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Hyperuricemia and its association with cardiovascular disease risk factors in type two diabetes mellitus patients at the University of Gondar Hospital, Northwest Ethiopia

Birhanu Woldeamlak[1], Ketsela Yirdaw[2], Belete Biadgo[2]

[1] *Clinical Chemistry Laboratory, University of Gondar Hospital, Ethiopia*

[2] *Department of Clinical Chemistry, School of Biomedical and Laboratory Sciences, College of Medicine and Health Science, University of Gondar, Ethiopia*

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Corresponding author:
Belete Biadgo
Department of Clinical Chemistry
School of Biomedical and Laboratory Sciences
College of Medicine and Health Science
University of Gondar
Ethiopia
E-mail: beletebiadigo@yahoo.com

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ABSTRACT

Background:

Hyperuricemia is associated with cardiovascular disease (CVD) that presents in diabetes mellitus patients. Therefore, the aim of this study was to appraise the serum uric acid and its association with CVD risk factors among diabetes mellitus patients.

Methods:

A cross-sectional study was carried out at the University of Gondar hospital from February to March, 2018. A total of 384 study participants were selected by systematic random sampling technique. Five milliliter blood sample was collected and analyzed using Mindray BS-200E machine. The data was analysed into SPSS version 20. Logistic regression model was used to investigate associated factors. A p-value <0.05 was considered statistically significant.

Results:

The prevalence of hyperuricemia among type 2 diabetic patients was 31.5%. The serum uric acid concentration was higher among male (33.1%) compared to female (28.9%). Elevated systolic blood pressure (AOR: 4.4, 95%CI: 2.1-9.3), family history of DM (AOR: 1.5, 95%CI: 1.2-2.5) and BMI ≥ 25 Kg/m^2 (AOR: 1.4, 95%CI: 1.1-3.7) were significantly associated with hyperuricemia. Increased BMI (52.4%), high waist circumference (63.0%) and elevated systolic blood pressure (58.2%) were the major CVD risk factors.

Conclusion:

The prevalence of hyperuricemia was high in type 2 diabetes patients. The major predictors of CVD risk factors were elevated systolic blood pressure, family history of DM and BMI ≥ 25 Kg/m^2 which lead to early diagnosis and treatment for hyperuricemia. Lastly, CVD risk factors are essential to reduce the disease among type 2 diabetic patients.

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Abbreviations

AOR: *Adjusted Odds Ratio*

ABCG2A: *TP Binding Cassette transporter sub family G member 2*

ADP: *Adenosine Diphosphate*

ALT: *Alanine Aminotransferase*

ATP: *Adenosine Triphosphate*

BMI: *Body Mass Index*

BP: *Blood Pressure*

CE: *Cholesteryl Esterase*

CI: *Confidence Interval*

COR: *Crude Odds Ratio*

CVD: *Cardiovascular Disease*

DM: *Diabetes Mellitus*

FBG: *Fasting Blood Glucose*

FHDM: *Family History of disease*

HDL: *High Density Lipoprotein*

HUA: *Hyperuricemia*

IR: *Insulin Resistance*

LDL: *Low Density Lipoprotein*

MetS: *Metabolic Syndrome*

MSU: *Monosodium Urate*

SUA: *Serum Uric Acid*

tCho: *Total Cholesterol*

T2DM: *Type 2 Diabetes Mellitu*

TG: *Triglyceride*

UA: *Uric Acid*

VLDL: *Very Low Density Lipoprotein*

WC: *Waist Circumference*

XOR: *Xanthine oxido-reductase*

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BACKGROUND

Uric acid (UA) is a final enzymatic product of purine metabolism in humans [1] and it is regulated by the xanthine-oxidoreductase enzyme, which converts hypoxanthine to xanthine and xanthine to uric acid [2]. An elevated concentration of UA is associated with a variety of cardiovascular conditions [3]. The balance between the intake endogenous synthesis, excretion ratio and metabolism of purines determines the concentrations of Serum Uric Acid (SUA). The alteration of any of these factors could cause hyperuricemia (HUA), which defined as a SUA concentration >6.8 mg/dL[4]. Currently, the prevalence of HUA is potentially attributed to recent shifts in diet and lifestyle, improved medical care and increased long life [5].

Developed countries tend to have a higher burden of gout than developing countries. Some ethnic groups are particularly vulnerable to gout, supporting the importance of genetic predisposition. Socioeconomic and dietary factors, as well as co-morbidities and medications that can impact UA levels and/or facilitate monosodium urate (MSU) crystal formation, are also important in determining the risk of developing gout [6].

