

# Urban-Rural Differences in the Trends of Type 1 and Type 2 Diabetes Among Adults Who Received Medical Treatment from Public Hospitals in Resource-Poor Community Tigray, Ethiopia

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**Objective:** This study carried out to describe urban-rural differences in the trend of type 1 and type 2 diabetes among adults who have received medical treatment from public hospitals over the last five years.

**Methods:** The trends of adult diabetes assessed from September 1, 2013, to August 31, 2018, using hospital-based retrospective medical records of 299,806 adult patients in the adult medical outpatient and emergency units. Data were collected using a uniform data abstraction format. An extended Mantel-Haenszel chi-square test of the linear trend used to examine the trend over time.

**Results:** Of the total 299,806 adult patients, 3056 (1.02% (95% CI: 0.98–1.06)) patients were confirmed diabetes patients. The overall trend in the proportion of diabetes had increased from 6.8 to 14.3 per 1000 adult patients. The trend of type 1 diabetes increased for both urban from 1.0 to 2.2 per 1000 adult urban residents and rural from 1.2 to 2.6 per 1000 adult rural residents, with statistically a significant increase ( $\chi^2=9.1$ ,  $P=0.002$ ) and ( $\chi^2=17.8$ ,  $P<0.001$ ) for linear trend, respectively. The trend of type 2 diabetes increased for both urban from 6.9 to 14.0 per 1000 adult urban residents and rural from 4.0 to 9.5 per 1000 adult rural residents, with a statistically significant increase ( $\chi^2=68.4$ ,  $P<0.001$ ) and ( $\chi^2=74.2$ ,  $P<0.001$ ) for linear trend, respectively. The higher increase in the proportion of both type 1 and type 2 diabetes observed among women patients.

**Conclusion:** The trend in the proportion of type 1 and type 2 diabetes increasing for both urban and rural residents, with a higher increase observed among women. These findings highlight health-care professionals and policymakers to design effective public health policies to treat each type of disease.

**Keywords:** urban, rural, trend, type 1 diabetes, type 2 diabetes

## Introduction

Diabetes is one of the most epidemic diseases of this century. The global size of diabetes has grown from 108 million in 1980 to 425 million in 2017, and this could be reached 693 million by 2045 and varies by age, gender and residence.<sup>1,2</sup> In the modern era, diabetes has no border that imposes unacceptably high human, social, and economic costs on countries at all income levels worldwide. In 2015, roughly 5 million people aged 20 to 79 years died from diabetes-related deaths, which is equivalent to one death every six seconds, and about 14.5% of the global all-cause mortality among adults.<sup>1–3</sup>

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Acute and long-term diabetes complications bring about substantial economic loss by increased use of health services, loss of productivity, disability, and premature death. As a result, diabetes imposes the economic burden on individuals, families, national health systems and the economy of a country.<sup>1,2,4</sup>

Even though incidence rates of diabetes are decreasing in the developed countries in the previous two decades such as in the United States (US) and Switzerland;<sup>4,5</sup> still, it is alarmingly increasing in low and middle-income countries (LMICs) such as China, India, and Brazil.<sup>6–8</sup> In 2017, about 80% of people with diabetes live in LMICs, since these countries were on rapid economic and societal transitions.<sup>1,9–11</sup>

Ethiopia is the leading country in Sub-Saharan Africa (SSA), with over 2.6 million adult diabetes patients; with an estimated diabetes prevalence of 5.2% in 2017,<sup>1,3</sup> probably catalyzed by economic and societal transitions, and childhood malnutrition, with about 70% of adults with undiagnosed diabetes.<sup>1,10,12</sup> Recent studies in Ethiopia<sup>13–15</sup> indicated that more than one-third of patients admitted with hyperglycemic emergencies were undiagnosed diabetes, which suggests people die undiagnosed and the prevalence of diabetes could be beyond this magnitude.

