SOCIAL DETERMINANTS OF HEALTH FOR CARDIOVASCULAR KIDNEY METABOLIC SYNDROME AMONG PATIENTS WITH DIABETES ON FOLLOW UP AT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA: A CROSS-SECTIONAL STUDY

BY

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ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCE, SCHOOL OF MEDICINE, DEPARTMENT OF INTERNAL MEDICINE, ENDOCRINOLOGY AND METABOLISM UNIT

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LIST OF ACRONYM /ABBREVIATIONS

BMI---Body mass index

CKD---Chronic kidney disease

CKM---Cardiovascular Kidney-Metabolic

CVD---Cardiovascular Diseases

FBS--- Fasting blood sugar

HbA1c---Hemoglobin A1c

HF---- Heart failure

LDL-C---LDL Cholesterol

NCD---Non-Communicable Diseases

OGGT -----Oral glucose tolerance test

RAAS--- Renin-angiotensin-aldosterone system

RBS----Random blood sugar

SDOH--- Social Determinants Of Health

SGLT2----Sodium–Glucose Cotransporter-2

SNS---Sympathetic nervous system

TASH---Tikur Anbessa Specialized Hospital

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ABSTRACT

Background

Cardiovascular Kidney-Metabolic Syndrome is a recently introduced term that is a complex disorder made up of cardiovascular disease, kidney disease, obesity, and diabetes. Despite the advancements in medical treatments of CKM syndrome, its prevalence and associated mortality rates remain alarmingly high. Beyond clinical care, social determinants of health (SDOH) may influence the burden of CKM syndrome in patients with diabetes.

Objectives

To assess social determinants of health that affect cardiovascular kidney-metabolic syndrome among adult patients with diabetes on follow-up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia

Method

During the study period, adult patients with diabetes on follow-up care at Tikur Anbesa Specialized Hospital participated in a hospital-based cross-sectional study. Every consecutive eligible patient was involved in the study until we had an adequate sample size. Three medical students and one physician as supervisor collected data following a one-day training using a pre-tested and structured interviewer-administered questionnaire via a Kobo toolbox. The data was then entered into SPSS version 29 for further analysis. The association was expressed in odds ratio with 95% confidence interval and P -value <0.05 was used as a significant level for associations between variables.

Results

A total of 422 adult patients with diabetes were included in this study. The mean ± SD age of the patients was 54.14±13.74 years. Fifty-two percent of the patients were males and 83.2% had type 2 diabetes or other specific causes. Half (50.9 %) of them have a high economic burden of housing price to income ratio. Seventy percent of patients eat vegetables less than or equal to three days a week, and 40% have less than 150 minutes of moderate physical activity. In this study, 52.4 % have cardiovascular kidney metabolic syndrome. Male patients (AOR: 1.73 (95% CI. 1.01, 2.94), lost follow-up for more than a year due to lack money (AOR: 2.69 95%CI, 1.01, 7.22), missed appointment due to lack of transportation in the past one year (AOR: 2.98 95% CI, 1.21, 7.33), patients with disability (AOR: 1.97, 95% CI, 1.12, 3.48), hypertension(AOR: 3.12

95% CI. 1.85, 5.28), obesity (AOR: 2.27, 95%CI, 1.17, 4.40) and retirement (AOR: 2.12, 95%CI, 1.04, 4.30) were more significantly associated with cardiovascular kidney syndrome.

Conclusion

More than half of patients with diabetes have cardiovascular kidney-metabolic syndrome. Clinicians should pay more attention to social determinants of health, including male gender, financial constraints, transportation issues, disability, and retirement. Low and middle-income countries should also emphasize addressing financial and logistical barriers through targeted support programs at the government level. Initiatives to improve transportation options and financial assistance for healthcare costs are crucial in mitigating these barriers.

Keywords

Cardiovascular Kidney Metabolic Syndrome, Diabetes, Social Determinants of Health, Glycemic control, Hemoglobin A1c

1. INTRODUCTION

1.1 BACKGROUND

Diabetes is a term used to describe disorders of improper metabolism of carbohydrates that are characterized by elevated blood sugar levels (1). Worldwide, the prevalence of diabetes has increased within the past few decades. An estimated 537 million individuals worldwide (24 million in the African region) have diabetes in 2021; by 2030, that figure is expected to rise to 643 million, and by 2045, it is predicted to reach 783 million (2). The primary cause of death worldwide is non-communicable diseases (NCD), which include diabetes, cancer, cardiovascular disease (CVD), and chronic respiratory disorders (3).

According to the 2015 STEPS survey, the prevalence of diabetes mellitus in Ethiopia including those on medication was 3.2% (3.5% males and 3.0% females). According to IDF estimates in 2021, the prevalence of diabetes was 3.3% among the total adult population of Ethiopia (2). The emerging pandemic of obesity is a central factor contributing to the maladaptive elements of insulin resistance, hypertension, dyslipidemia, and chronic inflammation central to vascular complications (4).

The presence of a constellation of cardiac, metabolic, and renal diseases, in a complex patient with diabetes, constitutes the Cardiovascular Kidney-Metabolic (CKM) Syndrome (5, 6). It is a recently introduced term and definition by the American Heart Association (AHA) in 2023. CKM-related screening falls into 2 primary categories: screening for biological factors and screening for Social determinants of health (SDOH) (6). A high burden of adverse SDOH is one of the risk-enhancing factors for CKM Syndrome. SDOH influences CKD development, diagnosis, and outcomes. Moreover, adverse SDOH is associated with disparities in cardiovascular health behaviors, including physical activity, dietary intake and nutrition, incident obesity and diabetes, and subsequent complications from these conditions (6, 7).

Ultimately, adverse individual- and neighborhood-level SDOH have downstream consequences for cardiovascular events and mortality (8). Health behaviors (physical activity and tobacco/alcohol use) are affected by different social determinants. SDOH plays a critical role in

CKM health, and healthcare systems must implement prevention and treatment models that reflect an SDOH focus. Specifically, social needs screening tools must be used across electronic health record platforms to reach diverse patient populations (9).

Several evidence gaps exist about screening for social needs and its association with CKM syndrome. The Seventy-fourth World Health Assembly in 2021 encouraged Member States to take action to address the social determinants of health (10). The effectiveness of routine social needs screening and referral to resources for improving CKM health behaviors such as nutrition and physical activity and outcomes needs to be studied. Interventions for social needs screening and referral must account for CKM-related health behavior and outcome disparities and promote health equity. Moreover, SDOH is intrinsically linked to access to CKM therapies, particularly cardioprotective glucose-lowering therapies (11).

Neurohormonal stimulation initiates a cycle of vascular endothelial dysfunction, oxidative stress, and inflammation which leads to intricate pathophysiological cross-talks between the kidneys and heart and bidirectional organ. A decrease in cardiac output is compensated for by activating the renin-angiotensin-aldosterone system (RAAS) and sympathetic nervous system (SNS). Renal hypoperfusion causes volume overload, cardiac hypertrophy, and fibrosis, as well as poor tubuloglomerular feedback that results in renal hypoxia and damage (12).

Interdisciplinary care teams which include care navigators, social workers, or community health workers have been shown to improve CKM health-related factors. Obtaining resources for social needs related to food, housing, medication, and transportation after screening was associated with reductions in blood pressure and LDL cholesterol (LDL-C) but not hemoglobin A1c (HbA1c) (13). Screening for and addressing social needs has also been linked to a reduction in emergency room visits (14). Other interventions have shown higher smoking cessation rates or greater fruit and vegetable consumption for those who gained resources to address social needs (15).

Screening for SDOH characterizes social and structural barriers to a healthy lifestyle, self-care, health care access, and disease prevention and management that powerfully influence the

identification of CKM risk factors and outcomes in CKM syndrome. Integrating SDOH into the approach to CKM care may enhance the real-world effectiveness of therapeutic approaches and promote health equity (6).

Financial strain (i.e., food and housing instability, transportation and utility needs, health care access), education and literacy, personal safety, and perceived need for help in addressing social needs are all measured by a variety of screening instruments (11). One of those guidelines is the Healthy People initiative, which is part of the Centers for Disease Control and Prevention program and aims to direct national efforts to promote health and prevent disease (7). The other most recent operational framework for monitoring social determinants of health equity is published by WHO in 2024 (16).

Lower income, fewer than 12 years of education, non-Hispanic Black were associated with lower kidney function according to a study done in the USA in 2020 (17). Religious participation was associated with reduced adverse health outcomes, like cardiovascular and kidney diseases, as seen in The Jackson Heart Study among African Americans in 2016 (18).

1.2 STATEMENT OF THE PROBLEM

There is a substantial correlation between cardiovascular disease (CVD) and chronic kidney disease (CKD) in individuals with diabetes (19). Cardiovascular disease (CVD) is the primary cause of morbidity and death in people with type 2 diabetes. With a 32.2% global prevalence, it accounts for 50.3% of all deaths worldwide. The existence of CKD increases the risk in an individual with diabetes (20). An estimated 9.1% of people worldwide were predicted to have CKD in 2017, which resulted in over 2.6 million kidney replacement treatments and 1.2 million deaths annually (21). Among type 2 diabetes, chronic kidney disease (CKD) is a significant microvascular consequence. According to data from the USA and the UK, roughly 20% and 40%, respectively, of individuals with diabetes go on to develop CKD (22, 23).