Recently, SUA has received attention as a potential biomarker dependently predicting the development of hypertension, diabetes mellitus (DM), and chronic kidney disease [7]. A close relationship exists between plasma UA levels and glucose utilization in type 2 diabetes mellitus (T2DM) [8], which results from a defect in insulin secretion or action, almost always with a major contribution from insulin resistance (IR) [9]. T2DM is a corollary of the interaction between a genetic predisposition, behavioral and environmental risk factors. Obesity and physical inactivity are the main non-genetic determinants of T2DM although, the genetic basis of the disease has yet to be identified [10]. The strong relationship between UA and T2DM is due to the development of renal dysfunction in T2DM [11].

There were studies that showed a clear relationship of increased UA levels with hypertension, metabolic syndrome (MetS), abdominal obesity, endothelial dysfunction, inflammation, subclinical atherosclerosis and an increased risk of cardiovascular events [12]. Some other factors can also induce HUA such as hypertension, possibly by urate reabsorption, which is caused by decreased renal blood flow [13]. Dyslipidemia may also cause HUA through a negative effect on renal function [14]. According to data from the National Health and Nutrition Examination Survey (NHANES) 2007–2008, the prevalence of HUA was 21% in American adults, reaching 26% in African Americans. Recently, the prevalence of HUA has been increasing [15]. Evidence has supported the association of high level of UA with MetS, T2DM and CVD [16].

Some of the recognized risk factors of CVD are high blood pressure, rapid acculturation and step up in economic conditions, economic transition, increased tobacco use, high blood lipids, physical idleness, over-weight and obese, DM and poor dietary habit [15]. Hyperglycemia and lipid metabolism disorder is also linked to a greater risk for vascular problems, kidney disease, nerve and retinal damage resulting in challenges in managing the disease adequately, especially in the presence of immune suppression, and predisposes individual to premature mortality. Moreover, this has cost and social implications for patients, their families, communities and the healthcare system. Currently, HUA in T2DM patients has been less well investigated in sub-Saharan Africans. Until now, the pathogenic role of UA in the development of the MetS is not complete, therefore, the aim of the study was to assess the current burden of HUA and its association with CVD risk factors among T2DM patients at the University of Gondar Hospital.

METHODS AND MATERIALS

Study design, period and area

Institution-based cross-sectional study was conducted from February to March, 2018 at the University of Gondar Hospital DM clinic, Gondar, Ethiopia. The University of Gondar Hospital is one of the biggest hospitals in Amhara region that provides health service, acts as a referral center for other district hospitals and has about 400 beds.

It is expected to deliver health service for about five million people in Northwest Ethiopia. As a teaching hospital, it plays an important role in teaching, research and community service.

According to the 2007 census, Gondar town has a total population of 323,900 [17].

Population

The source population was all T2DM patients who have access to be served at the University of Gondar Hospital. Moreover, the study population were all individuals with T2DM who visited the hospital during the study period and fulfilled eligibility criteria.

Inclusion and exclusion criteria

All T2DM patients > 18 years old who were willing to participate in this study were included. Pregnant women, severely ill individuals and patients on drugs known to have an effect on UA level except for anti-diabetic therapy and patients taking lipid lowering drugs were excluded from the study.

Operational definition

Study participants were classified as underweight (BMI<18.5 Kg/m^2), normal weight (18.5-24.9 Kg/m^2), overweight (BMI =25-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2)(18). Waist circumference (WC) >88 centimeter for female and WC >101 centimeter for male was taken as high WC [18] Systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg or current use of blood pressure-lowering medication was used to define hypertension [19]. The interpretation of test results for fasting blood sugar (FBS), UA and lipid profiles was based on the reference range recommended by the manufacturers instruction were considered as normal.

Sample size determination and sampling technique

Single population proportion formula was used by considering the proportion of 50% prevalence among T2DM. 5% desired precision and 95% confidence interval (CI) resulting in a total sample size of 384. The study participants were selected using a systematic random sampling technique.

Data collection and laboratory methods

Socio-demographic characteristics and clinical data were collected by trained nurses using a semi-structured questionnaire. In addition to that, trained laboratory technologists collect and analyzed the blood sample. Anthropometric measurement (weight, height) was measured according to WHO stepwise approach guideline. Height was measured to the nearest 0.5 cm using standiometer and weight was recorded to the nearest 0.1 kg with the patient wearing light clothes using a balance. BMI was calculated as weight divided by height squared (kg/m^2) [18].