Studies indicated that type 1 diabetes (T1D) and type 2 diabetes (T2D) are the two major public health concerns types of diabetes elsewhere in the world, including Ethiopia.<sup>16,17</sup> Even though both type 1 and type 2 diabetes results in hyperglycemia, pathophysiology, and etiology of the diseases are distinct and require us to consider each type of diabetes independently.<sup>18</sup> Study in the US suggested that type 1 and type 2 diabetes accounted for about 6% and 91% of all cases of diagnosed diabetes, respectively.<sup>19</sup> Recent studies in Italy and Ethiopia indicated, type 1 diabetes is strongly associated with poverty and markers of undernutrition, most marked in the rural cases and excess among men compared to women.<sup>17,20</sup> The trend on the prevalence of T2D is alarmingly increased over time in developing countries, including SSA countries due to marked economic and epidemiologic transitions, which result in altering lifestyle practices, and marked increases in overweight and obesity.<sup>6,21</sup>

Studies indicate that both type 1 and type 2 diabetes have become an increasingly prevalent, problematic and severe public health issue for both urban and rural residents, with the highest prevalence in urban areas.<sup>6,22,23</sup> Studies in Ethiopia, Myanmar, India, and Peru showed the prevalence of diabetes is higher for urban dwellers

compared to rural residents.<sup>6,24–26</sup> Location of residence is also important in terms of access to care and health outcomes; people living in rural areas have increased treatment gaps and acute complications with their diabetes.<sup>1,2,27</sup>

Sex-related differences in lifestyle may lead to differences in the risk of developing diabetes mellitus and, in consequence, to differences in the prevalence of this condition in women and men.<sup>27,28</sup> Studies in the US, Italy, and Ethiopia indicate that male participants had a higher risk than female study participants in all age-groups for both type 1 and type 2 diabetes.<sup>17,19,20</sup> But other studies in SSA countries suggested that the prevalence of diabetes is higher among women compared to men; this is due to higher rates of obesity among women,<sup>29,30</sup> or history of gestational diabetes mellitus, which is associated with an increased risk of subsequent T2D in mothers and their offspring.<sup>11,28</sup>

Although diabetes brings real economic loss by increased use of health services, loss of productivity, disability and premature death in the developing nations including Ethiopia, robust data on adult diabetes are scarce in Ethiopia as well in Tigray; where most clinical data are not timely assessed and made accessible for policy and decision-makers. This study demonstrated the trend in the proportion of adult T1D and T2D for both urban and rural residents, which will have a crucial input in shifting healthcare priorities for policymakers and planners for planning health services for the needy and preventing premature adult deaths.

## Methods and Materials

### Study Period and Population

The study was conducted in seven public hospitals of Tigray in northern Ethiopia among adult patients aged 18 years and above, who received medical treatment from adult medical outpatient and emergency units from September 1, 2013, to August 31, 2018.

### Study Design and Data Collection

This study was a hospital-based retrospective record review of patients registered in the study period and units. All five years' medical records of adult patients aged 18 years and above who received medical treatment were included in the review and screened from the registry log book. But adult patients with gestational diabetes and diabetes patients with referral papers were excluded from the study to decrease over enumeration of cases.

Data abstracted using a uniform data abstraction format prepared to gather relevant data from the medical records both paper copy file and e file/smart care/after the data abstraction format pretested from 295,806 adult patients. Nursing and public health experts recruited for data abstraction. Data collectors and supervisors were trained for one day on how to retrieve, abstract relevant data from the medical records, and keep records back in the original location. The data abstraction format pretested in 300 adult medical records two weeks before the actual data abstraction period for fitness and consistency.

## Operational Definitions

New diabetes case: Physician diagnosed as a diabetes patient for the first time with fasting blood sugar (FBS)  $\geq 126$  mg/dL, or repeated random blood sugar (RBS)  $\geq 200$  mg/dL plus fatigue, polyuria, polydipsia, and other symptoms, we considered a new diabetes patient.<sup>1,2</sup>

Type 1 diabetes: When the patient presented with FBS  $\geq 126$  mg/dL or RBS  $\geq 200$  mg/dL plus classic symptoms excessive urination, excessive thirst, unexplained weight loss, and increased hunger, we considered as type 1 diabetes patient.<sup>2</sup>

Type 2 diabetes: When the patient presented with FBS  $\geq 126$  mg/dL or RBS  $\geq 200$  mg/dL plus other symptoms such as excess body weight, physical inactivity, unhealthy diet, and family history of diabetes, we considered as T2D patient.<sup>2</sup>

## Data Analysis

Data entered in Epi data manager 4.3 for Windows 10 software and analyzed using SPSS Version 25.0 software, and we used a list-wise deletion for missing variables to have a complete case analysis across time. The key covariate of interest was the time (in years), which allowed the estimation of change in the prevalence of type 1 and type 2 diabetes over time. We calculated Mean and Standard Deviation (SD), and proportions for continuous variables and categorical variables, respectively. Extended Mantel-Haenzel chi-square test for linear trends used to examine trends in diabetes proportion for the period September 1, 2013, to August 31, 2018, using Epi info 7.1.5 STAT CALC, and the trends of both type 1 and type 2 diabetes observed by residence and gender. A p-value of  $<0.05$ , considered statistically significant for the linear trend, and findings presented in text, table, and figures.