In Africa, one in twenty-two (24 million) adults has diabetes. By 2045, there will be 55 million patients with diabetes worldwide, a 129% rise—the largest increase of any IDF Region (2). Cardiorenal complications are the primary cause of premature morbidity and mortality in the Africa (AFR) area, where the prevalence of diabetes mellitus is rising (24). The incidence and prevalence of diabetes have increased in Ethiopia too (25).

The presence of diabetes markedly increases the risk of morbidity and mortality of patients with heart failure, particularly if the microvascular complications of diabetes like diabetic nephropathy are also present (26). Nearly one-half of all patients with CKD stages 4 and 5 will develop CV disease (CVD), and approximately 40% to 50% of all deaths in this population are associated with CV mortality (27). One of the key gaps in the screening approaches for CKM syndrome is the inability to include SDOH screening. Interventions based on SDOH screening have resulted in temporal reductions in social needs. Some interventions have examined health outcomes in the setting of addressing social needs, and few studies have shown improvement in CKM-related factors (28).

Therefore, it is important to identify social needs to improve CKM health that are effective in resource-limited settings. There is no published research found specifically on SDOH and CKM

syndrome in Ethiopia. This study aims to identify social determinants of health that affect CKM syndrome in the set-up of low-income countries.

1.3 SIGNIFICANCE OF THE STUDY

The findings from this study aim to provide very important data regarding social determinants of health associated with cardiovascular kidney metabolic syndrome among patients with diabetes. This study aims to narrow the information gap regarding patients with diabetes and cardiovascular kidney metabolic complications.

The results of the study will help develop a module and guideline for assessing social determinants of health for people with diabetes locally and in similar low- and middle-income countries.

The findings will help develop a strategy to address social determinants of health ranging from hospital level to big community settings.

2. LITERATURE REVIEW

2.1 CARDIOVASCULAR KIDNEY-METABOLIC SYNDROME AMONG PATIENTS WITH DIABETES

2.1.1 Prevalence of diabetes mellitus

Diabetes is a serious, chronic metabolic disease marked by elevated blood glucose levels caused by the body's inability to produce enough of the hormone insulin or the inability to use effectively the insulin that it does produce It is one of the fastest-growing global health emergencies with an estimated 537 million adults aged 20–79 years living with the disease in 2021, accounting for 10% of the world's population. US, 88 million adults (35% of the population) have prediabetes, and 34 million (11%) have diabetes. In addition, 4 out of 5 individuals with diabetes reside in nations with low and middle incomes.

The rise in obesity is associated with an increase in this cardiometabolic disease (29). From a study in Nigeria in 2020, central obesity was highly prevalent (55.4%) among Africans with type 2 diabetes. Elderly persons, female sex, BMI above 25 kg/m2, hypertension, and residence in semi-urban and rural settings were highlighted as independent predisposing factors (30). The development of cardiovascular renal metabolic illness is facilitated by obesity and obesity-related diabetes mellitus and hypertension. The majority of research has connected visceral obesity to HFpEF and CKD development and progression (29). Approximately 6.7 million adults between 20–79 years are estimated to have died as a result of diabetes or its complications in 2021, corresponding to 12.2% of all fatalities in this age group worldwide. Cardiovascular disease accounts for one-third to one-half of all diabetes-related deaths (31).

2.1.2 CKD in patients with diabetes

Over time, diabetes can cause significant damage to the heart, blood vessels, eyes, kidneys, nerves, and other organs. Diabetes mellitus together with hypertension also causes eighty percent of end-stage renal disease (2). Chronic kidney disease (CKD) currently affects 14% of the total US population, including up to 40% of those with diabetes (32). CKD was the cause of 18% of disability-adjusted life-years that occurred at a BMI greater than 30 but represented less than

10% of all BMI-related deaths in 2015 (33). According to a 2015 meta-analysis of 16 studies conducted in Africa, the prevalence of CKD ranged from 11% to 83.7%. The incident event rates for proteinuria at 10 years of follow-up, end-stage renal disease at 5 years of follow-up, and death from nephropathy at 20 years of follow-up were 94.9%, 34.7%, and 18.4%, respectively (34).

From a study in South Africa in 2023, 25.0%, of patients with type 2 diabetes had CKD (35). A total of 309 (83.7%) study participants had CKD; 295 (80.0%) had significant albuminuria and 91 (24.7%) had eGFR < 60 ml/min from a study in Tanzania in 2013 (36). According to reports, the association between body mass index (BMI) and cardiovascular mortality, end-stage renal disease, and survival in CKD is U-shaped, with higher BMI values perhaps having a protective impact. (37, 38).

A meta-analysis research conducted in Ethiopia in 2020 found that 35.5% of people had diabetic kidney disease. Significantly linked factors included dyslipidemia, obesity, retinopathy, female gender, hypertension, and poor glycemic control (39). Approximately one-third of patients with diabetes have diabetic nephropathy, according to a cross-sectional study on the prevalence and risk factors of diabetic nephropathy conducted at the Tikur Anbessa Specialized Hospital. Higher HGA1C levels and male gender were linked risk variables (40).

2.1.3 CVD in patients with diabetes

The presence of CKD or diabetes doubles the risk of cardiovascular events, and when CKD and diabetes co-occur, risks are further increased (41). In Saudi Arabia, 72.72% of research participants had one or more diabetes-related complications (42). Cardiomyopathy affects up to 50% of patients from a study conducted in sub-Saharan Africa in 2005, while coronary heart disease affects 5% to 8% of people with type 2 diabetes. Diabetes affects around 15% of stroke patients, and 5% of patients with diabetes suffer cerebrovascular events at the time of diagnosis. The prevalence of peripheral vascular disease varies from 4% to 28% depending on the site (43).

In research conducted in the Harari region of Ethiopia in 2021, the overall prevalence of CVD among individuals with type 2 diabetes was 42.51%. It was associated with having

microvascular complications, drinking alcohol, being older, being physically inactive, having a higher body mass index, and having hypertension (44). According to a comprehensive review and meta-analysis done in 2023, 37.26% of research participants in Ethiopia with diabetes mellitus have cardiovascular disease, together with related risk factors (45).

2.1.4 Prevalence of CKM syndrome

The prevalence of cardiovascular kidney metabolic (CKM) conditions and their combinations was assessed among 530,747 adults with type 2 diabetes in the United States outpatient registry in 2018. They found that only 6.4% had no CKM conditions and 51% had 3 or more CKM conditions. The most prevalent individual conditions were hypertension (83%), hyperlipidemia (81%), coronary artery disease (32%), and chronic kidney disease (20%), and the most common combinations included various groupings of hypertension, hyperlipidemia, atherosclerotic cardiovascular disease, and CKD (46).

According to the 2013 ARIC study (47), 50 percent of stage 4 and 5 CKD patients have CVD (both atherothrombotic and non-atherothrombotic). In subsequent ARIC study, Kidney function was independently and robustly associated with SCD in the community, particularly when cystatin C or B2M was used (48). A 2022 metaanalysis of UACR and CVD mortality revealed that CVD mortality increases as CKD severity progresses (49).

2.1.5 Treatment Perspectives of CKM

The care of these illnesses also heavily relies on lifestyle measures, such as exercise, a nutritious diet, controlling weight, and quitting smoking. SGLT2 inhibitors are the main options for the treatment of CKM due to their demonstrated benefits for the cardiovascular system and renoprotection(26). A meta-analysis of 15 trials including 20,241 HF patients found that SGLT2 inhibitor medication decreased the likelihood of hospitalization (50). a meta-analysis of three randomized, double-blind, placebo-controlled, event-driven trials of SGLT2 inhibitors in patients with CKD: CREDENCE, DAPA-CKD, and EMPA- KIDNEY. showed a reduction in the risk of cardiovascular death by 20%. Relative risk reductions for fatal heart failure (HR 0.41) appeared more pronounced than other causes of cardiovascular death (HR 0.88) (51).

Renin-angiotensin-aldosterone system inhibitors, sodium-glucose cotransporter-2 inhibitors, glucagon-like peptide-1 receptor agonists, and nonsteroidal mineralocorticoid receptor antagonists are examples of both new and current cardiorenal medicines (19). GLP-1 RAs decreased the composite kidney outcome, which included worsening kidney function in patients with type 2 diabetes, doubling of serum creatinine, >40% drop in eGFR, kidney replacement treatment, or death from kidney failure, according to a meta-analysis of eight trials (52). The benefits of semaglutide in reducing kidney outcomes were consistent in participants with/without baseline SGLT2i use according to the FLOW trial (53). Finerenone lowered the risk of nonfatal myocardial infarction, nonfatal stroke, hospitalization, and CV mortality by 14%. Additionally, finerenone decreased by 23% the chance of the kidney composite endpoint, which is defined as a drop in eGFR of ≥57%, kidney failure, or death from kidney failure (54). In a recent FINE-HEART study in 2024, finerenone was associated with significantly lower deaths of any cause, cardiovascular events, and kidney outcomes (55).