Blood pressure was measured by nurses using an analogue sphygmomanometer. Five milliliter fasting venous blood sample was collected using serum separator test tube by following aseptic blood collection procedure. Serum glucose, lipid profiles and UA were measured by using Mindray BS-200E chemistry analyzer (Shenzhen Mindray Bio-Medical electronics Co. Ltd, China).

Data analysis and interpretation

Data was checked for its completeness, clarity and edited for its consistency and the data was entered to SPSS version 20 statistical package for analysis. Descriptive statistics were used to summarize the frequency distributions. Logistic regression analysis was used to determine the association between dependent and independent variables.

Variables with P value < 0.25 in binary logistic regression model were included into the multivariable analysis model to identify independent predictor variables for abnormal serum uric acid concentration. In addition, Pearson's correlation was used to determine the correlation between independent variables and serum UA.

Ethical consideration

Ethical clearance was obtained from the Research and Ethical Review Committee of School of Biomedical and Laboratory Sciences, College of Medicine and Health Sciences, University of Gondar. Permission letter was also taken from clinical director of the Hospital and head of the DM clinic. To ensure the confidentiality of the study participant's information, anonymous typing was applied, so that the name and any identifier of the participants were not written on the questionnaire.

RESULTS

Serum uric acid level according to socio-demographic characteristics of study participants

A total of 384 study participants were enrolled and the response rate obtained was 99.1%. In this study, a majority of 60.4% (n=232) of the study participants were males. The mean age of the study participants was 55.74 ± 9.05 years with a range of 36 to 88 years. 95% (n=365), 96.1 % (n=370), and 59.1% (n=227) study participants

Table 1 Serum uric acid level of the study participants according to socio-demographic characteristics

Variables	Category	N (%)	Uric acid level, N (%)		P-value
			Hyperuricemia	Normouricaemia	
Sex	Male	232(60.4)	77(33.2)	155(66.8)	0.382
	Female	152(39.6)	44(28.9)	108(71.1)	
Age	36-45	46(12.0)	14(30.4)	32(69.6)	**0.001***
	46-55	148(38.5)	28(18.9)	120(81.0)	
	56-65	139(36.2)	52(37.4)	87(62.6)	
	66-75	41(10.7)	24(58.5)	17(41.5)	
	76-88	10(2.6)	3(30.0)	7(70)	
Marital status	Unmarried	12(3.1)	7(58.3)	5(41.6)	**0.041***
	Married	370(96.1)	113(30.5)	257(69.4)	
Educational level	Literate	104(27.1)	33(31.7)	71(68.2)	0.898
	Illiterate	277(72.1)	86(31.0)	191(69.0)	
Resident	Urban	365(95.1)	115(31.5)	250(68.5)	0.995
	Rural	19(4.9)	6(31.5)	13(68.5)	
Occupation	Employed	276(59.1)	89(32.2)	187(67.8)	0.524
	Unemployed	104(39.8)	30(28.8)	74(71.1)	

Table 2 Serum uric acid level according to clinical characteristics of study participants

Variables	Category	N (%)	Uric acid level, N (%)		P-value
			Hyperuricemia	Normouricaemia	
FHDM	Yes	121(31.5)	57(47.1)	64(52.9)	0.001*
	No	263(68.5)	64(24.3)	199(75.6)	
Hypertension	Present	118(30.8)	82(69.4)	36(30.6)	0.001*
	Absent	266(69.2)	39(14.6)	227(85.4)	
WC	High	92(24.0)	58(63.0)	34(37.0)	0.001*
	Normal	292(76.0)	63(21.5)	229(78.4)	
BMI	Normal	239(62.2)	46(19.2)	193(80.7)	0.001*
	High	143(37.2)	75(52.4)	68(47.5)	
SBP	High	79(20.6)	46(58.2)	33(41.7)	0.001*
	Normal	305(79.4)	75(24.6)	230(75.4)	
DBP	High	56(14.6)	36(64.2)	20(35.8)	0.26
	Normal	328(85.4)	85(25.9)	243(74.1)	
Duration of DM	<5 yr	248(64.6)	63(25.4)	185(74.6)	0.02*
	6-10 yr	100(26)	44(44.0)	56(56.0)	
	>10 yr	36(9.4)	14(38.8)	22(61.2)	
Physical activity	No	304(79.2)	100(32.9)	204(67.1)	0.28
	Yes	80(20.8)	21(26.2)	59(73.8)	
Alcohol	Yes	88(22.9)	31(35.2)	57(64.7)	0.393
	No	296(77.1)	90(30.7)	206(69.2)	
Coffee	Yes	265(69.0)	81(30.5)	184(69.5)	0.552
	No	119(31.0)	40(33.6)	79(66.3)	