## Ethical Statement

The ethical statement protocol approved by the Institution Review Board (IRB) of Addis Ababa University-College of Health Sciences (AAU-CHS), and waiver letter obtained. In addition, a written permit obtained from the Tigray Regional State Health Bureau and respective hospitals' administrative bodies after submitting the protocol and explaining the purpose of the study. For the sake of privacy and confidentiality, no personal identifiers, such as names, were collected.

## Results

Out of the total 299,806 adult patients who received medical care services in the studied hospitals, 128,915 (43.0%) of the patients were women, and 126,559 (42.2%) of them were rural residents. From those patients who received medical treatment, 3056 (10.2 per 1000 adult patients) were confirmed, diabetes patients. The proportion of diabetes was 11.6 per 1000 urban residents, and 8.6 per 1000 rural residents. The mean ( $\pm$ SD) age of adult diabetes patients at diagnosis was 46.04 ( $\pm$ 14.96) years, with 26.41 ( $\pm$ 9.45), and 49.65 ( $\pm$ 12.98) years, for Type 1 diabetes (T1D) and Type 2 diabetes (T2D), respectively. Of the total of 3056 newly diagnosed adult diabetes patients, 1705 (55.8%) were men and 2011 (66%) of the diabetes patients were urban residents. Four hundred eighty-seven (15.9%) of adult diabetes patients, were type 1 diabetes patients and half of these were rural residents. Of the total 2569 T2D patients, 1768 (68.8%) were urban residents. Almost one-third of the diabetes patients treated at Ayder comprehensive specialized hospital (ACSH) (Table 1). [Supporting information available \(PPTX\) in Tables S1 and S2.](#)

The overall trend of diabetes had increased from 6.8 to 14.3 per 1000 adult patients, with increased for both urban (7.9 to 15.9 per 1000 adult urban residents) and rural (from 5.2 to 13.2 per 1000 adult rural residents) in the observation period (Figure 1). [Supporting information available in Tables S1 and S2.](#)

The trend of diabetes had a higher increase in those ages group 60 and above years, with 15.5 per 1000 adult patients compared to those in the age group of 18 to 29 years with 6.8 per 1000 adult patients in the observation period (Figure 2). [Supporting information available in Table S3.](#)

The overall proportion of Type 1 diabetes was 0.16% (95% CI: 0.15–0.18), with a statistically significant

**Table 1** Characteristics of Newly Diagnosed Adult Diabetes Patients in Selected Public Hospitals of Tigray, Ethiopia (September 1, 2013 to 2018, August 31, 2018)

Patient Characteristics	Frequency	Percent
Gender		
Men	1705	55.8
Women	1351	44.2
Residence		
Urban	2011	65.8
Rural	1045	34.2
Age		
<29	466	15.3
30 to 39	561	18.4
40 to 49	750	24.5
50 to 59	617	20.2
60 Years and above	662	21.7
Type of diabetes		
Type 1 diabetes	487	15.9
Type 2 diabetes	2569	84.1
Type 1 Diabetes		
Urban resident	243	49.1
Rural residents	244	50.1
Type 2 Diabetes		
Urban residents	1768	68.8
Rural residents	801	31.2
Hospital Diabetes Treated		
Ayder comprehensive specialized hospital	944	30.9
Mekelle hospital	465	15.2
Ma'y Chew Lemlem Karl hospital	408	13.4
Adigrat hospital	332	10.9
St Merry hospital	376	12.3
Suhul shire hospital	326	10.7
Abyi Adi hospital	205	6.7

increase ( $\chi^2=34.5$ ,  $P<0.001$ ) for linear trend. The proportion of T1D for both urban and rural residents was 0.14% (95% CI: 0.12–0.16) and 0.19% (95% CI: 0.17–0.22), with a statistically significant increase ( $\chi^2=9.1$ ,  $P=0.002$ ) and ( $\chi^2=17.8$ ,  $P<0.001$ ) for linear trend, respectively. The

proportion of T1D for women was 0.17% (95% CI: 0.12–0.16), with statistically significant increase ( $\chi^2=20.2$ ,  $P<0.001$ ) for linear trend, but not for men ( $\chi^2=3.1$ ,  $P=0.08$ ) (Table 2).