In a systematic review and meta-analysis done in 2024, GLP1 agonist and finerenone lowered the risk of MACE to 14% in patients with established atherosclerotic cardiovascular disease (HR, 0.861), whereas no effect was observed in patients without established atherosclerotic cardiovascular disease. Both finerenone (HR, 0.84) and GLP1-RA (HR, 0.81) reduced the risk of kidney disease progression (56). The Study of Heart and Renal Protection (SHARP) demonstrated that primary prevention with simvastatin and ezetimibe reduced major atherosclerotic events in people with CKD (57). in patients with heart failure and renal impairment. The absolute benefit of bisoprolol was greater for patients with chronic kidney disease than those without (58).

2.2 SOCIAL DETERMINANTS OF HEALTH FOR CARDIOVASCULAR KIDNEY METABOLIC SYNDROME AMONG PATIENTS WITH DIABETES

2.2.1 Demographic Information and Background Diabetes History

The study done in the USA found that older age, male sex, and tobacco use were associated with CKM (46). A prospective cohort study from the US showed that several metabolic (obesity,

hypertension, and diabetes) risk factors were associated with a significantly higher risk for CVD death (59). A study from Spain in 2017 found that the prognostic factors of all-cause mortality in patients with diabetes were age ≥ 80 years, presence of heart failure, presence of cognitive impairment, and no treatment with statins (60).

A Prospective Chinese study in 2014 showed overweight patients with type 2 diabetes had the worst metabolic profile and the highest prevalence of microvascular complications. Over a median follow-up of 9.3 years, incidences of cardiovascular disease were 0.6, 5.1, and 9.6 per 1,000 person-years in patients with type 1 diabetes, normal-weight patients with type 2 diabetes, and overweight patients with type 2 diabetes. The respective figures for ESRD were 2.2, 6.4, and 8.4 per 1,000 person-years (61). In general, female participants and the urban population had a significantly greater rate of complications according to a study in Saudi Arabia (42). The highest prevalence of left ventricular diastolic dysfunction was observed in the female population and individuals belonging to the age group of more than 45 years in Indian tertiary hospitals in 2016 (62). Cardiovascular risk factors significantly associated with renal impairment in elderly with type 2 diabetes were high glycated hemoglobin, albuminuria, and obesity reported in a study in Nigeria in 2022 (63).

Kidney disease was commonly associated with blood pressure, aging, obesity, length of diabetes, and glucose control from a study in Africa (34). The rate of CKD was slightly higher in males compared with females in the South African study. Most patients with CKD (95.1%) were greater than 50 years of age. Renin-angiotensin-aldosterone system inhibitors were used by 78.6% of patients (35). Older age was significantly associated with CKD in this population (36).

Hypertension was reported in 39.9% and myocardial infarction in 5.9%, while high cholesterol and triglyceride were noted in 59.9%, and 32.5% respectively reported from a study done in Sudan in 2017 among type 2 diabetes. Factors significantly associated with these complications were longer duration of diabetes, and living in urban areas(64). From a study in Africa, social determinants of undiagnosed diabetes in Namibia and South Africa were rural residence, age younger than 45 years old, and poorest-to-poorer groups(65).

2.2.2 Physical Environment and Economic Instability

A meta-analysis of seventy studies showed economic circumstances and early childhood development themes were associated with an increased risk of CVD and CVD mortality. They also found evidence that factors in the social/community context and neighborhood/built environment themes, such as social isolation, fewer social roles, loneliness, discrimination, ethnicity, neighborhood socioeconomic status, violence, and environmental attributes, had a role in CVD (66). Up to 25% of people with diabetes who are prescribed insulin report cost-related insulin underuse (67). Financial barriers remain a major source of health disparities, and costs should be a focus of treatment goals (68).

Having poor housing conditions and not having a regular provider were social determinants of health not to adhere to retinal examination in a study done in a prospective cohort study of enrollees in Washington (69). A prospective cohort study from the US showed that several social (unemployment, low family income, food insecurity, lack of home ownership, and unpartnered status) risk factors were associated with a significantly higher risk for CVD death (59). A study in Australia showed higher rates of mortality and morbidity in the low socioeconomic group which accounts for approximately twice the incidence than those in the medium socioeconomic status group, which were, in turn, 50% higher than those in the high SES group. In this study, approximately 25-30% of the northern territory Indigenous health disparity may be explained by socioeconomic disadvantage (70).

2.2.3 Access to Healthcare, Social Support and Community Resources

Social capital, which comprises community and personal network instrumental support, promotes better health, whereas lack of social support is associated with poorer health outcomes in individuals with diabetes (7). Community health workers can be part of a cost-effective, evidence-based strategy to improve the management of diabetes and cardiovascular risk factors in underserved communities and healthcare systems (71).

A systematic analysis done in 2012 showed that higher levels of social support were associated with outcomes including better glycemic control, knowledge, treatment adherence, quality of life, diagnosis awareness and acceptance, and stress reduction (72). In Kidney Early Evaluation

Program (KEEP) study, after adjustment for demographic characteristics, uninsured participants were 82% more likely than privately insured participants to die (HR, 1.82; 95% CI, 1.56-2.12; P < 0.001) and 72% more likely to develop ESRD (HR, 1.72; 95% CI, 1.33-2.22; P < 0.001). The association between insurance and outcomes varied by CKD stage (73). A study from lower- and middle-income countries with a focus on India regarding social, political, and legal determinants of kidney health showed poverty, illiterate, unstable housing, food insecurities, and healthcare accessibility as significant factors for kidney disease worsening (74). According to a meta-analysis in 2022, social support, depression, family support, and education significantly affected the glycemic control of patients with diabetes (75).

2.2.4 Educational Status and Health Behaviors

In the GREECS study, overall all-cause mortality was almost twofold higher in the low-education group than in the intermediate-education and high-education groups (40% vs. 22% and 19%, respectively, p<0.001). A U-shaped association was found for the relationship between ACS prognosis and educational status, with poor prognosis among the low-education and high-education groups (76).

A prospective cohort study from the US showed that several behavioral (current smoking, lack of leisure-time physical activity, and sleep <6 or >8 h/d), risk factors were associated with a significantly higher risk for CVD death (59). Social determinants of diabetes and cardiovascular disease from the South African National Health and Nutrition Examination Survey were older age, low income, bad self-rated health, and lack of physical activity (77).

Significant associations were found between educational attainment and smoking, lack of regular exercise, overweight, diet atherogenicity, and knowledge about behavioral risk factors for cardiovascular disease in a study done in 1991 in New York (78). The ADDITION-Cambridge study in 2019 showed decreasing alcohol intake by ≥ 2 units/week was associated with a lower hazard of CVD vs maintenance [HR: 0.56, 95% CI 0.36, 0.87]. Decreasing daily calorie intake by ≥ 300 kcal was associated with a lower hazard of all-cause mortality vs maintenance [HR: 0.56, 95% CI 0.34, 0.92] (79).

