factors and if the medical examination reveals any abnormalities that need immediate treatment, I will inform you and link to hospital or other health facilities

Incentives and payment for participating in the study: You will not be provided with any direct incentives for your participation in this study. But the cost for your medical examination will be covered.

Confidentiality: All information about the patients will be kept confidential. The name of participant will be coded. The information sheet that links the coded number to patient name will be locked inside a computer and it will not be revealed to anyone except your physician and the principal investigator.

Right to refuse or withdraw: You have full right to withdraw from participating in the study at any time before and after consent without explaining the reason and not respond to some or all the questions. Your decision will not affect your right to get health service you are supposed to get otherwise.

Contact Address

If you have any question or concern, you can contact Mohammed Aliye at any time using the following address:

Mohammed Aliye, MSc student at Addis Ababa University, college of Health sciences and department of Medical Laboratory Sciences.

Mohammed Aliye

Tel: 09-19-28-44-63

Email: mohaliye6@gmail.com

Addis Ababa, Ethiopia

THANK YOU VERY MUCH!!!

ለጥናቱተሳታፊዎችየሚሰጥመረጃ (AMHARIC VERSION INFORMATION SHEET)

የጥናቱርዕስ:የልታወቀየሱካርበሽታ ና ተያያዥመንስኤበወራቤከተማበሚኖሩአዋቂዎችመካከል

ተመራማሪ፡መሀመድአሊየ

አማካሪዎች፡

1. **አቶሳሙኤልኪንዴ** (MSc, Assit. Prof. Phd candidate)
2. **አቶጎበናደዳፎ**(MSc in Clinical chemisytry)
3. መቀደስአለሙ (Msc in clinical chemistry)

የተቋሙስም፡-አድስአበባዩኒቨርሲቲ፣ ጤናሳይንስኮሌጅ ፣ሜዲካልላቦራቶሪትምህርትክፍል

ወጪውንየሚሸፍነውተቋም፡ አድስአበበዩኒቨርሲቲ

መግቢያ፡-

ይህየማብራሪያቅፅአሁንእርስዎእንዲሳተፉየምንጠይቀዎትንምርምርጥናትየሚያብራራነው፡፡
በዚህጥናትለመሰሳተፍከመወሰንዎበፊትይህንንቅፅመረጃሰብሳቢዎቹበሚያነቡበትጊዜበዚህጥናትመሳ
ተፍከጀመሩበኃላበማንኛውምጊዜጥያቄካለዎትመጠየቅይችላሉ፡፡

የጥናቱዓላማ፡-የልታወቀየሱካርበሽታናተያያዥመንስኤበወራቤከተማበሚኖሩአዋቂዎችመካከል

የጥናቱሂደት፡ **ይህንጥናትለማካሄድየደምናሙናበመውሰድየላብራቶሪምርመራማደርግነው፡፡**

ከጥናቱጋርየተያያዘጉዳት/አለመመቸት፡
እርስዎበዚህጥናትውስጥበመሳተፈዎለከፋጉዳትየሚጋለጡበትሁኔታአይኖርም፡፡
ደምበሚወሰድበትወቅትአነስተኛህመምሊሰማወትይችላል፡፡
እንዲሁምየመቅላትእናየማበጥሁኔታደምከተወሰደበትቦታላይሊታይይችላል፡፡
ነገርግንእነዚህሁኔታዎችየከፋጉዳትየሚያስከትሉአይደሉም፡፡

በጥናቱየመሳተፍጥቅም፡እርስዎበዚህጥናትላይበመሳተፍዎነፃየስኳርምርመራ--ያገኛሉ፡

የጥናቱተሳታፊድርሻ፡-
በዚህጥናትለመሳተፍፍቃደኛከሆኑከጤናዎሁኔታጋርየተያያዙናሌሎችየግልመረጃዎችንእንዲሰጡይ

ጠየቃለሁ፡፡ በመቀጠልምየሰዉነትክብደተዎንእናየደምግፊተዎንእንዲለኩና 3 ሚሊመጠንያለውየደምናሙናለተጠቀሰዉዓላማእንድንወስድይጠየቃሉ፡፡

የጥናቱተሳታፊዉመብት፡

በጥናቱላይለመሳተፍባይስማሙምንምአይነትቅጣትየማያስከትልሲሆንማንኛውምእርሰዎሊያገኙየ ሚገባውንህክምናናተያያዥመብትየማያሳጣመሆኑንእናረጋግጣለን፡፡

