Diabetes in Ethiopia 2000-2016 – prevalence and related acute and chronic complications; a systematic review

N Abebe, T Kebede, and D Addise

Introduction

Diabetes mellitus is not a single disease entity but rather a group of metabolic disorders sharing the common underlying feature of hyperglycaemia, which results from defects in insulin secretion, insulin action, or both.[1] Its long-term complications include: retinopathy with potential loss of vision; nephropathy leading to renal failure; peripheral neuropathy with risk of foot ulceration, amputations, and Charcot joints; and autonomic neuropathy causing gastrointestinal, genitourinary, and cardiovascular symptoms, as well as sexual dysfunction[2–8] In addition, patients with diabetes have an increased risk of atherosclerotic cardiovascular, peripheral arterial, and cerebrovascular disease.[9]

Diabetes is one of the largest health emergencies of the 21st century. The World Health Organization (WHO) estimates that globally, hyperglycaemia is the third highest risk factor for premature mortality, after high blood pressure and tobacco use.[10] It accounts for 5 million (14.5%) of global all-cause mortality among people aged 20–79 years, which is higher than the combined number of deaths from the three major infectious diseases (1.5 million deaths from HIV/AIDS, 1.5 million from tuberculosis, and 0.6 million from malaria in 2013).[10] Many governments and public health professionals however, remain largely unaware of the current impact of diabetes and its complications.

In high-income countries, approximately 87–91% of all people with diabetes have type 2 diabetes (T2DM), 7–12% have type 1 diabetes (T1DM), and 1–3% have other types of diabetes. The relative proportions of T1DM and T2DM have not been reported in sufficient detail in low- and middle-income countries.[10]

According to the International Diabetes Federation (IDF), some 415 million people worldwide, or 8.8% of adults aged 20–79 years, were estimated to have diabetes in 2015. Of these, about 75% lived in low- and middle-income countries. If these trends continue, by 2040, some 642 million people (or one in ten adults) will have diabetes. The largest increases will take place in the regions where economies are moving from low-income to middle-income levels.[10]

Nardos Abebe and Desalegn Addise, Ethiopian Public Health Institute, Regional Laboratories Capacity Building Directorate, Addis Ababa, Ethiopia; and Tedla Kebede, Addis Ababa University, College of Health Sciences, Department of Internal Medicine, Endocrinology and Metabolite Unit, Addis Ababa, Ethiopia. Correspondence to: Nardos Abebe Email: nardosabebe799@gmail.com

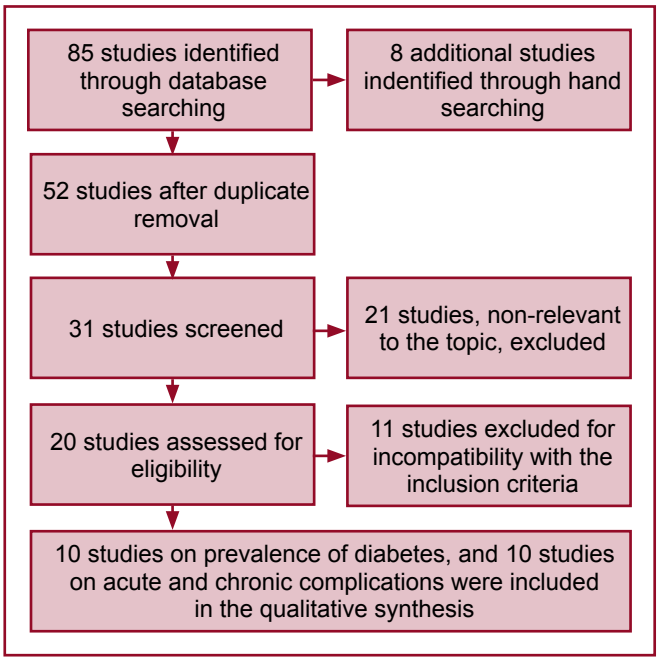

Figure 1. Summary of literature research

In 2015, the IDF also estimated that, in the Africa region, 14.2 million adults aged 20–79 years had diabetes, representing a prevalence of 3.2%. The majority (59%) of people with diabetes live in cities, even though the population is predominantly (61%) rural. This region has also the highest proportion of previously undiagnosed diabetes; over two-thirds (67%) of people with diabetes being unaware they have the disease.[10]