2.3 CONCEPTUAL FRAMEWORK

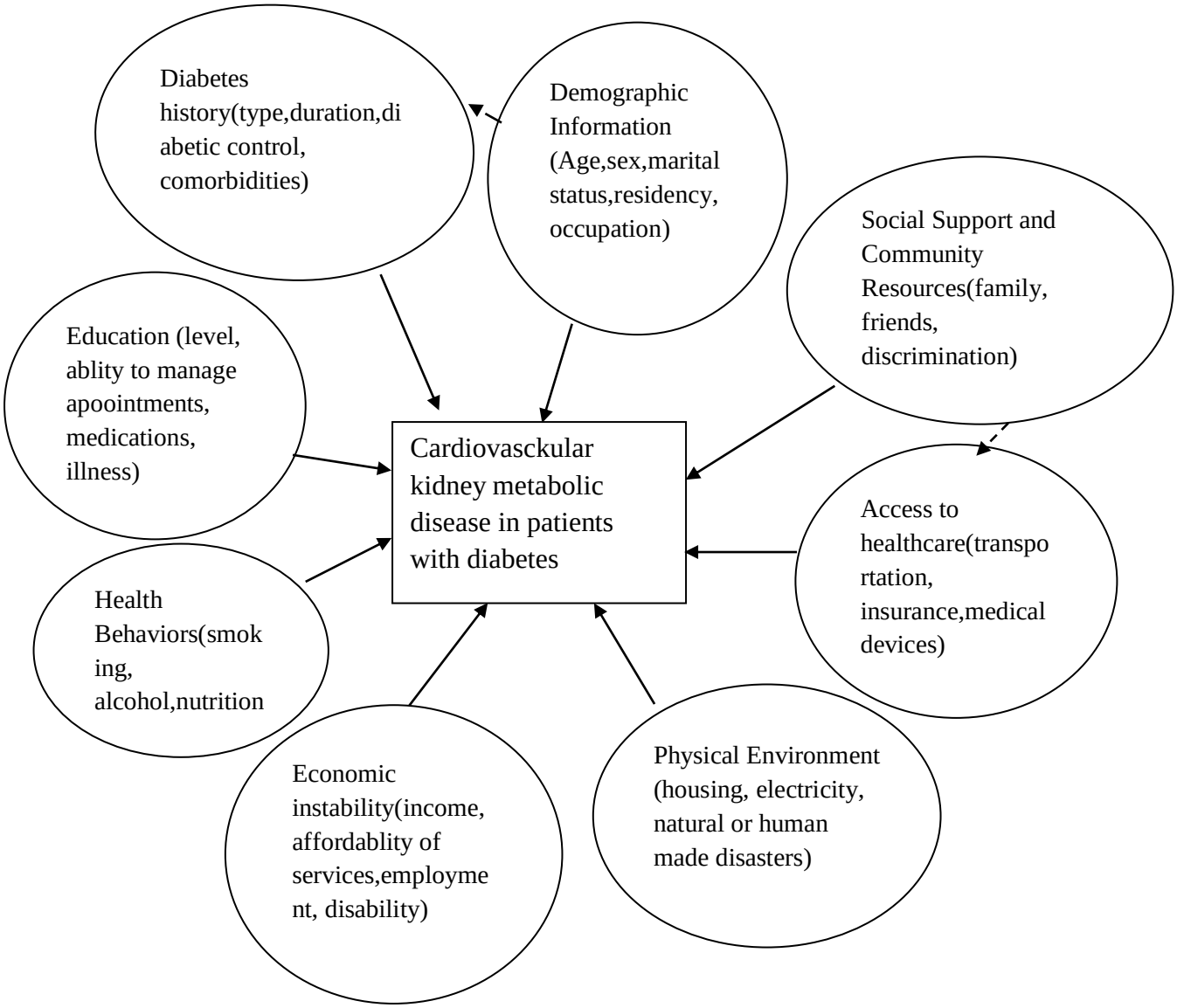


Figure 1. Conceptual framework to assess social determinants of health for cardiovascular kidney metabolic syndrome among adult patients with diabetes.

3. OBJECTIVES

3.1 GENERAL OBJECTIVES

- To assess social determinants of health that affect CKM syndrome among Adult Patients with Diabetes on Follow-up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia from May 1, 2024 to June 30, 2024

3.2 SPECIFIC OBJECTIVES

- To determine the socio-demographic characteristics and types of diabetes mellitus of the study participants.
- To assess the physical environment and economic instability that affects CKM disease among adult patients with diabetes at an outpatient follow-up clinic
- To determine the educational status and health behaviors that affect CKM disease among adult patients with diabetes at outpatient follow-up clinic
- To determine the access to healthcare, social support, and community resources that affect CKM disease among adult patients with diabetes at outpatient follow-up clinic
- To identify the burden of cardiovascular kidney metabolic syndrome among adult patients with diabetes at outpatient follow-up clinic
-To determine the association of social determinants of health with CKM syndrome among the study participants

4. METHODS

4.1 STUDY AREA

A hospital-based cross-sectional study was conducted among diabetes patients who were attending diabetic clinics at Tikur Anbessa Specialized Hospital (TASH), Ethiopia. The hospital is found in Lideta Sub City, Addis Ababa, Ethiopia. It is the largest tertiary hospital with clinics practiced at the subspecialty level in each unit. Patients are referred to this hospital from health institutions across the country. The endocrinology and metabolism unit in the hospital had four clinic visits scheduled every week. The average number of patients with diabetes attending the clinic in a month ranges from 800-1000. This study was conducted from May 1, 2024 to June 30, 2024.

4.2 STUDY DESIGN

Hospital-based cross-sectional study design was used.

4.3 SOURCE AND STUDY POPULATION

4.3.1. Source Population:

The source population consisted of all adult patients with diabetes on follow-up at the endocrinology and metabolism clinic of TASH.

4.3.2. Study Population:

The study population consisted of adult patients with diabetes on follow-up at the endocrinology and metabolism clinic of TASH who had an appointment during the study period.

4.4 SAMPLE SIZE DETERMINATION

There is no published paper with a similar study focused on social determinants of health and cardiovascular kidney metabolic disease done in Ethiopia and low-income countries. Therefore, the sample size for the study will be determined using a single population proportion formula from a prevalence of 50 %, level of significance to be 5% ($\alpha = 0.05$), $Z\ \alpha/2 = 1.96$, margin of error to be 5% ($d = 0.05$).

Then a total sample size is:

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

$$n_1 = \frac{(1.96)^2 \times 0.5\,(1-0.5)}{0.0025} = 384$$

Adding a 10% non-responders rate, the total sample size will be 422.

4.5 SAMPLING TECHNIQUE

Every consecutive eligible patient was involved in the study until we had an adequate sample size.

4.6 DATA COLLECTION PROCEDURE

All methods were conducted in compliance with the Declaration of Helsinki guideline. Informed verbal consent was obtained from each study participant before data collection. All participants included in this study were also informed that their data would be used as part of publications in anonymized form, to which they gave consent.

Using a pretested structured questionnaire developed from the recent WHO operational framework of SDOH, social determinants of health were directly collected from patients by data collectors at the diabetic clinic during the study period. Cardiovascular kidney metabolic disease (heart failure, coronary heart disease, cerebrovascular disease, arrhythmia, cardiomyopathy, peripheral artery disease, or diabetic nephropathy), comorbid conditions, glycemic control, and type of diabetes were collected from the patient's documented data using a medical record number. Data collectors had a day orientation by the principal investigator on how to collect data from patients and electronic data. Data collectors were selected from the hospital students.

4.7 INCLUSION AND EXCLUSION CRITERIA

4.7.1 Inclusion Criteria

- All adult patients with diabetes on follow-up at the endocrinology and metabolism clinic of TASH.

4.7.2 Exclusion Criteria

- Pregnant patients
- Those patients with incomplete medical records.

4.8 DATA QUALITY CONTROL

Three medical students and one physician as a supervisor were involved in collecting the data after taking one day of training by the principal investigator. A pre-test was conducted on 5% of the sample size to check the consistency and the data completeness in records. A few minor changes to the questionnaire were made based on the pre-test results. The tool utilized in this study also underwent face validation by expert endocrinologists and public health specialists to ensure its appropriateness for our population and research objectives. The collected data was checked for completeness and consistency daily by the supervisor and principal investigator.

4.9 STUDY VARIABLES

4.9.1 Independent variables

- Demographic Information - age, gender, marital status, residency, occupation, birth order
- Economic instability - income level, employment, housing cost, affordability of services, disability
- Education status – educational level, ability to manage appointments, medications, and illnesses
- Access to healthcare - transportation, insurance, glucometer
- Physical environment – housing status and stability, electricity, natural or human-made disasters
- Social Support and Community Resources - family support, social support
- Health Behaviors - smoking, alcohol consumption, type of diet, physical activity,
- Diabetes history - type of diabetes, duration of diabetes, glycemic control

4.9.2 Dependent variable

- Cardiovascular kidney metabolic syndrome

4.10 DATA ANALYSIS

After data was checked manually for completeness and consistency it was exported into SPSS version 29 software for further cleaning and analysis. Frequencies, percentages, and mean scores were computed in the descriptive statistics. Using bivariate analysis, independent variables were assessed for the association with cardiovascular kidney metabolic syndrome. The result was presented using tables, graphs, and text. The association was expressed in odds ratio with 95% confidence interval and P -value <0.05 was used as a significant level for associations between dependent and independent variables.

4.11 OPERATIONAL DEFINITION

- Cardiovascular Kidney Metabolic Syndrome (CKM) - The presence of cardiovascular diseases (heart failure, coronary heart disease, cerebrovascular disease, arrhythmia, cardiomyopathy, or peripheral artery disease) and/or diabetic nephropathy in patients with diabetes (80).
- Cardiovascular disease - Presence of heart failure, coronary heart disease, cerebrovascular disease, arrhythmia, cardiomyopathy, or peripheral artery disease (81).
- Diabetic nephropathy - Persistent elevation of urinary albumin excretion (urine albumin to creatinine ratio above 30 mg/g or 24-hour urine protein above 150 mg), low estimated glomerular filtration rate (eGFR less than 60 mL/min/1.73 m2), or other manifestations of kidney damage for more than 3 months (82).
- The inability to afford healthy foods was defined based on the ability to consistently afford meals meeting the plate method recommended by the American Diabetes Association (ADA). The plate method is composed of 50% vegetables, 25% carbohydrates, and 25% protein (83).

4.12 ETHICAL CONSIDERATION

All methods were conducted in compliance with the Declaration of Helsinki guidelines. An ethical clearance letter was obtained from Addis Ababa University College of Health Sciences, Department of Internal Medicine, Department Review Board. Informed verbal consent was obtained from each study participant before data collection. All participants included in this study were also informed that their data would be used as part of publications in anonymized form, to which they gave consent. Another code was given to each patient and the patient's name or card number was never been used by any means throughout the research.

4.13 DISSEMINATION AND UTILIZATION

The final report will be presented as Partial Fulfillment of the Requirements for Endocrinologists and disseminated to the hospital administrative bodies, the Ministry of Health, and other concerned bodies. Finally, the findings will be presented in different seminars, meetings, and workshops and will be published in reputable peer-reviewed scientific journals.

5. RESULTS

5.1 Demographic information and background diabetes history

A total of 422 adult patients with diabetes were included in this study. The mean age of participants was 54.14 years. Most of the participants (95.02 %) were from urban areas, 52.84 % were males, 83.2% had type 2 diabetes or other specific causes, and almost two third of the patients had hypertension (table 1).