የጥናቱመረጃዎችምስጥራዊነት፡

እርሰዎንበተመለከተየምንናገኘውንመረጃበጥናቱወቅትምሆነከዚያበኃላባሉትጊዜያትእንዲሁምከጥና ቱየተገኘውመረጃሚስጥራዊነትየሚጠበቅሲሆንመረጃዎቹምየሚያዙትበስምሳይሆንበልዩኮድነው፡፡ ይኸውመረጃበጥንቃቄየሚያዝናየተፈቀደለትተመራማሪእናለህክምናባለሙያዉብቻይህምእጅግአስፈ ላጊበሆነጊዜብቻካልሆነበስተቀርለሌላለማንምሰውአይሰጥም፡፡
ማንኛውምከርስዎጋርየተያያዘውጤትበልዩኮድብቻየሚያዝሲሆንውጤቱምለሳይንሳዊዓላማብቻስምበ ማይገልፅሁኔታእንዲታተምይደረጋል፡፡

ስለጥናቱመረጃማግኘትቢፈልጉ፡

ጥናቱንበተመለከተግልጽያልሆነማንኛዉንምጥያቄካለዎትነፃሆነውከዚህበታችባለውአድራሻመጠየቅ ይችላሉ፡፡

መሀመድአሊየ

ስልክ: 09-19-28-44-63

ኢሜል: mohaliye6@gmail.com

አድስአበበ,ኢትዮጵያ

በጣምእናመሰግናለን!

ANNEX II- Consent form

I confirm that, as I give consent to participate in the study, it is with a clear understanding of the objectives and conditions of the study and with recognition of my right to withdraw from the study if I change my idea. I have been given the necessary information about the research. I have also been assured that I can withdraw my consent at any time without penalty or loss of benefits. The proposal is explained to me in the appropriate language I understand. I_____ do here by give consent to Dr. /Mr. /Mrs. /Miss _____to include me in the proposed research.

Participant code _____

Participant (signature) _____date_____

Name of the data collector_____

Data collector (signature) _____date_____

Consent Form (Amharic Version)

ከላይየተፃፈውንየመረጃቅፅአንብቤየጥናቱዓላማናጥቅምበግልጽተረድቻለሁበማንኛውምጊዜከጥናቱያ ለምንምችግርናመንገላታትመውጣትእንደምንችልተገልፆልኛል፡፡
ከዚህምበተጨማሪምየጥናቱንዓላማበሚገባኝቋንቋተረድቻለሁ፡፡
በዚህመሠረትያለጥናትቡድኑአባላትተፅዕኖበመሉፈቃደኝነትበዚህጥናትውስጥበመሣተፍየሚጠበቅ ብኝንአስተዋፅዖለማበርከትበፊርማዬአረጋግጣለሁ፡፡

የተሳታፊውየሚስጥርቁጥር ----------

የተሳታፊውፊርማ ----------ቀን ----------

የመረጃሰብሳቢውስም ----------

የመረጃሰብሳቢውፊርማ ----------ቀን ----------

ANNEX III: Laboratory principles and procedures

A. Determination of the fasting glucose

The cobas c311 performs a UV test to detect glucose in blood serum and plasma. The enzyme hexokinase (HK) catalyzes the reaction between glucose and adenosine triphosphate (ATP) to form glucose-6-phosphate (G-6-P) and adenosine diphosphate (ADP). In the presence of nicotinamide adenine dinucleotide (NAD), G-6-P is oxidized by the enzyme glucose-6-phosphate dehydrogenase (G-6-PD) to 6-phosphogluconate and reduced nicotinamide adenine dinucleotide (NADH). The increase in NADH concentration is directly proportional to the glucose concentration and can be measured spectrophotometrically at 340 nm.The enzymatic reference method is performed with hexokinase.4 Hexokinase catalyzes the phosphorylation of glucose to glucose-6-phosphate by ATP.

Procedure

i. Participant Preparation (patient should be fasting) come to blood collection siteclean the area of the collection with an antiseptic, like alcohol, to kill any germs.
ii. Tie an elastic band around upper arm, causing veins to swell with blood.
iii. Insert a sterile needle into a vein. There may be feeling of slight to moderate pain when the needle goes in, but it is possible to reduce the pain by relaxing arm.
iv. blood is then drawn in to appropriate tube
v. When drawing blood is finished, the blood collector removes the needle and places a bandage over the puncture site.
vi. Pressure will be applied to the puncture site for a few minutes to prevent bruising.
vii. The sample of blood is then sent to a lab for testing to be tested by the fully automated chemistry analyzer

B. Colorimetric determination of total cholesterol

Total cholesterol will be measured enzymatically in serum in a series of coupled reactions that hydrolyze cholesteryl esters and oxidize the 3-OH group of cholesterol. Cholesterol esters are hydrolyzed to free cholesterol by cholesterol ester hydrolase. The free cholesterol produced is oxidized by cholesterol oxidase to cholest-4-en-3-on with the simultaneous production of hydrogen peroxide, which oxidatively couples with 4-aminoantipyrine and phenol in the presence of peroxidase to yield Quinoneimine dye with maximum absorption between 500-550 nm.