Currently, Ethiopia has been challenged by the growing magnitude of non-communicable diseases (NCDs) such as diabetes. Ethiopia is among the top four countries with the highest adult diabetic populations in sub-Saharan Africa. Patient attendance rates and medical admissions related to diabetes in major hospitals have been rising. This requires a shift in healthcare priorities and up-to-date data on the prevalence and related complications of diabetes in Ethiopia, to help plan and prioritise health programmes. Such information can be an important base

Authors	Year of publication, locality	Sample size	Study population	Diagnostic criteria	Prevalence			BMI
					Types of diabetes	Location	Gender	
Megerssa et al[11]	2013, Bishoftu	422	Community	Fasting glucose	Mixed	–	–	25–30=9.8% >30=8.6%
Ambachew et al[12]	2015, Mekelle	20,939	Hospital	OGTT	Total 1.3% T1DM 18% T2DM 82%	Urban 81% Rural 19%	Male 43% Female 57%	≥25=60%
Habtewold et al[13]	2016, Debre Berhan	368	Hospital	WHO	Total 0.3% T1DM 15.4% T2DM 80.7% GDM 3.8%	–	–	≥25=7.6%
Abebe et al[14]	2014, north west Ethiopia	2141	Community	Fasting glucose	Mixed (69% previously undiagnosed)	Urban 5% Rural 2%	**Urban** Male 4.3% Fem. 5.6% **Rural** Male 1.7% Fem. 2.6%	≥25=7.8%
Admassu et al[15]	2015, Harar	714	Community	Fasting glucose	T2DM 7.0% (21% known, 89% previously undiagnosed)	–	–	≥25=8%
Nshisso et al[16]	2013, Addis Ababa	2153	Community	IDF	Mixed 6.5% (27% previously undiagnosed)	–	Male 6.4% Female 6.6%	Women 25%, >30 Male 2% Female 8.9%
Yemane et al[17]	2007, Jimma	526	Community	OGTT	T2DM 5.3% IGT 7.0% IFG 7.8%	–	Male 9.1% Female 4.2%	25–30= 16% >30 =4%
Abebe et al[18]	2013, Gondar	354,524	Hospital	–	Total 0.4% T1DM 50.1% T2DM 49.9%	Rural 32% Urban 68%	Male 57.5% Female 42.5%	
Among tuberculosis patients								
Getachew et al[19]	2014, Gondar	199	Hospital	Fasting glucose	Total 8.5% (53% previously undiagnosed)	Urban 10% Rural 7%	Male 11.1% Female 4.9%	≥25=2%
Workneh et al[20]	2016, south eastern Amhara	1314	Community	WHO	Total 8.3% (59% previously undiagnosed)	Urban 54% Rural 46%	Male 45.9% Female 54.1%	≥25=26%

Table 1. Prevalence studies of diabetes in Ethiopia 2000–2016

for policy on diabetes prevention and treatment. The aim of this review is to provide an overview on diabetes prevalence and related chronic and acute diabetic complications in Ethiopia.

Methods

Search strategy. A systematic review of peer-reviewed literature was undertaken to identify studies that estimated the prevalence of diabetes, and its complications in Ethiopia, between 1 January 2000 and 31 December 2016. We used MeSH of PubMed search engines, using the medical subject titles 'diabetes mellitus' and 'complications of diabetes', combined with the terms 'tuberculosis', 'obesity', and 'Ethiopia'. Also, relevant articles from electronically available, but non-indexed local journals were also included. Relevant data from WHO and IDF were also used.

Selection and eligibility of studies. The inclusion criteria used were: (i) studies with clear objectives and methodologies; (ii) studies published within the agreed time limits; (iii) studies addressing the prevalence of diabetes and its complications; (iv) studies published in the English language; and (v) studies for which full texts were obtained for this review. The details of the papers considered and the final studies chosen are shown in Figure 1.