Table 1: Demographic Information and Background Diabetes History of Patients with Diabetes on Follow-Up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia:

Variables		Frequency	Percent
Socio-demographic characteristics			
Age of participants	Mean±SD= 54.14±13.74 min=18 and max=90		
Age groups	45 and below	115	27.3%
	46-55	96	22.7%
	56-65	117	27.7%
	66 and above	94	22.3%
Sex of participants	Male	223	52.84 %
	Female	199	47.16%
Marital status	Single	48	11.4%
	Married	337	79.9%
	Divorced or Widowed	37	8.8%
Residence	Rural	21	4.98%
	Urban	401	95.02%
Diabetes History			
Type of diabetes	Type 1 diabetes	71	16.8%
	Type 2 diabetes or other specific causes	351	83.2%
Duration of diabetes in years	< 5	105	24.9%
	5-9	76	18.0%
	10-20	138	32.7%
	>20	103	24.4%
Recent HbA1c level measured within the past three months	≤ 7%	124	29.4%
	7-10%	203	48.1%
	>10%	95	22.5%
FBS control status	Good FBS control (80- 130 mg/dl)	179	42.4%
	Poor FBS control (<80 mg/dl or >130 mg/dl)	243	57.6%
Hypertension	Yes	264	62.6%
	No	158	37.4%
Dyslipidemia	Yes	143	33.9%
	No	279	66.1%

5.2 Physical Environment and Economic Instability

Most of the patients (84.4 %) have lived in their current house for more than 5 years. However, half (49.1 %) of them have a high economic burden of a housing price-to-income ratio of above 40 percent. Most of the patients (91.2%) have regular access to electricity and (74.9%) have comfortable space for physical activity. A significant number (41.9%) of patients couldn't afford to eat healthy food (table 2).

Table 2: Physical Environment and Economic Instability of Patients with Diabetes on Follow-Up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia:

Variables		Frequency	Percent
Physical Environment			
Housing stability	< 5 years	66	15.6%
	≥ years	356	84.4%
Housing price-to-income ratio above 40 %	Yes	207	49.1%
	No	215	50.9%
Access to electricity?	Yes	385	91.2%
	No	37	8.8%
Natural or human-made disasters in the past year	Yes	33	7.8%
	No	389	92.2%
A comfortable space for physical activity	Yes	316	74.9%
	No	106	25.1%
Economic characteristics			
Monthly income	< 2000	105	24.9%
	2001-5000	145	34.4%
	5001-9000	71	16.8%
	> 9000	101	23.9%
Skipped medication due to lack of money	Yes	100	23.40 %
	No	322	76.30 %
Lost to follow-up due to lack of	Yes	35	8.3%

money	No	387	91.7%
Skipped renal, eye, or dental screening due to cost issue	Yes	67	15.9%
	No	355	84.1%
Couldn't afford to eat healthy food	Yes	177	41.9%
	No	245	58.1%
Employment status	Employed	157	37.2%
	Unemployed	116	27.5%
	Retired	117	27.7%
	Others	32	7.6%
Disabilities (extremity, vision, or cognitive)	Yes	93	22.0%
	No	329	78.0%
Under 18 children in the family	Yes	196	46.4%
	No	226	53.6%
Family members with disabilities	Yes	35	8.3%
	No	387	91.7%
Elderly family members who are unable to work	Yes	113	26.8%
	No	387	91.7%

5.3 Educational Status and Health Behaviors

Most of the patients (94.5 %) have attended at least primary school and above. They can able to self-manage to take their medication (90.8%) and (95.5%) can remember their hospital appointments. However, 70.6 % of patients eat vegetables less than or equal to three days a week and 40 % of the patients have less than 150 minutes of moderate physical activity. The mean BMI of the patients was 26.47 (table 3).

Table 3: Educational Status and Health Behaviors of Patients with Diabetes on Follow-Up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia:

Educational background			
Level of education	No formal education	23	5.5%
	Primary school	87	20.6%
	Secondary school	136	32.2%
	Higher education	176	41.7%
Self-manage to take medications?	Yes	383	90.8%
	No	39	9.2%
Self-manage to remember their hospital appointments	Yes	403	95.5%
	No	19	4.5%
Basic diabetic self-management skills	Yes	358	84.8%
	No	64	15.2%
Health behaviors			
How often do you eat vegetables	Three or less than three days a week	298	70.6%
	More than 3 days a week	124	29.4%
Minutes do you practice moderate Physical activity	Less than 150 minutes	169	40.0%
	Greater than 150 minutes	253	60.0%
Type of physical activity do you practice regularly	Aerobics	331	78.4%
	Aerobics and strengthening	20	4.7%
	None	71	16.8%
What is your smoking history?	Yes	61	14.5%
	No	361	85.5%
Alcohol consumption history	Never drinks alcohol	305	72.3%
	Less than two or three bottles a day for female and male patients respectively	98	23.2%
	Greater than two or three bottles a day for female and male patients respectively	19	4.5%
BMI	Mean±SD=26.47±4.99, min=16.07 and max 45.28		
	Normal/underweight (≤24.9)	175	41.5%
	Overweight (25-29.9)	156	37.0%
	Obese (≥30)	91	21.5%
Ever tried herbal or other traditional medication	Yes	58	13.7%
	No	364	86.3%

5.4 Access To Healthcare, Social Support And Community Resources

Most of the patients (80.1%) have their glucometer and 87.7 % have community-based health insurance. Almost two-thirds (63.3%) of the patients have a follow-up in at least two departments. Eighty-seven percent of the patients didn't have social support other than their family (table 4).

Table 4: Access to Healthcare, Social Support, and Community Resources Patients with Diabetes on Follow-Up at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia:

Average out-of-pocket health care expenditure per month	Less than 10% of your income	228	54.0%
	10 - 25 % of your income	116	27.5%
	More than 25% of your	78	18.5%
Have glucometer	Yes	338	80.1%
	No	84	19.9%
Have health insurance	Yes	370	87.7%
	No	52	12.3%
Missed an appointment due to a lack of transport in the past year	Yes	35	8.3%
	No	387	91.7%
Number of outpatient department follow-up	One	155	36.7%
	Two or more clinics	267	63.3%
Missed follow-up, too busy visiting several clinics in the past year	Yes	24	5.7%
	No	398	94.3%
Family support to treat their diabetes	Yes	366	86.7%
	No	56	13.3%
Health professionals in the family	Yes	123	29.1%
	No	299	70.9%
Frequency of religious places visit	<once a week	74	17.5%
	Once a week	120	28.4%
	>once a week	228	54.0%
Social support other than family	Yes	55	13.0%
	No	367	87.0%
Loss of a family member by death in the past year	Yes	65	15.4%
	No	357	84.6%

5.5 Prevalence of cardiovascular kidney metabolic syndrome

More than half of patients (52.4 %, 95% CI (47.6 % - 56.9 %)) have cardiovascular kidney metabolic syndrome. Most of the patients have diabetic nephropathy.

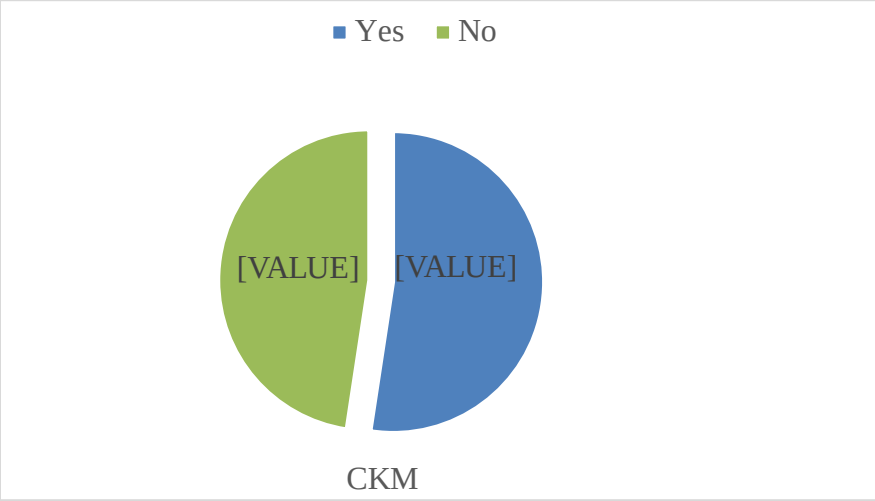


Figure 2: Prevalence of cardiovascular kidney metabolic syndrome among Patients with Diabetes in Tikur Anbessa Specialized Hospital, 2024