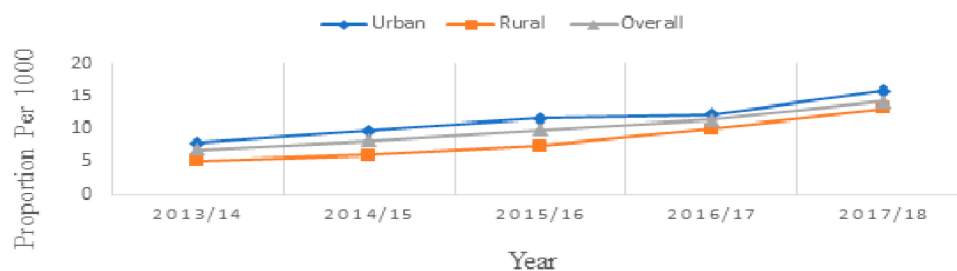
The overall trend of type 1 diabetes had increased from 1.1 to 2.4 per 1000 adult patients, with the trend of type 1 diabetes increased for both urban (1.0 to 2.2 per 1000 adult urban residents) and rural (from 1.2 to 2.6 per 1000 adult rural residents) in the observation period (Figure 3).

The overall proportion of T2D was 0.86% (95% CI: 0.82–0.89), with statistically significant increase ( $\chi^2=151.0$ ,  $P<0.001$ ) for linear trend. The proportion of T2D for both urban and rural residents was 1.0% (95% CI: 0.97–1.10) and 0.63% (95% CI: 0.59–0.68), with statistically significant increase ( $\chi^2=68.4$ ,  $P<0.001$ ) and ( $\chi^2=74.2$ ,  $P<0.001$ ) for linear trend, respectively. The proportion of T2D for both men and women was 0.84% (95% CI: 0.79–0.88) and 0.88% (95% CI: 0.83–0.94), with statistically significant increase ( $\chi^2=32.0$ ,  $P<0.001$ ) and ( $\chi^2=70.3$ ,  $P<0.001$ ) for linear trend, respectively (Table 3).

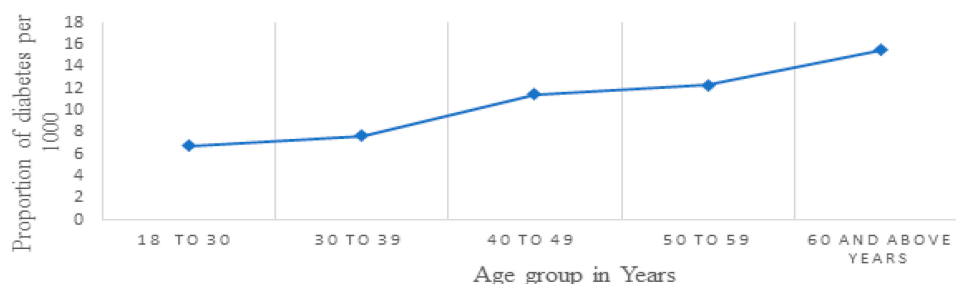
The overall trend of T2D has increased from 5.7 to 12.0 per 1000 adult patients, with increased for both urban (6.9 to 14.0 per 1000 adult urban residents) and rural (from 4.0 to 9.5 per 1000 adult rural residents) in the observation period (Figure 4).

## Discussion

The present study used a retrospective record administrative health care data from hospital logbook and patient charts to investigate urban-rural differences in the trend of type 1 and type 2 diabetes among adult patients in resource-poor community Tigray between September 1, 2013, and August 31, 2018. The proportion of diabetes in this study was 10.2 per 1000 adult patients, with 11.6 per 1000 urban residents and 8.6 per 1000 rural residents with age. The trend in the proportion of adult diabetes steadily increased with time in



**Figure 1** The overall trends in the proportion of diabetes by residence in the selected public hospitals of Tigray, Ethiopia (September 1, 2013 to August 31, 2018).



**Figure 2** Trends in the proportion of diabetes by age category per 1000 adult patients in the selected public hospitals of Tigray, Ethiopia (September 1, 2013 to August 31, 2018).