Complication	Locality and year of publication	Author	Sample size	Type of diabetes	Prevalence
Retinotherapy	2015, Dessie	Abejew et al[21]	216	Mixed	12%
	2010, Jimma	Worku et al[22]	305	T1DM/T2DM	18%/43%
	2005, Addis Ababa	Feleke et al[23]	229	Mixed	33%
	2015, Black Lion Hospital (Addis)	Gizaw et al[24]	731	T1DM/T2DM	16%/10%
	2000, Menelik II Hospital	Ejigu et al[25]	283	Mixed	31%
	2015, Northwest Ethiopia	Alemu et al[27]	544	T1DM	Urban 16% Rural 5%
	2011, Jimma	Gudina et al[28]	329	Mixed	23%
	2008, Mekelle	Gill et al[29]	105	Mixed	21%
	2013, Jimma	Sharew et al[30]	324	Mixed	41%
Foot ulcers	2015, Black Lion Hospital (Addis)	Gizaw et al[24]	731	T1DM/T2DM	11%/17%
	2014, Arbaminch Hospital	Deribe et al[26]	216	Mixed	15%
	2010, Jimma	Worku et al[22]	305	T1DM/T2DM	3.4%/5.3%
	2015, Dessie	Abejew et al[21]	216	Mixed	1.8%
	2000, Menelik II Hospital	Ejigu et al[25]	283	Mixed	1.7%
	2011, Jimma	Gudina et al[28]	329	Mixed	10 %
Neuropathy	2015, Dessie	Abejew al[21]	216	Mixed	6%
	2010, Jimma	Worku et al[22]	305	T1DM/T2DM	16%/37%
	2005, Addis Ababa	Feleke et al[23]	229	Mixed	10%
	2000, Menelik II Hospital	Ejigu et al[25]	283	Mixed	35%
	2011, Jimma	Gudina et al[28]	329	Mixed	25%
	2008, Mekelle Hospital	Gill et al[29]	105	Mixed	41%
Nephropathy	2010, Jimma	Worku et al[22]	305	T1DM/T2DM	9%/20%
	2005, Addis Ababa	Feleke et al[23]	229	Mixed	21%
	2015, Dessie	Abejew et al[21]	216	Mixed	1%
	2015, Black Lion Hospital (Addis)	Gizaw et al[24]	731	T1DM/T2DM	21%/15%
	2000, Menelik II Hospital	Ejigu et al[25]	283	Mixed	23%
	2008, Mekelle	Gill et al[29]	105	Mixed	2%
Hypertension	2010, Jimma	Worku et al[22]	305	T1DM/T2DM	3%/39%
	2005, Addis Ababa	Feleke et al[23]	229	Mixed	34%
	2015, Dessie	Abejew et al[21]	216	Mixed	18%
	2015, Black Lion Hospital (Addis)	Gizaw et al[24]	731	T1DM/T2DM	29%/27%
Erectile Dysfunction	2015, Dessie	Abejew et al[21]	216	Mixed	1%
	2010, Jimma	Worku et al[22]	305	T1DM/T2DM	2.6%/5.3%
	2000, Menelik II Hospital	Ejigu et al[25]	283	Mixed	22%

Table 2. Patterns of chronic complications of diabetes in Ethiopia 2000–2016

Results

Prevalence of diabetes. Six community-based and four hospital-based studies provided data on diabetes prevalence in Ethiopia in the last 17 years (Table 1). The prevalence of diabetes varied across Ethiopia, ranging from 0.3% at Debre Berhan Referral Hospital to 7.0% in Harar town. In addition, the prevalence among tuberculosis (TB) patients was 8.3% and 8.5% in the South East Amhara region and at the University of Gondar Hospital respectively.

Five studies distinguished between urban and rural diabetes prevalence and all found a higher prevalence in urban areas (Table 1). Likewise, from the six studies reporting on previously undiagnosed diabetes, the proportion ranged from 27% in Addis Ababa to 79% in Harar (Table 1). This systematic review identified three studies on impaired glucose tolerance (IGT), impaired fasting glycaemia (IFG), and gestational diabetes (GDM), with prevalances of 7.0% for IGT, 7.8% for IFG, and 3.8% for GDM (Table 1).