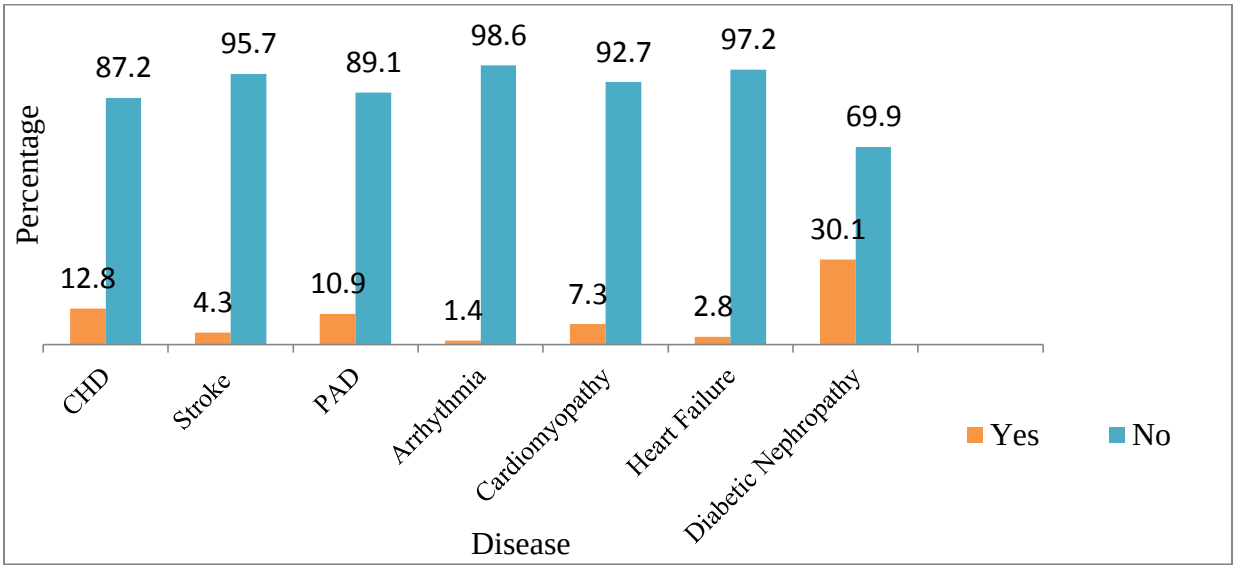


Figure 3: Percentage of each disease of cardiovascular kidney metabolic syndrome among Patients with Diabetes at Tikur Anbessa Specialized Hospital, 2024

5.6 Association of Social Determinants of Health and Cardiovascular Kidney Metabolic Syndrome

In the bivariable binary logistic analysis, sex, skipped medication due to lack of money in the past year, lost to follow-up for more than a year due to lack of money, having a disability, level of education, self-manage to take medication, missed appointment due to lack of money in the past one year, family member death, age, hypertension, duration of diabetes, marital status, employment status, vegetable intake, Smoking history, BMI and type of diabetes were candidate variables for multivariable analysis. However, in the multivariable analysis male sex, lost to follow-up for more than one year due to lack of money, disability, missed appointments due to lack of transportation in the past year, hypertension, employment status, and BMI were significantly associated with CKM syndrome.

Keeping other variables constant, male patients with diabetes were nearly twofold (AOR: 1.73 (95% CI. 1.01, 2.94) more risk for CKM compared with their counterparts. Similarly, patients with diabetes who lost follow-up for more than a year due to lack of money (AOR: 2.69 95%CI, 1.01, 7.22) and missed appointments due to lack of transportation in the past year (AOR: 2.98 95% CI, 1.21, 7.33) were more than two times risk factor for CKM compared with the counterparts.

Patients with diabetes who have a disability were nearly two times (AOR: 1.97, 95% CI, 1.12, 3.48) more risk for CKM compared with no disability. Similarly, patients with diabetes having hypertension and obesity were more than three (AOR: 3.12 95% CI. 1.85, 5.28) and two (AOR: 2.27, 95%CI, 1.17, 4.40) folds more risk for CKM compared with the counterparts respectively. Patients who retired were nearly two times (AOR: 2.12, 95%CI, 1.04, 4.30) more risk for CKM compared with those currently employed (table 5).

Table 5: Association of Social Determinants of Health and Cardiovascular Kidney Metabolic Syndrome Among Patients with diabetes at Tikur Anbessa Specialized Hospital, 2024

Variable		CKM		COR (95% CI.)	AOR (95% C.I)	P
		Yes	No			
Gender	Male	95	128	1.53(1.04,2.25)	1.73 (1.01, 2.94)	.043*
	Female	106	93	1	1	
Age	<45	79	36	1	1	
	45-55	38	58	3.34(1.89 , 5.91)	2.08(.96, 4.49)	.060
	56-65	53	64	2.65 (1.55, 4.53)	.89 (.38, 2.06)	.795
	>65	31	63	4.46 (2.48,7.99)	1.14(.43, 3.03)	.780
Educational level	No formal edu.	6	17	1.24(.79,1.94)	1.43(.83, 2.46)	.189
	Primary school	44	43	3.01(1.11,8.08)	2.95(.89,9.73)	.074
	Secondary school	70	66	1.03 (.60, 1.77)	.88(.46, 1.67)	.707
	College &above	81	95	1	1	
Marital status	Widowed/divorced	22	15	1.36(.56,3.31)	.46 (.15, 1.41)	.174
	Married	147	190	2.58(1.36, 4.89)	1.04 (.44, 2.48)	.916
	Single	32	16	1	1	
Skipped medication due to lack of money in the past year	No	163	159	1	1	
	Yes	38	62	.02(1.67,1.05)	1.47(.84, 2.57)	.174
Lost to follow-up due to lack of money for more than a year	No	188	199		1	
	Yes	13	22	1.59 (.78, 3.26)	2.69 (1.01, 7.22)	.049*
Having disability	No	172	157		1	
	Yes	29	64	2.41(1.48,3.94)	1.97(1.12,3.48)	.019*
BMI	Normal/underweight	92	83	1	1	
	Overweight	74	82	1.22 (.79,1.89)	1.0(.59,1.685)	.999
	Obese	35	56	1.77(1.05,2.97)	2.27(1.17, 4.40)	.015*
Self-manage to take medication	No	12	27	2.19(1.07,4.45)	2.24 (.91, 5.53)	.079
	Yes	189	194	1	1	
Missed appointment due to lack of transportation in the past year	Yes	22	13	1.96 (.96, 4.01)	2.98(1.21, 7.33)	.017*
	No	179	208	1	1	
Family member death within one year	No	176	181	1	1	
	Yes	25	40	1.55 (.90, 2.67)	1.83(.96, 3.46)	.063
Hypertension	No	105	53	1	1	
	Yes	96	168	3.46 (2.29, 5.24)	3.12 (1.85, 5.28)	<.001*
Type of diabetes	I	49	22	1	1	
	II	152	199	2.91 (1.69, 5.03)	1.06 (.43, 2.61)	.897
Duration of diabetes in year	<5	56	49		1	.318
	5-10	36	40	1.27(.70, 2.29)	1.52(.75, 3.08)	.244
	>10	109	132	1.38 (.87, 2.19)	1.53 (.86, 2.72)	.147
Employment status	Employed	90	67	1	1	
	Unemployed	56	60	1.43 (.88, 2.33)	1.36(.73, 2.50)	.322
	Retired	42	75	2.39 (1.46, 3.92)	2.12 (1.04, 4.30)	.037*
	Others/Students	13	19	1.96(.90, 4.253	2.19(.87, 5.46)	.093
Vegetable intake/week	≤3 days	136	162	1.31 (.86, 1.99)	1.32(.80, 2.16)	.270
	>3days	65	59	1	1	
Smoking history	Yes	24	37	1.48(.85 , 2.58)	1.12(.58,2.18)	.726
	No	177	184	1	1	

* Significant association (p-value less than 0.05)

6. DISCUSSION

Social determinants of health (SDOH) are the economic, environmental, political, and social conditions in which people live and are responsible for a major part of health inequality worldwide (84). Adverse social conditions have a prominent impact on cardiovascular kidney metabolic syndrome during the life course (85).

Our finding revealed that more than half (52.4 %, 95% CI (47.6 % - 56.9 %)) of patients with diabetes study participants had CKM syndrome. Our finding was higher than the study done in the USA which reported 26.3% of US adults between 2015-2020 to have CKM syndrome (86). It is also higher than the study done in Israel in 2022 which showed that 12.6% of the patients had at least one condition within the diabetic cardiorenal spectrum (87). This discrepancy might be due to inconsistency of definitions and terms used in CKM syndrome as the studies in Israel and the USA used at least one of the criteria to define CKM syndrome. The other reason may also be due to differences in socioeconomic status and healthcare setup. Furthermore, racial disparity affects the prevalence of chronic kidney disease (CKD), with the highest prevalence observed among Black individuals due to high-risk genotypes like APOL1 as seen in ARIC and other studies (88, 89). This higher prevalence of CKM syndrome also implies that the diabetes is not well managed so it has progressed to a more advanced stage where multiple systems are affected. It underscores the need for integrated care that simultaneously addresses all aspects of the syndrome.

Our analysis reveals that male sex (AOR: 1.73 (95% CI. 1.01, 2.94), lost to follow-up for more than one year due to financial constraints (AOR: 2.69 95% CI, 1.01, 7.22), disability (AOR: 1.97, 95% CI, 1.12, 3.48), missed appointments due to lack of transportation in the past one year(AOR: 2.98 95% CI, 1.21, 7.33), retirement (AOR: 2.12, 95%CI, 1.04, 4.30), hypertension (AOR: 3.12 95% CI. 1.85, 5.28), and obesity (AOR: 2.27, 95%CI, 1.17, 4.40) are all significantly associated with CKM syndrome. The increased risk of CKM syndrome among male patients with diabetes suggests a potential gender disparity in CKM syndrome susceptibility (90). This may be due to the cardiovascular protective effect of estrogen in pre-menopausal women, more visceral fat among men compared to females**,** and delayed healthcare seeking (91, 92)**.** This aligns with existing literature (except for a Saudi Arabian study) (42) indicating that men may be

at higher risk for cardiovascular and metabolic conditions due to both biological and behavioral factors (35, 40, 46). The statistically significant association between lost to follow-up for more than a year due to lack of money and missed appointments due to transportation in the past year issues with CKM syndrome highlights the critical role of economic and logistical barriers in health management. These findings are consistent with previous research that identifies financial constraints and access to transportation as significant barriers to effective disease management and preventive care (6, 93). This limited access to healthcare facilities may lead to a denial from specialists and expert evaluation and a lack of better treatment which may cause cardiovascular kidney metabolic disease.