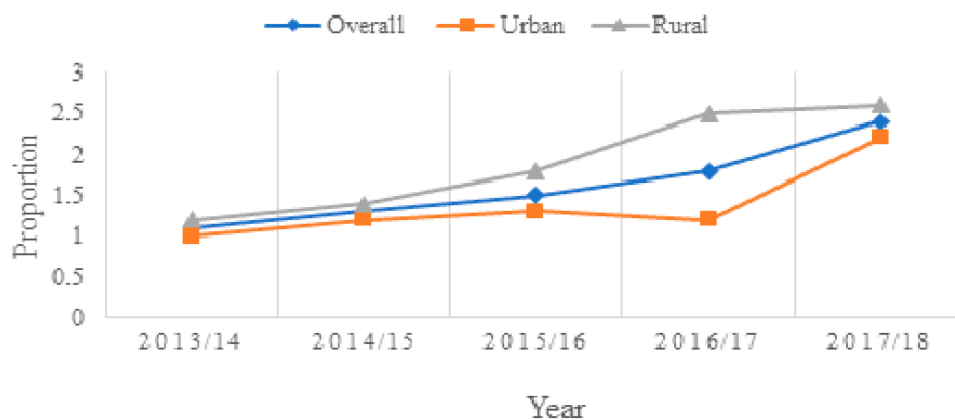
both urban and rural residents for both T1D and T2D, and for both men and women patients in the observation period.

The finding of this study suggests, the trend in the proportion of adult diabetes has definitely risen more than double over the last five-years observation period,

**Table 2** The Trends of T1D by Residence and Gender (Extended Mantel-Haenszel Chi-Square and Proportion) in the Selected Hospitals of Tigray, Ethiopia (September, 2013 to August, 2018)

Variable	Year	DM Patients	OPD Patients	Proportion of DM (%)	95% CI	MH-OR
Overall Proportion of T1D	2013/14	59	55,734	0.11	[0.08–0.14]	1.000
	2014/15	76	58,806	0.13	[0.10–0.16]	1.221
	2015/16	91	60,221	0.15	[0.12–0.19]	1.428
	2016/17	109	61,805	0.18	[0.14–0.21]	1.667
	2017/18	152	63,240	0.24	[0.21–0.28]	2.274
	Total	487	299,806	0.16	[0.15–0.18]	$\chi^2= 34.5, P<0.001$
Proportion of T1D Among Urban Residents	2013/14	31	31,914	0.10	[0.07–0.14]	1.000
	2014/15	42	34,370	0.12	[0.09–0.16]	1.254
	2015/16	45	34,645	0.13	[0.10–0.17]	1.334
	2016/17	44	36,244	0.12	[0.09–0.16]	1.250
	2017/18	81	36,074	0.22	[0.18–0.28]	2.315
	Total	243	173,247	0.14	[0.12–0.16]	$\chi^2= 9.1, P=0.002$
Proportion of T1D Among Rural Residents	2013/14	28	23,820	0.12	[0.08–0.17]	1.000
	2014/15	34	24,436	0.14	[0.10–0.19]	1.188
	2015/16	46	25,576	0.18	[0.13–0.24]	1.536
	2016/17	65	25,561	0.25	[0.20–0.32]	2.173
	2017/18	71	27,166	0.26	[0.21–0.33]	2.233
	Total	244	126,559	0.19	[0.17–0.22]	$\chi^2=17.8, P<0.001$
Proportion of T1D Among Men	2013/14	39	31,312	0.12	[0.09–0.17]	1.00
	2014/15	39	34,273	0.11	[0.08–0.16]	0.914
	2015/16	45	34,267	0.13	[0.10–0.18]	1.054
	2016/17	63	36,579	0.17	[0.13–0.22]	1.383
	2017/18	77	34,460	0.22	[0.18–0.28]	1.796
	Total	263	170,891	0.15	[0.14–0.17]	$\chi^2= 3.1, P= 0.08$
Proportion of T1D Among Women	2013/14	20	24,422	0.08	[0.05–0.13]	1.000
	2014/15	37	24,533	0.15	[0.11–0.21]	1.828
	2015/16	46	25,952	0.18	[0.13–0.23]	2.235
	2016/17	46	25,226	0.18	[0.14–0.24]	2.211
	2017/18	75	28,780	0.26	[0.21–0.33]	3.162
	Total	224	128,915	0.17	[0.15–0.20]	$\chi^2=20.2, P<0.001$