*FHDM: Family History of Diabetes mellitus; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; WC: Waist Circumference; BMI: Body Mass Index; *P-value < 0.05, statistically significant association.*

Table 3 **Serum uric acid level and biochemical parameters of the study participants**

Variables	Category	N (%)	Uric acid level, N (%)		P-value
			Hyperuricemia	Normouricaemia	
TG (mg/dl)	High Normal	199(51.8) 185(48.1)	85(42.7) 36(19.4)	114(57.3) 149(80.6)	0.001
tCho (mg/dl)	High Normal	171(44.5) 213(60.1)	66(38.6) 55(25.8)	105(61.4) 158(74.2)	0.007
LDL (mg/dl)	High Normal	131(34.1) 253(65.8)	73(55.7) 48(18.9)	58(44.3) 208(81.1)	0.001
HDL (mg/dl)	Low Normal	77(20.0) 307(79.9)	61(79.2) 60(19.5)	16(20.8) 247(80.5)	0.001
FBS (mg/dl)	High Normal	362(94.2) 22(5.7)	118(32.6) 3(13.6)	224(61.8) 19(8)	0.063

TG: Triglyceride; FBG: Fasting Blood Glucose; tCho: Total Cholesterol; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; mg/dl: milligram per deciliter.

were urban dwellers, married and employed, respectively. The prevalence of HUA was 31.5% (n=121) with 95% CI, 27.3-36.2. The serum uric acid concentration was higher among male study participants compared to female (33.1% versus 28.9% respectively) and the prevalence was also higher among ≥45 years age group (31.8%) (Table 1).

Serum uric acid level according to clinical characteristics of study participants

The prevalence of HUA was higher among study participants with a family history of diabetes (47.1%). Higher prevalence of HUA was determined among patients with ≥5-year duration of diabetes (42.6%), overweight (BMI: 25–29.9 Kg/m^2) 52.4% (n= 49), hypertensive (69.4%) T2DM patients.

The high percentage of abnormal serum uric acid concentration was determined among study participants with central obesity (63.0%), with elevated SBP (58.2%), and with family history of DM (47.1%) (Table 2).

Serum uric acid level and biochemical parameters of study participants

The HUA concentration was determined among 42.7% (n=85) study participants with hypertriglyceridemia, among 79.2% (n=61) with reduced HDL, and in 32.6% (n=118) with hyperglycemic (Table 3).

Correlations of selected cardiovascular disease risk factors with serum uric acid level

The Pearson's correlation coefficient had indicated significantly positive correlation between

HUA and biochemical parameters like TG (r= 0.3, p value=0.001), FBG (r=0.3, p value=0.063), tCho (r=0.3, p value=0.007), and significantly negative correlation with HDL (r=-0.3, p value=0.001). In addition to that, some anthropometric parameters including BMI (r=0.1), WC (r=0.3) and SBP (r=0.2) have significantly positive correlation with HUA (Table 4).

The association between serum uric acid and cardiovascular disease risk factors among type 2 Diabetes Mellitus patients

In this study, T2DM patients with a higher Systolic BP (AOR = 4.4, 95% C.I (2.1-9.3), WC (AOR = 3.7, 95% CI (1.6-8.8), and with high BMI (AOR = 1.4, 95% C.I (1.1-3.7) were considerably associated with hyperuricemia (Table 5).

The prevalence of cardiovascular disease risk factors among T2DM patients

About, 29.6% (n=121) of the study, participants have single CVD risk factor, that is followed by two CVD risk factor 24.8% (n=93). At least one CVD risk factor was observed in 97.4% (n=374) of the study participants. Hypertension 58.6%; dyslipidemia 64.9%; overweight: 37.2% and central obesity: 24.0% were selected CVD risk factors (Figure 1).