Patients with disabilities nearly double the risk of CKM syndrome compared to those without disabilities similar to other studies done in the USA (94). Similarly, in a study of Korean National Health Insurance data from 2009 to 2019, the hazard ratio of disability for the incidence of heart disease in those with diabetes was significantly increased (95). A retrospective study showed a higher incidence of CHD in the physical disability group compared to the non-physical disability group during the 7.5-year follow-up period (96). This underscores the additional challenges faced by individuals with disabilities, including potentially limited access to healthcare, increased risk of traditional cardiovascular risk factors, and difficulties in managing chronic conditions, which contribute to their increased risk.

The prevalence of hypertension in this study (62.6%) was high which emphasizes the need for integrated care approaches and public health interventions among patients with diabetes. The strong associations between hypertension (AOR: 3.12 95% CI. 1.85, 5.28) and obesity (AOR: 2.27, 95% CI, 1.17, 4.40) with CKM syndrome further emphasize the role of these traditional risk factors similar to other studies done in Spain, Nigeria, and Ethiopia (29, 30, 44, 97). Both conditions are well-documented contributors to metabolic and cardiovascular syndromes, reinforcing the need for integrated management strategies that address these comorbidities (98). Hypertension damages the endothelium of blood vessels, promoting inflammation and plaque formation, accelerates atherosclerosis, is linked to insulin resistance, and causes hypertensive nephrosclerosis (99). Obesity also increases blood volume and cardiac output**,** renin-angiotensin-aldosterone system induces inflammation, and dyslipidemia (100). However, it contradicts other

studies that obesity has a protective effect (37, 38). This difference may be due to more specific studies about longevity in CKD and heart failure patients in the other studies.

Retired individuals are at nearly twice the risk for CKM syndrome compared to those currently employed. In retired patients with diabetes, the combination of aging, longer duration of diabetes, changes in lifestyle like decreased physical activity, comorbidities like hypertension and dyslipidemia, and cumulative oxidative stress and inflammation all may contribute to an elevated risk of cardiovascular, kidney, and metabolic diseases. Proper diabetes management, regular physical activity, dietary control, and monitoring of comorbid conditions are essential in reducing these risks. However, those complications alone might contribute to the early retirement of patients. In one study workers with CVD or diabetes had a significantly increased probability of of early retirement (101).

Putting it all together, our research confirmed the significant association of different social determinants of health and cardiovascular kidney metabolic diseases. It also strengthened the already established association of male sex, hypertension, and obesity as a risk for diabetes, CKD, and cardiovascular disease. A key strength of this research is the use of standardized questionnaires and tools, a relatively larger sample size, and the collection of data directly from patients in addition to electronic medical record data. This study had the following limitations. The cross-sectional design restricts our ability to infer causality. We didn't also assess the different stages of CKM syndrome. However, this is the first study in Africa that focused on social determinants of health and cardiovascular kidney metabolic diseases which could be a baseline research for physicians and further researchers.

7 CONCLUSION

The prevalence of CKM syndrome among patients with diabetes was high. Being male, lost to follow-up for more than a year due to lack of money, missing appointments due to lack of transportation in the past year, having a disability, presence of hypertension, being retired from work, and BMI $\geq$ 30 kg/m^2 had increased risk of CKM syndrome.

8. RECOMMENDATION

For healthcare providers in low- and middle-income countries, recognizing the increased risk associated with disability, financial constraints, and employment status can inform more tailored and supportive care strategies. For hospitals in low and middle-income countries, we recommend incorporating social determinants of health in the computer-based patient record system of patients with diabetes. The Ministry of Health and other non-governmental organizations should address financial and logistical barriers through targeted support programs that could improve follow-up rates and adherence to care among patients with diabetes. Future researchers should focus on investigating the effectiveness of interventions designed to address financial, logistical, and social barriers to prevent and manage CKM syndrome.

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10. ANNEXES

Annex I: Assurance of principal investigator

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress reports to my advisors and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: _____

Signature: _____

Date: _____

Approval of the primary Advisor

Name of the primary advisor:_____

Signature: _____

Approval of the Co-Advisor

Name of the Co-Advisor:_____

Signature: _____

Annex II: Information sheet

Dear participant, Good Morning/Afternoon

My name is_____. I am a member of the study that is carried out at Tikur Anbessa Specialized Hospital, AAU, Addis Ababa, Ethiopia conducted by Kibret Enyew Belay from the Endocrinology Sub-specialty program.

The main purpose of this study is to assess the association of Social Determinants of Health and cardiovascular kidney metabolic diseases among patients with diabetes at Tikur Anbessa Specialized Hospital. There is no harm in participating in this study but part of your time (10 -15 minutes) will be consumed to answer the questions. Feasible recommendations will be proposed and may benefit you directly or indirectly by emphasizing those problems.

The study will be conducted by interviewing you about social determinants of health in your daily life and from medical record history about your glycemic control, comorbidities, and vascular complications. Everything from your information and records would be completely confidential to the research and the data are stored without your name and only used for this study. Additionally, taking part in this study is completely voluntary.

Address of the principal investigator
Name: Kibret Enyew (MD, Internist, Endocrinology Fellow)
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Annex III: consent form

You are invited to take part in this research because you are a patient living with diabetes and have follow up at diabetic clinic. There will be 422 individuals taking part in this research. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please listen to the following information carefully and feel free to ask if it is not clear or to discuss it with anyone you wish. Please take time to decide whether or not you want to take part in this research. We would like to stress that taking part in this study is entirely voluntary, you can refuse to take part in this study or you can withdraw your participation from the study at any time without any consequences to you.

Patients with diabetes have a number of social determinants of health that will affect glycemic control and cardiovascular kidney metabolic diseases as complications. Insufficient data exists in Ethiopia about the relationship between social variables and kidney and cardiovascular disease. These research issues were brought up by these observations and the unclear extent of this issue in our setting. The objective of this study is to assess social determinants of health for cardiovascular kidney metabolic syndrome among patients with diabetes. There will be no payment for participation in this study.

I,----------, have heard the information in the information sheet and understood the purpose and significance of the study. I agree to participate in the research voluntarily with the hope of contributing to assessing social determinants of health in cardiovascular kidney metabolic disease in patients with diabetes.

Signature: _____ Date: _____

Thanks for your time.

Annex IV: Data Extraction tool

Study unit ID number----------

Table 6: Data Extraction Check List to Assess Social Determinants of Health and Cardiovascular Kidney Metabolic Syndrome Among Adult Patients with Diabetes on Follow-up at Tikur Anbessa Specialized Hospital

Serial number	Questions	Response & Coding Categories
Section 1. Demographic Information		
101	How old are you?	----------years
102	Sex	A. Male B. Female
103	What is your current marital status?	A. Married B. Divorced C. Single D. Widowed
104	Where is your residency?	A. Urban B. Rural
105	What is your occupation?	A. Civil servant B. Private C. Housewife D. Daily laborer E.. Farmer F. Others
106	What is your birth order?	A. First B. Middle C. Last
Section 2. Economic Instability		
201	What is your monthly income level ?	A. Less than 2000 birr, B. 2000-5,000 birr

		C. 5000- 9,000 birr D. Above 9000 birr
202	Have you ever skipped medication due to lack of money to buy the drugs in the past year?	A. Yes B. No
203	Have you ever lost to follow up for more than a year due to lack of money?	A. Yes B. B.No
204	Have you ever skipped renal, eye, or dental screening due to cost issues in the past year?	A. Yes. B. No
205	Are you unable to eat healthy foods due to affordability issues?	A. Yes B. No
206	What is your current employment status?	A.Employed B. Unemployed C. Retired D. Student E. Other
207	Do you have any disabilities (extremity, vision, or cognition)?	A. Yes B. No
208	What is the number of small children whose age is less than 18 years old in the family? What is the number of family members with disabilities extremity, vision, or cognition? What is the number of elderly family members who are unable to work?	---------- ---------- ----------
Section 3. Physical Environment		
301	How long did you live in your current house (housing stability?)	A. Less than 5 years B. More than 5 years
302	Is your housing cost overburden(Housing price-to-income ratio above 40 %) to you?	A.Yes B. No
303	Do you have regular access to electricity?	A. Yes B. No
306	Have you encountered natural or human-made disasters (droughts, floods, war) in the past year?	A. Yes B. No