**Abbreviations:** DM, diabetes; MH-OR, mantel-haenszel-odd ratio; OPD, out patient department.



**Figure 3** Trends in the proportion of type 1 diabetes by residence per 1000 adult patients in the selected public hospitals of Tigray, Ethiopia (September 1, 2013 to August 31, 2018).

and this is consistent with studies in Ethiopia, Brazil, China, and India.<sup>6,24,28,31</sup> Therefore, rapid economic and societal transitions, childhood nutritional stunting, chronic undernutrition, improving recording, and diabetes detection mechanisms could lie behind these alarmingly increasing trends of diabetes.<sup>17,25</sup>

Even though the findings of this study showed faster increase in the trend of adult diabetes, the prevalence is lower than from the findings of Ethiopia, Tanzania, Iran, and India.<sup>6,22,31,32</sup> The discrepancy might be due to differences in the level of urbanization, health literacy, diagnostics criteria, underestimating diabetes for patients with other illnesses.<sup>1,25,32</sup> The current finding is also much lower compared to the national estimated prevalence of diabetes with 5.2%, which might be due to people die undiagnosed, and about 70% of people with diabetes do not know that they have diabetes.<sup>1</sup>

This study pointed out the trend in the proportion of adult diabetes has increased among all age groups and most pronounced being with people aged 60 and older years. This finding is in line with similar studies in the US, Sweden, Bulgaria, and Panama, with increasing the trend of diabetes with age over time.<sup>4,33–35</sup> Aging could impair  $\beta$ -cell function and impaired  $\beta$ -cell adaptation to insulin resistance leading to impaired insulin secretion, which might be related to obesity and decreased physical activity.<sup>36</sup>

Studies indicated that diabetes becomes an increasingly prevalent, challenging, and severe public health issue in the 21st century, for both the urban and rural residents, with the highest prevalence in urbanized regions.<sup>1,6,25,27</sup> In the current study, even though the trend of adult diabetes is increasing for both urban and rural residents, but the highest proportion observed in urban residents. This study is

consistent with studies in Ethiopia, Myanmar, Iran, India, and Kazakhstan.<sup>6,22,24,25,37</sup> Affluent people live in urban areas, reducing the number of people living in traditional rural livelihoods, which might result in obesity associated with rising living standards.<sup>1,6,25,38</sup> Likewise, urban life is a more complicated, stressful, and competitive life compared with the rural ones.<sup>25,38,39</sup> Although the urban population has better access to the healthcare services, including reliable screening methods and diabetes treatment, people die undiagnosed due to lack of health services in rural residents.<sup>39</sup>

A study in the US suggested that type 1 and type 2 diabetes accounted for about 6% and 91% of all cases of diagnosed diabetes, respectively.<sup>19</sup> Recent studies in Italy and Ethiopia indicated, type 1 diabetes is strongly associated with poverty and markers of undernutrition, most marked in the rural cases and excess among men compared to women.<sup>17,20,40</sup> The trend in the prevalence of T2D is alarmingly increasing over time in developing countries, including SSA countries due to marked economic and epidemiologic transitions, which result in altering lifestyle practices and marked increases in overweight and obesity.<sup>21,28,41</sup>

In several epidemiological studies, T1D in adults is a significant and widespread health problem associated with unacceptably high rates of morbidity and mortality in SSA countries, as a result of childhood nutritional stunting, chronic undernutrition, and environmental factors.<sup>17,20,42</sup> Although the proportion of T1D in the current study is 1.6 per 1000 adult patients, the potential proportion might be greater than that indicated finding. It might be due to many people die before they are diagnosed and access to diabetes treatment and some type 1 diabetes misclassified as

**Table 3** The Trends of T2D by Residence and Gender (Extended Mantel-Haenszel Chi-Square and Proportion) in Hospitals of Tigray, Ethiopia (September, 2013 to August, 2018)