Table 4 Pearson's correlation of cardiovascular disease risk factors with serum uric acid level at University of Gondar Hospital, 2018

Parameters	Mean ± SD	Correlation coefficients	P-value
TG (mg/dl)	272.2 ± 194.6	0.3	0.001*
FBG (mg/dl)	192.8 ± 66.9	0.3	0.063
tCho (mg/dl)	226 ± 152.5	0.3	0.007*
HDL (mg/dl)	57.4 ± 19.8	-0.3	0.001*
LDL (mg/dl)	97.8 ±52.3	0.3	0.001*
SBP (mmHg)	131.6 ± 13.8	0.2	0.001*
DBP (mmHg)	81.9 ± 8.6	0.2	0.001*
WC (cm)	94.3 ± 9.4	0.3	0.001*
BMI (kg/m^2)	25.4 ± 12.3	0.1	0.003*

TG: Triglyceride; FBG: Fasting Blood Glucose; tCho: Total Cholesterol; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; WC: Waist Circumference; BMI: Body Mass Index; mmHg: millimeter mercury; mg/dl: milligram per deciliter; kg/m^2: Kilogram per meter square
** P-value < 0.05 is statistically significant.*

Table 5 **Logistic regression analysis of the association of serum uric acid and cardiovascular disease risk factors among T2DM patients**

Variables		N (%)	Uric acid level		COR (95% CI)	AOR	P-value
			Hyper-uricemia	Normouri-caemia			
Sex	Male	232 (60.4)	77	155	1.2 (0.7-1.9)	-	-
	Female	152 (39.6)	44	108	1	-	
Age	>45	336 (87.5)	107	229	1.1 (0.5-2.2)	-	-
	<45	48 (12.5)	14	34	1	-	
Duration of DM	0-5	248 (64.6)	63	185	1	1	**0.002***
	6-10	118 (30.8)	53	65	2.3 (1.5-3.8)	2.4 (1.4-4.2)	
	>10	18 (4.6)	5	13	1.1 (0.3-3.2)	-	
Hypertension	Present	118 (30.8)	82	36	13.2 (7.8-22.2)	13.9 (7.9-24.6)	**0.001***
	Absent	266 (69.2)	39	227	1	1	
Systolic BP	High	79 (20.6)	46	33	4.2 (2.5-7.1)	4.4 (2.1-9.3)	**0.03***
	Normal	305 (79.4)	75	230	1	1	
Diastolic BP	High	56 (14.6)	36	20	5.1 (2.8-9.3)	2.2 (0.8-5.6)	0.089
	Normal	328 (85.4)	85	243	1	-	

Family history DM	Yes	121 (31.5)	57	64	2.7 (1.7-4.3)	1.5 (1.2-2.5)	0.05
	No	263 (68.5)	64	199	1	1	
WC	High	92 (24)	58	34	6.2 (3.7-10.2)	3.7 (1.6-8.8)	**0.001***
	Normal	292 (76)	63	229	1	1	
BMI	High	143 (37.4)	75	68	4.6 (2.9-7.3)	2.0 (1.1-3.7)	**0.03***
	Normal	239 (62.6)	46	193	1	1	
Alcohol drinking habit	Yes	88 (22.9)	31	57	1.2 (0.7-2.0)	-	-
	No	296 (77.1)	90	206	1	-	
Coffee drinking habit	Yes	265 (69)	81	184	0.8 (0.5-1.3)	-	-
	No	119 (31)	40	79	1	-	
Physical activity	Yes	80 (20.8)	21	59	0.7 (0.4-1.2)	-	-
	No	304 (79.2)	100	204	1	-	

*WC: Waist Circumference; BMI: Body Mass Index; DM: Diabetes Mellitus; BP: Blood Pressure; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; * P value < 0.05 is statistically significant.*