Pattern of BMI (body mass index) and diabetes complications. Nine studies assessed the pattern of BMI (Table 1). The obesity rates ranged from 4.0% in Jimma in 2007, to 8.6% in Bishoftu in 2013. Ten studies on the prevalence of chronic complications of diabetes were published from 2000 to 2016 (Table 2) and four papers on acute complications (Table 3) were found. The recorded prevalence for retinopathy ranged from 5.0% in

Complication	Locality and year of publication	Author	Sample size	Type of diabetes	Prevalence
Diabetic ketoacidosis (DKA)	2015, Addis Ababa 2015, Dessie 2010, Jimma 2011, Jimma	Gizaw et al[24] Abejew et al[21] Worku et al[22] Gudina et al[28]	405 216 305 329	T1DM/T2DM Mixed T1DM/ T2DMMixed	62%/5% 20% 34%/14% 41%
Hypoglycaemia	2015, Dessie 2015, Addis Ababa	Abejew et al[21] Gizaw et al[24]	216 405	Mixed T1DM/T2DM	7% <1%/2%
Hyperosmolar hyperglycaemic state (HHS)	2015, Dessie	Abejew et al[21]	216	Mixed	2%

Table 3. Pattern of acute complications of diabetes in Ethiopia 2000–2016

rural northwest Ethiopia to 43.4% for T2DM patients at Jimma University Hospital, southwest Ethiopia. Neuropathy prevalence ranged from 6.0% at Dessie to 41.0% at Mekelle (Table 2). With regard to acute complications, there was a history of ketoacidosis (DKA) in 19.9% of cases (both T1DM and T2DM) at Dessie Hospital, and in 62.0% of cases (for T1DM) at the Black Lion Hospital in Addis Ababa (Table 3).

Discussion

The prevalence of diabetes in most localities of Ethiopia, except at Mekelle Hospital, Gondar University Teaching Referral Hospital, and at Debre Birhan Referral Hospital, appears to have increased from that estimated by the IDF in 2015 (i.e. 3.9%).[10] The researchers also observed considerably higher variation in diabetes prevalence across different localities of Ethiopia, 0.3% and 7.0% for the lowest and the highest prevalence respectively. However, it is difficult to compare most studies done in Ethiopia due to differences in diagnostic criteria of diabetes, methodology of tests, and sampling modes. These variations in prevalence might also be due to the socio-demographic and lifestyle differences in the localities reviewed.

In this review, two studies documented the prevalence of diabetes (8.3% and 8.5%) among TB patients – higher than the diabetes prevalence (3.9%) reported in the general population in Ethiopia.[10] Also, the proportion of diabetes was 9.6% among smear-positive and 8.2% among smear-negative cases. Generally, diabetes is increasing in resource-poor countries where TB rates are high.[19] Similar to the studies reviewed here, two studies have also indicated that 20% of smear-positive TB patients in India, and 25% in Mexico were associated with diabetes.[31, 32]

Evidence clearly suggests that diabetes and insulin resistance play a role in the development of TB. Nonetheless, the extent to which TB increases the risk of diabetes has not been clearly defined. Some data suggest that patients with TB may be at increased risk of diabetes.[33, 34] The stress of severe chronic infection leads to increased insulin resistance and increased insulin demand that may unmask an underlying beta-cell deficiency, leading to hyperglycaemia.[35] In most instances this is reversible, and resolves once the infection is treated. However, hyperglycaemia may progress to full-blown diabetes in some individuals, especially those who have other risk factors.[36]

A remarkable difference is observed in the prevalence of diabetes among urban and rural dwellers in the reviewed studies, with the prevalence among urban dwellers being higher than that of rural dwellers. With reduced physical exercise, the adoption of Western lifestyles, and the ageing population, people in urban areas are more prone to developing diabetes.[37] In the last two decades there has been a considerable change in the lifestyle of urban people, with significant population growth in Ethiopia. Increasing urbanisation and the accompanying changes in lifestyle are strongly associated with the increase in diabetes in Ethiopia, like other sub-Saharan African countries.[38, 39]

The proportion of previously undiagnosed diabetes cases is higher in four of the five studies which were included in this review. Owing to the highly asymptomatic nature of T2DM and/or lack of knowledge on diabetes, the public often do not recognise its symptoms and this may lead to delay in diagnosis.[23] The high proportion of previously undiagnosed diabetes may also reflect the low awareness of the public and primary healthcare providers about the disease.[40] Furthermore, these review findings may reflect insufficient priority given to diabetes in Ethiopia at a national scale.