Group of Proportion	Year	DM Patients	OPD Patients	Proportion of DM (%)	95% CI	MH-OR
Overall Proportion of T2D	2013/14	317	55,734	0.57	[0.51–0.63]	1.000
	2014/15	407	58,806	0.69	[0.63–0.76]	1.216
	2015/16	502	60,221	0.83	[0.76–0.91]	1.470
	2016/17	593	61,805	0.96	[0.89–1.00]	1.694
	2017/18	750	63,240	1.20	[1.10–1.30]	2.098
	Total	2569	299,806	0.86	[0.82–0.89]	$\chi^2=151$ , P<0.001
Proportion of T2D Among Urban Residents	2013/14	221	31,914	0.69	[0.60–0.79]	1.000
	2014/15	294	34,370	0.86	[0.77–0.96]	1.237
	2015/16	359	34,645	1.00	[0.93–1.10]	1.497
	2016/17	402	36,244	1.10	[1.00–1.20]	1.608
	2017/18	492	36,074	1.40	[1.20–1.50]	1.983
	Total	1768	173,247	1.00	[0.97–1.10]	$\chi^2=68.4$ , P<0.001
Proportion of T2D Among Rural Residents	2013/14	96	23,820	0.40	[0.33–0.49]	1.000
	2014/15	113	24,436	0.46	[0.38–0.56]	1.148
	2015/16	143	25,576	0.56	[0.47–0.66]	1.389
	2016/17	191	25,561	0.75	[0.65–0.86]	1.860
	2017/18	258	27,166	0.95	[0.84–1.10]	2.369
	Total	801	126,559	0.63	[0.59–0.68]	$\chi^2=74.2$ , P<0.001
Proportion of T2D Among Men	2013/14	184	31,312	0.59	[0.51–0.68]	1.000
	2014/15	225	34,273	0.66	[0.58–0.75]	1.118
	2015/16	281	34,267	0.82	[0.73–0.92]	1.399
	2016/17	351	36,579	0.96	[0.86–1.10]	1.639
	2017/18	389	34,460	1.10	[1.10–1.20]	1.932
	Total	1430	170,891	0.84	[0.79–0.88]	$\chi^2=32.0$ , P<0.001
Proportion of T2D Among Women	2013/14	133	24,422	0.54	[0.46–0.64]	1.000
	2014/15	182	24,533	0.74	[0.64–0.86]	1.365
	2015/16	221	25,952	0.85	[0.75–0.97]	1.569
	2016/17	242	25,226	0.96	[0.85–1.10]	1.769
	2017/18	361	28,780	1.30	[1.10–1.40]	2.320
	Total	1139	128,915	0.88	[0.83–0.94]	$\chi^2=70.3$ , P<0.001

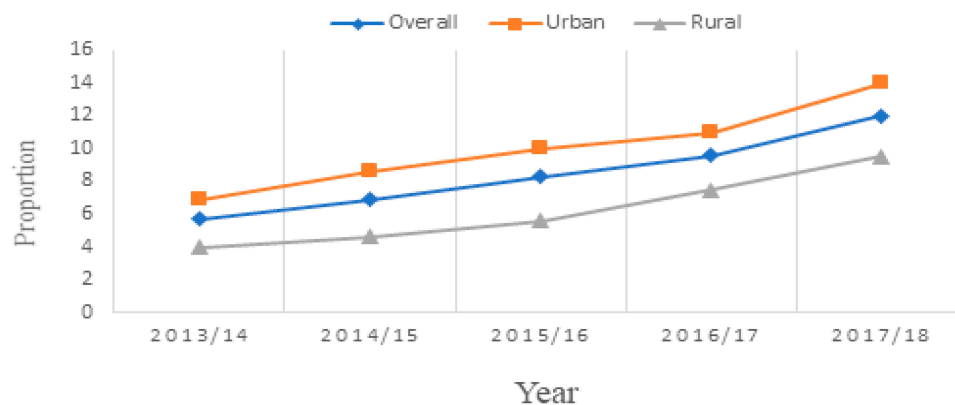
**Abbreviations:** DM, diabetes; MH-OR, mantel-haenszel-odd ratio; OPD, out patient department.