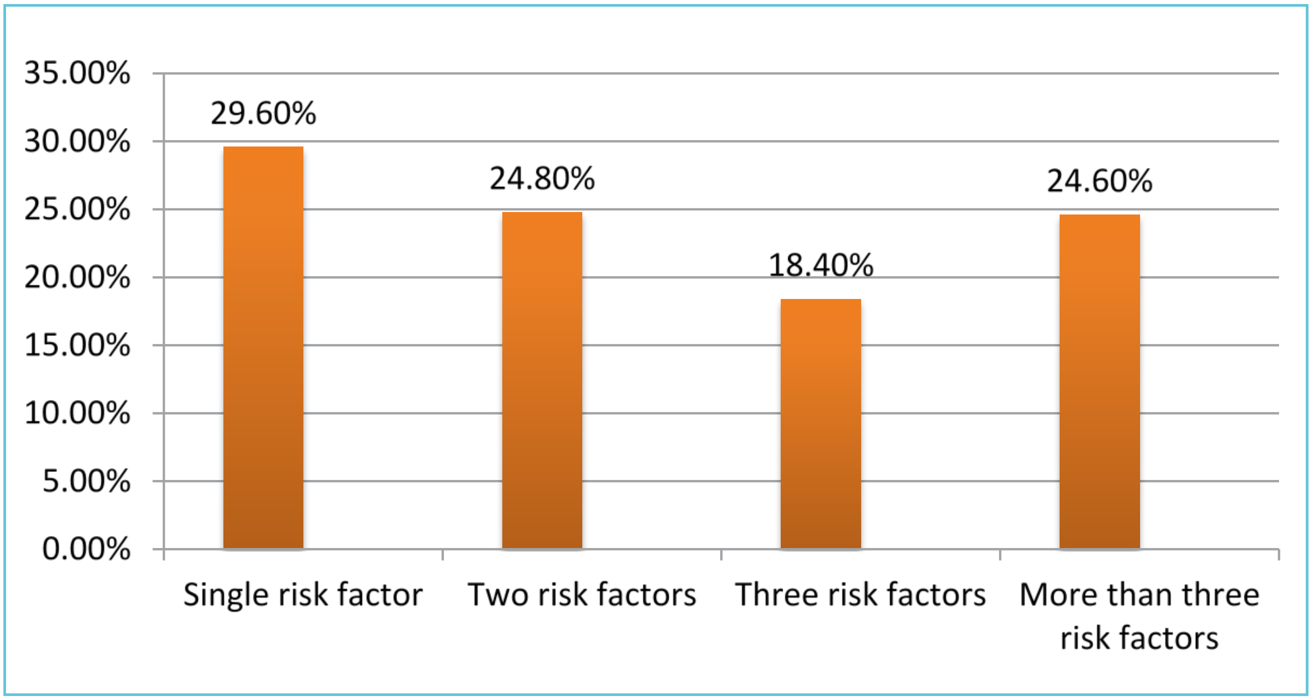
DISCUSSION

A previous study has reported that moderately raised levels of SUA have been considered as a simple biochemical defect with little clinical significance. However, recently, it has become increasingly clear that moderately elevated SUA levels are independently associated with increased cardiovascular morbidity and mortality in T2DM patients [20].

The main finding of this study was high prevalence of HUA concentration among T2DM patients. There was significant association between HUA and the various types of the CVD risk factors, and an increase in number of each CVD risk factor among the study participants.

In this study, the prevalence of HUA among T2DM patients was 31.5%. The magnitude of HUA that was reported by Wang J et al. from China (32.2%), Shah P et al. from Egypt (32.0%),

Figure 1 The overall prevalence of cardiovascular disease risk factors among T2DM patients at University of Gondar Hospital, northwest Ethiopia, 2018



Woyesa et al. from Hawassa, Ethiopia (33.8%)[21-23] was comparable to our finding. In contrast to the current finding, low prevalence of HUA was reported by Moulin SR et al. from Angola (25.0%) and Mundhe et al. from India (25.3%)[24, 25], and much less prevalence was reported from US (21.0%)(26). The variation in prevalence across studies might be due to the different life style, and the existence of ethnic variation between people in different countries [27].

The magnitude of HUA in males was higher than females in our study, which was supported by the study conducted in Nigeria and India [25, 28]. These sex differences of SUA levels have been attributed to the influence of sex hormones [29], due to the mechanism of estrogen in promoting UA excretion [30].

The other possible explanation for this, could be that males are more exposed to alcohol consumption [29] since, beer contains large amounts of purine [31] and the increased renal ATP binding cassette transporter sub family G member 2 (ABCG2) expression in men compared with women. The expression of the ABCG2 protein induces HUA through the reabsorption of urate [32].

In contrast to our finding, the prevalence of HUA from China, by Wang et al [23], was high among female study participants. The difference might be due to the ethnic difference of the study participants across countries.

On the other hand, the prevalence HUA in Nigeria [33] and Taiwan [34] were comparable in both genders. Beyond dietetic factors, HUA can also be related to the genetic predisposition for higher urate reabsorption in the kidneys.

Previous studies had shown that the ABCG2 protein, a UA transporter, shows differences in its expression and function by ethnicity [27].