Reactions

The test comes in the form of a commercial kit in which serum sample will be incubated with enzymes and reagents from the kit and the change in absorption at 500nm is measured spectrophotometrically. This change in absorption is proportional to the concentration of total cholesterol in the serum sample and can be calculated by comparison with absorption changes that occur with standard solutions containing known cholesterol Concentrations.

Procedure

Ten microliter (10µL) serum sample will be added into the sample cups and put on the sample disk which rotates to bring the desire sample cup in to position next to the sample probefor specimen sampling. About 1000µL reaction reagent (4-Aminophenazone, phenol, peroxidase, cholesterol esterase, and cholesterol oxidase) will be pipetted into reagent bottles leveled for TC and put on reagent disk and then on the screen menu of the machine TC will be entered as a parameter to be tested. The sample probe will pipettes sample from the sample disk and transfers to the reaction disk which contains cuvettes. On the other side of the machine, the reagent probe will pipettes reagents from the reagent disk and transfers it into reaction disk which is a large rotatable disk holding reusable cuvettes with a stirring paddle to stir or mix thoroughly the sample and the reagents. The cuvettes will be immersed into reaction water bath and incubated at 37^0C for 5 minutes. Next the reaction disk will be rotated the cells to all reaction stations including the photometer light path. Finally, the light will passes through the cuvettes and absorbance of the sample will be measured at 500nm.

C. Serum Triacylglycerol assay method

The method is based on the enzymatic hydrolysis of triglycerides to glycerol and free fatty acids (FFA) by lipoprotein lipase (LPL). Glycerol is converted to glycerol-3-phosphate (G3P) and adenosine-5-phosphate by glycerol kinase and Adenosine tri phosphate. G-3-P is oxidized by glycerol phosphate oxidase to form dihydroxy acetone phosphate and hydrogen peroxide (H_2O_2). In the presence of peroxidase and H_2O_2, 4-aminoantipyrine couples with phenol to form a coloured product (a quininoid dye) that can be measured spectrophotometrically at a wave length of 500nm.

Reactions Principle:

The triglyceride test comes in the form of a commercial kit containing the reagents, reactants and enzymes needed. Serum samples will be incubated with the kit reagents and enzymes for 5 minutes at 37^0C and absorbance measured at 500 nm against the reagent blank and against known concentrations of standard triglyceride concentrations. The change in absorbance is proportional to the concentration of triglyceride in the serum sample.

Procedure

Ten micro liter (10μL) serum samples will be added into the sample cups and put on the sample disk which rotates to bring the desire sample cup into position next to the sample probe for specimen sampling. About 1000μL buffer and 1000μL substrate will be pipetted into reagent bottles labeled for TG and put on the reagent disk. Then on the screen menu of the machine TG will be entered as a parameter to be tested. The sample probe will pipettes sample from the sample disk and transfers to the reaction disk which contains cuvettes. On the other side of the machine, the reagent probe will pipettes reagents from the reagent disk and transfers itinto rotatable reaction disk holding reusable cuvettes with a stirring paddle to stir or mix thoroughly the sample and the reagents. The cuvettes will be immersed in to reaction water bath and incubated at 37^0C for 5 minutes. Next the reaction disk will be rotates the cells to all reaction stations including the photometer light path. Finally, the light will passes through the cuvettes and absorbance of the sample will be measured at 500nm.

ANNEX IV: Questionnaire

Addis Ababa University, college of health sciences, department of medical laboratory sciences

Instructions: This questionnaire contains a question, which is pertinent to the research objectives. You are kindly requested to answer all as much as possible and carefully by filling the blank spaces and encircling one appropriate choice from the alternatives given.

Participant Identification

Participant serial number _____ Identification code_____

Participant address_____ Phone number_____

PART I: Socio-demographic and behavioral Characteristics

S.NO	**Questions**	**Alternatives**
1.	Age	In year……..
2.	Sex	1. Male 2. Female
3.	Educational status	1. Unable to read and write 2. Read and write 3. Primary 4. High school 5. College and university
4.	Marital status	1. Single 2. Married 3. Divorced 4. Widowed
6.	Occupational status	1. Civil servant 2. Housewife 3. Merchant

		4. Private worker 5. Farmer 6. Other specify----------
7.	Do you smoke?	1. Yes 2. No
8.	Doyouexercise?	1. Yes 2. No
7.	Do you chew khat?	1. Yes 2. No
8.	Do you drink alcohol?	1. Yes 2. No
9.	Family history of DM	1. Yes 2. No