305	Do you have access to a comfortable space for walk and physical activity?	A. Yes B. No
Section 4. Educational Status		
401	What is your educational level?	A. No formal education B. Primary C. Secondary D. College and above
402	Are you able to self-manage how to take your medications?	A. yes B. No
403	Are you able to self-manage to remember your hospital appointments?	A. yes B. No
404	Do you know basic diabetic self-management skills(hypoglycemia, insulin adjustments)?	A. Yes B. No
Section 5. Access to Healthcare		
501	What is the cost of your out-of-pocket health care expenditure per month on average?	A Less than 10% of your income B. 10 - 25 % of your income C, More than 25% of your income
502	Do you have a glucometer?	A. yes B. No
503	Do you have health insurance("Tena Medihin")?	A. Yes B. No
504	Is there an interruption of health insurance coverage?	A. Yes B. No
505	Have you ever missed an appointment due to a lack of transportation in the past year?	A.Yes B. No
506	How many clinics or outpatient departments do you visit in your follow-up?	A. Less than two C. Two or more
507	Did you miss follow-up clinics due to multiple department visits in the past year?	A. Yes B. No
Section 6. Social Support and Community Resources		

601	Do you have family support to help treat your diabetes?	A. Yes B. No
602	Is there a health professional in the family?	A. Yes B. No
603	How frequently do you visit religious places?	A. Less than once a week B. Once a week C. More than once a week
604	Do you have other social support (charity, friends, home care, NGOs) to help you manage your diabetes?	A. Yes B. No
606	Do you have a history of internal displacement/migration in the past year?	A. Yes B. No
606	Have you encountered physical violence, psychological violence, or sexual violence in the past year?	A. Yes B. B No
607	Have you ever been discriminated against due to your illness at any time?	A. Yes B. No
608	Is there any loss in a family member by death in the past year?	A. Yes B. No
Section 7. Health Behaviors:		
701	How often do you eat vegetables?	A. Daily B. most days in a week C. Few days in a week D.Occationally E. none
702	How many minutes do you practice moderate Physical activity(equivalent to brisk walking) per week?	A. <150 minutes B.>150 minutes
703	What type of physical activity do you practice regularly?	A. Aerobics B. Strengthening C. Both D. None

704	What is your smoking history?	A. Past smoking history B. Active smoker C. Never smokes
705	What is your alcohol consumption history?	A. Never drink alcohol B. Less than two or three bottles a day for female and male patients respectively C. Greater than two or three bottles a day for female and male patients respectively
706	What is the nutrition Status(BMI) of the patient?	A. less than 18 B. 18-24 C. 25-30 D above 30
707	Have you ever tried herbal or other traditional medication?	A. Yes B. No
Section 8. Diabetes History		
801	What is the type of diabetes the patient has?	A. Type 1 diabetes B. Type 2 diabetes c. Other specific causes of diabetes
802	What is the duration of diabetes history?	----------
803	What is the recent glycemic control ? A. HbA1c B. FBS	 ---------- ----------
804	What comorbidities does the patient have?	A. Hypertension,B Dyslipidemia, C. Overweight /Obesity D. Others specify
Section 9. Cardiovascular kidney metabolic Syndrome		
901	Which of the following complications does the patient have?	A. Coronary Heart Disease, B. Stroke, C. Peripheral Artery Disease D. Renal Artery Stenosis E. Arrhythmia F. Cardiomyopathy G. Heart Failure H. Diabetic Nephropathy

አባሪ፡ የመረጃ ወረቀት

ውድ ተሳታፊ፣ እንዴት አደሩ/ዋሉ?

መግቢያ

የኔ ስም_____ እባላለሁ . በአዲስ አበባ ዩኒቨርሲቲ በጥቁር አንበሳ ስፔሻላይዝድ ሆስፒታል ፣ አዲስ አበባ ፣ ኢትዮጵያ በ ኢንዶክሪኖሎጂ ንዑስ ልዩ ፕሮግራም በ ክብረት እንየው በላይ የሚካሄደው ጥናት አባል ነኝ።

የዚህ ጥናት ዋና አላማ በጥቁር አንበሳ ስፔሻላይዝድ ሆስፒታል የስኳር ህመምተኞችን የማህበራዊ ጤና ጉዳዮች እና የልብና የደም ሥር ፣የኩላሊት ፣እና ስኳር በሽታዎችን ትስስር ለመገምገም ነው። በዚህ ጥናት ውስጥ መሳተፍ ምንም ጉዳት የለውም። ነገር ግን ከፊል ጊዜዎ (ከ10-15 ደቂቃዎች) ለጥያቄዎች መልስ ለመስጠት ይጠፋሉ። በጥናቱ መሰረት ጠቃሚ ምክሮች ይቀርባሉ። በእነዚያ ችግሮች ላይ በማተኮር በቀጥታም ሆነ በተዘዋዋሪ ሊጠቅሙዎት ይችላሉ።

ጥናቱ የሚካሄደው በዕለት ተዕለት ሕይወትዎ ውስጥ ስላለው ማህበራዊ የጤና ጉዳዮች እና ስለ እርስዎ ስኳር ቁጥጥር ፣ ተያያዥ በሽታዎች እና የልብና የደም ሥር ፣የኩላሊት ፣እና የ ስኳር ህመም ከህክምና መዝገብ ታሪክ የሚወሰድ ሲሆን ተጨማሪ ጥያቄወችን ደግሞ ከእርስዎ የምንወስድ ይሆናል። ከእርስዎ መረጃ ውስጥ ያሉት ሁሉም ነገሮች ለምርምርው ሙሉ በሙሉ ሚስጥራዊ ይሆናሉ እና ለዚህ ጥናት ዓላማ ብቻ ጥቅም ላይ ይውላል። በተጨማሪም፣ በዚህ ጥናት ውስጥ መሳተፍ ሙሉ በሙሉ በፈቃደኝነት ነው።

ለማንኛውም ጥያቄዎች የዋና መርማሪው አድራሻ
ስም፡ ክብረት እንየው
የሞባይል ስልክ: +251-980232550
ኢሜል፡ enyewkibret1@gmail.com
ኢንዶክሪኖሎጂ እና ሜታቦሊዝም ክፍል፣ የውስጥ ደዌ ሕክምና ክፍል፣ የሕክምና ትምህርት ቤት፣ የጤና ሳይንስ ኮሌጅ፣ አዲስ አበባ ዩኒቨርሲቲ

አባሪ፡ የፈቃድ ቅጽ

በዚህ ጥናት ላይ እንዲሳተፉ የተጋበዙበት ምክንያት እርስዎ በስኳር ህመም የሚኖር ህመምተኛ ስለሆኑ እና በስኳር ህመምተኛ ክሊኒክ ውስጥ ክትትል ስለሚያደርጉ ነው። በዚህ ጥናት ውስጥ 422 ግለሰቦች ይሳተፋሉ። ከመወሰንዎ በፊት ጥናቱ ለምን እንደሚደረግ እና ምን እንደሚያካትቱ መረዳት ለእርስዎ አስፈላጊ ነው። እባክዎ የሚከተለውን መረጃ በጥሞና ያዳምጡ እና ግልጽ ካልሆነ ለመጠየቅ ወይም ከሚፈልጉት ሰው ጋር ለመወያየት ነፃነት ይሰማዎ። እባክዎ በዚህ ጥናት ውስጥ ለመሳተፍ ወይም ላለመሳተፍ ለመወሰን ጊዜ ይውሰዱ። በዚህ ጥናት ውስጥ መሳተፍ ሙሉ በሙሉ በፈቃደኝነት ላይ የተመሰረተ መሆኑን ልናሳስብ እንወዳለን። በዚህ ጥናት ላይ ለመሳተፍ እምቢ ማለት ትችላላችሁ ወይም በእናንተ ላይ ምንም አይነት መዘዝ ሳይኖር በማንኛውም ጊዜ ተሳትፎዎን ከጥናቱ ማንሳት ይችላሉ።

የስኳር በሽታ ያለባቸው ታካሚዎች የስኳር መጠን ቁጥጥርን እና የልብና የደም ሥር ፣የኩላሊት ሜታቦሊዝም በሽታዎችን እንደ ውስብስብነት የሚነኩ በርካታ የማህበራዊ ጤና ችግሮች አሏቸው። በማህበራዊ ህይወት ዙርያ እና በኩላሊት እና የልብ እና የደም ቧንቧ በሽታዎች መካከል ስላለው ግንኙነት በኢትዮጵያ በቂ መረጃ የለም። እነዚህ የምርምር ጉዳዮች የተነሱት በእነዚህ ምልከታዎች እና የዚህ ጉዳይ ስፋት በእኛ ሀገር ግልጽ ስላልሆነ ነው። የዚህ ጥናት ዓላማዎች በስኳር ህመምተኞች መካከል የልብና የደም ሥር የኩላሊት ሜታቦሊክ ህመም እና ጤናን የሚወስኑ ማህበራዊ ችግሮችን መገምገም ነው ። በዚህ ጥናት ውስጥ ለመሳተፍ ምንም ክፍያ አይኖርም። እኔ ..... በመረጃ ወረቀቱ ውስጥ ያለውን መረጃ ሰምቻለሁ። የጥናቱ ዓላማ እና አስፈላጊነት ተረድቻለሁ። በስኳር ህመምተኞች የልብና የደም ሥር ፣የኩላሊት ፣እና ሜታቦሊዝም በሽታ ላይ የጤንነት ሁኔታን ለመገምገም የበኩሌን አስተዋፅኦ ለማድረግ በፈቃደኝነት በምርምር ለመሳተፍ ተስማምቻለሁ።

ፊርማ፡ _____ ቀን፡ _____

ስለ ጊዜዎ እናመሰግናለን።