T2D.<sup>20,42,43</sup> The overall trend of type 1 diabetes is increasing in the current study, which is consistent with other studies in the US, Sweden, and SSA countries.<sup>18, 44,45</sup>

Different studies suggest that there are major differences in the age and gender of presenting cases together with marked urban-rural variations in the incidence of T1D.<sup>17,19,20</sup> We found differences in the proportion of type 1 diabetes between urban and rural areas with almost twofold higher in the rural compared to the urban residents. Type 1 diabetes is strongly associated with poverty and markers of undernutrition most marked in the rural cases,<sup>17,46</sup> and acute nature of the disease made rural residents seek medical care.<sup>47</sup> This is inconsistent with studies in Ethiopia urban centers had higher incidence

rates than the surrounding rural areas,<sup>17</sup> which could be due to genetic, environmental, cultural, and socioeconomic variations. Another striking feature of the disease in this study was an excess proportion of T1D in women compared to their men counterparts. It could be due to little attention given to girls in their childhood which lead to undernutrition, genetic susceptibility, and undernutrition at particular times in pregnancy affects many genes that control hepatic and pancreatic function.<sup>17,19,20,36</sup> This finding is inconsistent with findings in Ethiopia and Italy, where the proportion of type 1 diabetes is excess among men.<sup>17,19,20</sup>

Even though T2D prevalence is reaching epidemic proportions elsewhere in the world, it is disproportionately



**Figure 4** Trends in the proportion of T2D by residence per 1000 adult patients in the selected public hospitals of Tigray, Ethiopia (September 1, 2013 to August 31, 2018).

higher in low-income countries.<sup>1,2</sup> SSA countries, including Ethiopia, take the lion share in the magnitude of diabetes due to a rapidly epidemiologic and demographic transition.<sup>1,6,26</sup> In developing countries, the prevalence of T2DM is higher among urban residents compared to their rural counterparts; however, it is higher for rural residents in developed countries.<sup>6,25,27</sup>

The trend of T2DM is increasing with time for both urban and rural residents. In this study, we found a higher proportion of T2DM in an urban resident compared to a rural resident. These marked urban and rural differences in the prevalence of T2DM have reported in other developing countries in India, Bangladesh, and Peru.<sup>6,23,48</sup> This increase might be due to epidemiologic and demographic transitions, with a sedentary lifestyle and unhealthy diet are still problematic and with a notable increment trend.<sup>1,25</sup> This study is inconsistent with study in Canada where prevalence of T2DM is higher among rural residents compared to urban residents.<sup>27</sup>

Several studies indicated that the prevalence of T2DM is higher among men compared to women.<sup>6,25,49</sup> Unlike other studies, we found in this study, women with a higher proportion of T2DM compared to men. This discrepancy could be due to a higher rate of obesity among women compared to their men counterparts<sup>29,30</sup> and history of gestational diabetes mellitus, which is associated with increased risk of subsequent T2D in mothers.<sup>11,28</sup>

It is imperative to acknowledge, as our results must be viewed in light of several important limitations. The first limitation, the incompleteness of the data in the review charts had some missing data for some variables, which could have led to differences in an unmeasured independent variable for which no correction could be made. The second limitation, data were not validated, which could

have led to misclassification of diabetes type. Third, the data were retrospective chart review and underestimate the total number of adults with diabetes, due to some patient charts were lost and not all adult patients who received medical service from the study units were tested for diabetes for those who came for other medical illnesses. The fourth, the study is limited to medical outpatient and emergency units, which do not include obstetrics and surgical units, which might underestimate the proportion of diabetes. Although this finding is not representative of the entire nation, it can generalize for those who are receiving medical services from adult medical outpatient and emergency units of general hospitals of Tigray.

## Conclusion

The overall trend of diabetes is increasing with age over time in the study period. We observed significant increases in the trend of both type 1 and type 2 diabetes among adult patients, for both urban and rural residents steadily with time. A higher proportion of type 1 diabetes is increased in rural residents, and with a statistically significant increase in women study participants, but not in men. Type 2 diabetes has a higher proportion of increase among urban residents, and women participants with time in the observation period.

Our study results might hasten the academia and public interest, resulting in renewed efforts to design effective public health policies. Knowledge about regional prevalence and trend of type 1 and type 2 diabetes in both urban and rural residents might facilitate assessment of the burden of disease and long-term cost-effectiveness of public health interventions and policies aimed at improving diabetes management and help to prioritize regional and national plans for future type-specific health services.



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## Author Contributions

All authors contributed from the development of the proposal to data analysis, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work. Specifically, GG conceived the idea and developed the study proposal, did the fieldwork, analyzed data, interpreted the findings, and led the manuscript writing. FEQ was involved in proposal development, planning the fieldwork, data analysis and interpretation, manuscript editing and manuscript review. ND and HY were involved in proposal development, planning the fieldwork, data interpretation, manuscript editing, and manuscript review.

## Disclosure

The authors report no conflicts of interest in this work.

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