The prevalence of GDM appears to be much lower than that reported by earlier (pre-2000) studies conducted in Ethiopia, which found the prevalence in two localities to be above 0.34%.[41,42] Because of the very limited data available on IFG and IGT in diabetes cases in Ethiopia, it is difficult to discuss and describe the prevalence. Similarly, it is hard to describe trends of diabetes prevalence over time. Nevertheless, one study provided data on the trend of diabetes prevalence in Gondar, and demonstrated both T1DM and T2DM cases to have increased by 125% on average.[18]

BMI has obvious associations with T2DM. In a study in Bishoftu, overweight subjects were 4.3 times more likely to have previously undiagnosed diabetes than subjects with a normal BMI.[11] Correspondingly, in other study, the mean BMI increased from 15.9 to 18.3 for T1DM, and from 23.8 to 24.6 for T2DM between 2000 and 2009.[18] The fact that mean BMI in this study was not above the

normal range indicates that the cardio-metabolic risk factors such as BMI may not necessarily follow patterns found in Western populations.

The prevalence of chronic complications is at an intermediate to low level compared with that recorded formerly in 1987[43] where the prevalence of complications was nephropathy 23%, retinopathy 31%, neuropathy 52%, and erectile dysfunction 55%. In fact, diabetic complications are common in Ethiopia. Additionally, diabetes-related admissions in Addis Ababa have increased from 7% in 2005 to 34% in 2009.[44]

Common risk factors for diabetic complications are gender,[45] long duration of diabetes,[46] poor glycaemic control,[47] negative attitude towards diabetes,[47, 48] poor treatment adherence,[49] and poor knowledge about the disease and its management.[47] In Addis Ababa, only 5% of diabetic patients were able to do self blood glucose monitoring at home, and none of them had a recently measured glycated haemoglobin (HbA1c) determination.[23] DKA is an acute complication more commonly seen in T1DM than T2DM patients. In addition, the proportion with DKA is significantly higher than other forms of acute complications (e.g. hypoglycaemia and hyperosmolar hyperglycaemic state).[50]

The availability of data on the prevalence of diabetes and its complications in Ethiopia over the past 15 years is limited, and hence it is impossible to describe progress and distribution over time. Moreover, the reviewed studies were conducted in different years, varying from 2000 to 2016, and criteria for the diagnosis of diabetes, IFG, and IGT sometimes differed. Definitions used for complication diagnosis also varied. Regardless of all these limitations, the current review still provides valuable information about diabetes and its related complications in Ethiopia.

With increasing prevalence and related complications, diabetes is becoming a pressing public health problem for Ethiopia. If effective interventions are implemented in the near future it may be possible to prevent much of this burden, as primary prevention and treatment can reduce the incidence of diabetes and related complications. Therefore, it is important to establish effective and integrated diabetes programmes.