In our study, age greater than 45 years had high prevalence of HUA, which was similar to the study conducted in Hawassa, Ethiopia [22] and

China [23]. The reason that might occur is that the effect of diuretics [35], due to ABCG2 protein, which increases as age increases and renal complications during aging [27].

The magnitude of hypertension (58.6%) in our study was comparable with the study conducted in Himalayan areas (61.5%)(36), and its prevalence was lower from Northern Catalonians (74.5%) [37]. In addition to that, the overall magnitude of dyslipidemia in our study was lower compared to the study in North Catalonia (77.7%) [37].

Similar study conducted in North Catalonia showed the different types of specific CVD risk factors, which include high BMI (>25 kg/m^2) (60.9%) and hypertension (80.3%), which was higher than the current study.

On the other hand, hypertriglyceridemia (35.6%) and lower HDL (19.5%) were lower compared with our study. The possible explanation might be due to the life style, ethnicity and cultural difference between those two regions [37].

The simultaneous presence of three or more CVD risk factors in the current study was observed in 24.6% of the study participants. This was much less from the study conducted in North Catalonia (91.3) [37].

The occurrence of at least one CVD risk factor in our study was observed in 97.4%. In this study, the duration of DM and family history of diabetes had statistically significant association with HUA, which is in line with the finding reported from India (38).

The possible mechanisms to explain these associations are the use of diuretics [35] or impaired renal function [39]. Genetic predisposition could be one of the reasons for the effect of HUA because of the gross overproduction of UA which results from the inability to recycle either hypoxanthine or guanine in patients genetically deficient in Hypoxanthine-guanine phosphoribosyl transferase (HPRT), inducing a lack of feed-back control of purine synthesis, which accompanied by rapid catabolism of purines to UA [40].

Increased SBP had significantly associated with HUA, which was supported by the study conducted in Black Africans [24].

The possible factor might be the use of antihypertensive agents, such as diuretics, which are known to increase HUA [35] and T2DM with hypertensive patients showed a significant association with HUA compared to non-hypertensive participants which is supported by a study on Black Africans, hence, anti-hypertensive therapy contributes significantly increases HUA [41].

In this study, high WC and high BMI (>25Kg/m^2) were significantly associated with HUA. This finding was supported by studies conducted in Nigerian, China and India [23, 25, 28]. The possible reason might be as a result of increase in Xanthine oxidoreductase (XOR) in obese individuals catalyzes oxidative hydroxylation of hypoxanthine to xanthine to uric acid (35).The level of HUA, accompanied with a significantly correlation with LDL, TG, TC, and HDL levels, in our study, which is agreed with study conducted in US [42]. Evidence also supported that dyslipidemia may cause HUA a negative effect on renal function [14].

Anthropometric measurements, such as high BMI, high SBP, high WC, as well as biochemical parameters, such as FBG and TG, were positively correlated with HUA.

The current study showed that, low HDL had a negative correlation with HUA, which were supported by the studies conducted in Ethiopia, China, Taiwan and India [22, 23, 34, 43], and a number of pathophysiological mechanisms have been explained to these associations including insulin resistance (IR) [44], the use of diuretics [35] or impaired renal function [39].

Patients who have IR, secrete larger amounts of insulin to maintain an adequate glucose metabolism and the kidney responds to the high insulin levels by decreasing UA clearance, probably linked to insulin-induced urinary sodium retention [45].

Due to these, the kidney has been implicated as the potential link between IR and compensatory hyperinsulinemia and the development of HUA.

The limitation of this study was cross-sectional nature of the study design that does not allow the establishment of causal relationship.

CONCLUSION AND RECOMMENDATION

The prevalence of hyperuricemia was high in type 2 diabetes patients. The major predictors of CVD risk factors were elevated systolic blood pressure, family history of DM and BMI ≥ 25 Kg/m^2.

There was significantly positive correlation of HUA with hypertriglyceridemia, hypercholesterolemia, high LDL, high WC and increased BMI. Therefore, early diagnosis and treatment for hyperuricemia and CVD risk factors are essential to reduce the disease among type 2 diabetic patients.

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Availability of data and materials

All relevant data supporting the conclusion are within the paper. The datasets used for this manuscript are available from the corresponding author on reasonable request.

Authors' contributions

All authors participated in data collection, analysis, and interpretation of the result, write up and reviewed the initial and final drafts of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declared that there is no competing interest.

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