PART II: Anthropometric Measurements

10.	Height(m) -------	
11.	Body weight (Kg) -------	
12.	Waist circumference(m)----------	

PARTIII:-blood pressure measurements

13.	Systolic blood pressure(mmHg) ---------	
14.	Diastolic blood pressure (mmHg) ----------	

PARTV:-Laboratory Test Result

Code	Age	Sex	Unit	Reference Range
15.	FBS		……..mg/dl	
16.	TC		……..mg/dl	
17.	TG		……..mg/dl	
18.	LDL-C		…….mg/dl	

Name of Laboratory Investigator ---------- Signature----------date----------

QUESTIONNAIRE (AMHARIC VERSION)

አድስአበበኒቨርሲቲ፣ጤናሳይንስኮሌጅ፣ሜዲካልላቦራቶሪትምህርትክፍል

መመሪያ፡-

ይህመጠይቅበውሰጡከጥናቱዓላማጋርየተያያዙጥያቄዎችንይሟልእርሰዎምትክክለኛዉንመል ስእንድሰጡንበትህትናእነጠይቆታልንበታቻለዎመጠንበጥንቃቄባዶቦታዎችንበመሙላትወይ ምከተሰጡትአማራጮችውስጥተገቢየሆኑትንመልሶችንያክብቡካልሆነጥያቄውሲነበብለዎት ክክለኛዉንመልሰይናገሩ፡፡

የተሳታፊመለያ

የተሳታፊተራቁጥር----------የተሳታፊመለያኮድ----------

አድራሻ---------- ስልክቁጥር----------

ክፍል1፡ የማህበራዊናስነ-ህዝብባህሪያት

ተ. ቁ	መጠይቅ	አማራጮች
1.	ዕድሜ	በዓምት……..
2.	ፆታ	1.ወንድ 2. ሴት
3.	የትምህርትደረጃ	1. ማንበብ ና መጻፍየማይችል 2. ማንበብናመጻፍ 3. አንደኛደረጃ 4. ሁለተኛደረጃ 5. ኮሌጅ ና ዩኒቨርሲቲ
4.	የጋብቻሁኔታ	1. ያላገባ/ች 2. ያገባ/ች 3. የተፋቱ 4. በሞትየተለየ/ች

5.	የሚኖሩበትአካባቢ	1. ገጠር 2. ከተማ
6.	የሚተዳደሩበትስራአይነት	1.የመንግስትሰራተኛ 2. የቤትእመቤት 3. ነጋዴ 4. የግልሰራተኛ 5. ገበሬ 6. ሌላከሆነይጥቀሱ……..
7.	ታጨሰስህ/ሽ?	1.አዎ 2.አይደላም
8.	የአካልብቃትኢንቅስቃሴታደርጋለሽ?	1.አዎ 2.አይደላም
7.	ጫትትቅማለ/ሽ?	1.አዎ 2.አይደላም
8.	አልኮልትጠጣለ/ሽ?	1.አዎ 2.አይደላም

ክፍል2:የሰዉነትልኬት

7.	ቁመት (ሜ.) -------	
8.	ክብደት (ኪ.ግ) -------	
9.	የወገብዙሪያ(ሜ)-------	

ክፍል2፡

የደምግፊትልኬት

10.	ሲስቶሊክየደምግፊት……(mmHg)
11.	ዳያስቶሊክየደምግፊት……(mmHg)

ክፍል 4: ክሊኒካልዳታ

12.	ከዚህበፊትበቤተሰብስኳርየለበትነበር	1.አዎ 2.አይደላም

ክፍል 5 ፡ የላቦራቶሪምርመራዉጤት

መለያኮድ	ዕድሜ	ዋታ	ዩኒት	ሪፈረንስ ሬንጅ
13.	FBS		Mg/dl ……	
14.	TC	……..mg/dl		
15.	TG	……..mg/dl		
16.	LDL-C	…….mg/dl		

የመረማራውላቦራቶሪበለሙያስም---------- ፊርማ----------ቀን----------

ANNEX-V declaration sheet

The undersigned declares that this proposal complies with the regulations of the University and meets the accepted standards with respect to originality and quality. PI also agrees to accept responsibility for the scientific ethical and technical conduct of the research project and for provision of required progress reports.

Mohammed Aliye (MSc. candidate) Signature _____Date_____

Approval of Advisors

Mr. Samuel Kinde (MSc, Assit.Prof,Phd candidate) Signature _____Date_____

Mr. GobenaDedafo (MSc in clinical chemistry) Signature _____Date _____

Mrs. MekdesAlem (MSc in clinical chemistry) Signature _____Date _____