References

1. Kumar V, Abbas AK, Aster JC, et al. *Basic Pathology*. 9th edn. Philadelphia: WB Saunders; 2013: 739–51.
2. Hove MN, Kristensen JK, Lauritzen T, et al. The prevalence of retinopathy in an unselected population of type 2 diabetes patients from Arhus County, Denmark. *Acta Ophthalmol Scand* 2004; 82: 443–8.
3. Seki M, Tanaka T, Nawa H, et al. Involvement of brain-derived neurotrophic factor in early retinal neuropathy of streptozotocin-induced diabetes in rats: therapeutic potential of brain-derived neurotrophic factor for dopaminergic amacrine cells. *Diabetes* 2004; 53: 2412–9.
4. Huang C, Kim Y, Caramori MLA, et al. Cellular basis of diabetic nephropathy: II. The transforming growth factor-beta system and diabetic nephropathy lesions in type 1 diabetes. *Diabetes* 2002; 51: 3577–81.
5. Looker HC, Fagot-Campagna A, Gunter EW, et al. Homocysteine as a risk factor for nephropathy and retinopathy in type 2 diabetes. *Diabetologia* 2003; 46: 766–72.
6. Svensson M, Eriksson J. Glycemic control, age at onset, and development of microvascular complications in childhood-onset type 1 diabetes: a population-based study in northern. *Diabetes* 2004; 27: 955–62.
7. Saely CH, Aczel S, Marte T, et al. Cardiovascular complications in type 2 diabetes mellitus depend on the coronary angiographic state rather than on the diabetic state. *Diabetologia* 2004; 47: 145–6.
8. Wallace C, Reiber GE, LeMaster J, et al. Incidence of falls, risk factors for falls, and fall-related fractures in individuals with diabetes and a prior foot ulcer. *Diabetes Care* 2002; 25: 1983–6.
9. Piero MN. Diabetes mellitus – a devastating metabolic disorder. *Asian J Biomed Pharm Sci* 2015; 4: 1–7.
10. International Diabetes Federation. *Diabetes Atlas*. IDF. 7th edn. 2015.
11. Megerssa YC, Gebre MW, Birru SM, et al. Prevalence of undiagnosed diabetes mellitus and its risk factors in selected institutions at Bishoftu Town, East Shoa, Ethiopia. *Diabetes Metab* 2013. DOI: 10.4172/2155-6156.S12-008
12. Ambachew Y, Kahsay S, Tesfay R, et al. Prevalence of diabetes mellitus among patients visiting medical outpatient department of Ayder Referral Hospital, Mekelle, Ethiopia: three years pooled. *Int J Pharma Sci Res* 2015; 6: 435–9.
13. Habtewold TD, Tsega WD, Wale BY. Diabetes mellitus in outpatients in Debre Berhan Referral Hospital, Ethiopia. *J Diab Res* 2016. DOI: 10.1155/2016/3571368
14. Abebe SM, Berhane Y, Worku A, et al. Diabetes mellitus in northwest Ethiopia: a community-based study. *BMC Public Health* 2014. DOI: 10.1186/1471-2458-14-97
15. Admassu D, Dessie Y, Teji K, et al. Type 2 diabetes mellitus among government employees in Harar Town, Eastern Ethiopia: a cross-sectional study. *Res Rep Endo Dis* 2015; 5: 71–77.
16. Nshisso DL, Reese A, Gelaye B, et al. Prevalence of hypertension and diabetes among Ethiopian adults. *Diabetes Metab Syndr* 2012; 6: 36–41.
17. Yemane T, Belachew T, Asaminew B, et al. Type 2 diabetes mellitus in Jimma Town, south west Ethiopia. *Ethiopian J Health Sci* 2007; 17: 107–14.
18. Abebe SM, Berhane Y, Worku A, et al. Increasing trends of diabetes mellitus and body weight: a ten year observation at Gondar University Teaching Referral Hospital, northwest Ethiopia. *PLoS One* 2013; 8: 10–13.
19. Getachew A, Mekonnen S, Alemu S, et al. High magnitude of diabetes mellitus among active pulmonary tuberculosis patients in Ethiopia. Brit Med J 2014; 4: 862–72.
20. Workneh MH, Bjune GA, Yimer SA. Prevalence and associated factors of diabetes mellitus among tuberculosis patients in south eastern Amhara Region, Ethiopia: a cross-sectional study. *PLoS One* 2016; 11: e0147621.
21. Abejew AA, Belay AZ, Kerie MW. Diabetic complications among adult diabetic patients of a tertiary hospital in northeast Ethiopia. *Adv Public Health* 2015. DOI: 10.1155/2015/290920
22. Worku D, Hamza L, Woldemichael K. Patterns of diabetic complications at Jimma University Specialized Hospital, southwest Ethiopia. *Ethiop J Health Sci* 2010; 20: 33–9.
23. Feleke Y, Enquselassie F. An assessment of the health care system for diabetes in Addis Ababa, Ethiopia. *Ethiop J Health Dev* 2005; 19: 204–10.
24. Gizaw M, Harries AD, Ade S, et al. Diabetes mellitus in Addis Ababa, Ethiopia: admissions, complications and outcomes in a large referral hospital. *Public Health Action* 2015; 5: 74–8.
25. Ejigu A. Pattern of chronic complications of diabetic patients in Menelik II Hospital, Ethiopia. *Ethiop J Health Dev* 2000; 14: 113–6.
26. Deribe B, Woldemichael K, Nemera G. Prevalence and factors influencing diabetic foot ulcers among diabetic patients attending Arbaminch Hospital, South Ethiopia. *J Diabetes Metab* 2014; 5: 1–7.
27. Alemu S, Dessie A, Tsegaw A, et al. Retinopathy in type 1 diabetes mellitus: major differences between rural and urban dwellers in northwest Ethiopia. *Diabetes Res Clin Pract* 2015; 109: 191–8.
28. Gudina EK, Amade ST, Tesfamichael FA, et al. Assessment of quality of care given to diabetic patients at Jimma University Specialised Hospital diabetes follow-up clinic, Jimma, Ethiopia. *BMC Endocrine Disorders* 2011. DOI: 10.1186/1472-6823-11-19
29. Gill GV, Gebrekidan A, English P, et al. Diabetic complications and glycaemic control in remote North Africa. *Q J Med* 2008; 101: 793–8.
30. Sharew G, Ilako DR, Kimani K, et al. Prevalence of diabetic retinopathy in Jimma University Hospital, south west Ethiopia.

Ethiop Med J 2013; 51: 105–13.
31. Stevenson CR, Forouhi NG, Roglic G, et al. Diabetes and tuberculosis: the impact of the diabetes epidemic on tuberculosis incidence. *BMC Public Health* 2007. DOI: 10.1186/1471-2458-7-234
32. Ponce-De-Leon A, Garcia-Garcia M, Garcia-Sancho MC, et al. Tuberculosis and diabetes in southern Mexico. *Diabetes Care* 2004; 27: 1584–90.
33. Kapur A, Harries AD. The double burden of diabetes and tuberculosis – public health implications. *Diabetes Res Clin Pract* 2013; 101.
34. Viswanathan V, Kumpatla S, Aravindalochanan V, et al. Prevalence of diabetes and pre-diabetes and associated risk factors among tuberculosis patients in India. *PLoS One* 2012; 7: e41367.
35. Dooley KE, Chaisson RE. Tuberculosis and diabetes mellitus: convergence of two epidemics. *Lancet Infect Dis* 2009; 9: 737–46.
36. Creswell J, Raviglione M, Ottmani S, et al. Tuberculosis and non-communicable diseases: neglected links and missed opportunities. *Eur Respir J* 2011; 37: 1269–82.
37. Ahmad L A, Crandall JP. Type 2 diabetes prevention: a review. *Clin Diabetes* 2010; 28: 53–9.
38. Dalal S, Beunza JJ, Volmink J, et al. Non-communicable diseases in sub-Saharan Africa: what we know now. *Int J Epidemiol* 2011; 40: 885–901.
39. Mbanya J-C, Motala AA, et al. Diabetes in sub-Saharan Africa. *Lancet* 2010; 375: 2254–66.
40. Hjelm K, Mufunda E, Hjelm K, et al. Zimbabwean diabetics' beliefs about health and illness: an interview study. *BMC Int Health Hum Rights* 2010. DOI: 10.1186/1472-698X-10-7
41. Seyoum B, Kiros K, Haileselase T, et al. Prevalence of gestational diabetes mellitus in rural pregnant mothers in northern Ethiopia. *Diabetes Res Clin Pract* 1999; 46: 247–51.
42. Admassu G, Gaym A. Outcome of pregnancy complicated by diabetes at Tikur Anbessa Hospital, Addis Ababa, Ethiopia – a five year review. Ethiop J Repr Health 2009; 3: 34–43.
43. Mengistu M. The pattern of chronic complications in adult Ethiopian diabetics. *Ethiop Med J* 1987; 25: 167–76.
44. Adem A, Demis T, Feleke Y. Trend of diabetic admissions in Tikur Anbessa and St. Paul's University Teaching Hospitals from January 2005 to December 2009, Addis Ababa, Ethiopia. *Ethiop Med J* 2011; 49: 231–8.
45. Fitzgerald JT, Anderson RM, Davis WK. Gender differences in diabetes attitudes and adherence. *Diabetes Educ* 1995; 21: 523–9.
46. Roaeid RB, Kablan AA. Diabetes mortality and causes of death in Benghazi: a 5-year retrospective analysis of death certificates. *East Mediterr Health J* 2010; 16: 65–9.
47. Alebachew Woldu M, Diriba Wami C. Factors associated with poor glycaemic control among patients with type 2 diabetes mellitus in Ambo Hospital, Ambo, Ethiopia. *Endocrinol Metab Syndr* 2014; 3. DOI: 10.4172/2161-1017.1000143
48. Mukhopadhyay P, Paul B, Das D, et al. Perceptions and practices of type 2 diabetics: a cross-sectional study in a tertiary care hospital in Kolkata. *Int J Diabetes Dev Ctries* 2010; 30: 143–9.
49. Clark M. Adherence to treatment in patients with type 2 diabetes. *J Diabetes Nurs* 2004; 8: 386–91.
50. Seyoum B, Mengistu Z, Berhanu P, et al. Retinopathy in patients of Tikur Anbessa Hospital diabetic clinic. *Ethiop Med J* 2001; 39: 123–31.