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Prevalence of food insecurity in patients with diabetes in western Kenya

S. Cheng[1], J. Kamano[2,3], N. K. Kirui[2,3,4,5,6], E. Manuthu[5], V. Buckwalter[5,6], K. Ouma[5,6] and S. D. Pastakia[1,2,3,4,5,6]

[1]Purdue University College of Pharmacy, West Lafayette, IN, USA, [2]Moi Teaching and Referral Hospital (MTRH), Eldoret, [3]US Agency for International Development-AMPATH Partnership, Eldoret, [4]Kitale District Hospital, Kitale, [5]Webuye District Hospital, Webuye and [6]Moi University School of Medicine, Eldoret, Kenya

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Abstract

Aims To determine the characteristics of patients with diabetes who reported food insecurity at three diabetes clinics in western Kenya.

Methods This study includes routinely collected demographic data at the first presentation of patients with diabetes at clinics in western Kenya from 1 January 2006 to 24 September 2011. A validated questionnaire was used to assess food insecurity with descriptive and comparative statistics being used to analyse the food-secure and food-insecure populations.

Results The number of patients presenting to these clinics who were food-secure and those who were food-insecure was 1179 (68.0%) and 554 (32.0%), respectively. Comparative analysis shows a statistically significant difference in weight, BMI, the presence of a caretaker, and use of insulin between the two groups. These variables were lower in the food-insecure group. The overall assessment of the clinic population revealed an abnormally high mean HbA1c concentration of 81 mmol/mol (9.6%).

Conclusions Despite the widely recognized contribution of caloric over-nutrition to the development of diabetes, this study highlights the high prevalence of food insecurity amongst patients with diabetes in rural, resource-constrained settings. Other factors, such as the lower prevalence of obesity, poor glucose control, challenges in the use of insulin because of the risk of hypoglycaemia, and varying subtypes of diabetes in this population, point to the need for additional research in understanding the aetiology, pathophysiology and optimum management of this condition, as well as understanding the effects of enhancing food security.

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Introduction

Diabetes is a chronic disease that represents a rapidly growing problem in Kenya and sub-Saharan Africa [1]. According to International Diabetes Federation estimates in 2010, 520 000 (3.5%) Kenyans have diabetes and this number is expected to double to 1.2 million (4.7%) by 2030. In the same report, impaired glucose tolerance affected ~8.6% (1.3 million) of the Kenyan population in 2010 and is expected to rise to 9.3% (2.5 million) by 2030 [2]. This increase is thought to be attributable mainly to lifestyle changes, such as increasing urbanization and decreases in physical activity [3,4].

Correspondence to: Sonak D Pastakia. E-mail: spastaki@gmail.com

Despite these traditional risk factors for the increasing prevalence of diabetes, there are many understudied setting-specific risk factors such as food insecurity, which continue to afflict rural settings in developing countries. Food insecurity is the inability of a household to acquire consistent, adequate, nutritional food; having to rely on emergency food supplies or scavenging [5,6]. Food insecurity has been associated with diabetes and is considered a risk factor for diabetes in non-elderly adults [5,7]. The lack of food security is known to cause symptoms of anxiety, depression and fatigue, and to lead to the inadequate control of diabetes [5,7,8]. Adults who do not have adequate money for food have 40% worse glycaemic control compared with those who are more financially secure in resource-rich countries [9]. Poor glycae-

What's new?

- The focus on addressing the rising burden of diabetes has largely been on traditional risk factors such as caloric over-nutrition and a sedentary lifestyle.
- In the rural resource-constrained setting analysed in the present study, many potential differences exist in both the presentation and causes of diabetes.
- This study highlights the unique characteristics seen on initial presentation as approximately one-third of the patients in this study report food insecurity, with the overall population demonstrating lower BMIs and elevated initial HbA1c concentrations.
- Contextualized prevention and management approaches need to be further investigated to better understand this population.

mic control results in more physician consultations and a higher consumption of medical resources [10]. The fluctuation in blood glucose concentrations in these patients presents difficulties in the management of insulin dosing and can create extreme episodes of hypoglycaemia or hyperglycaemia, often requiring hospitalization [10,11]. It was estimated that in the 46 countries of the WHO African Region in 2000, 7.02 million people had diabetes, which resulted in a total economic loss of $25.51bn [11]. This presents further challenges in already resource-limited settings.

Not only does food insecurity contribute to poor glycaemic control, it is also associated with the causation of diabetes [5,7]. Different subtypes of diabetes have been characterized in sub-Saharan Africa apart from Type 1 and Type 2 diabetes. These include the understudied variants of diabetes such as ketosis-prone atypical diabetes, atypical African diabetes and tropical diabetes. One subtype of diabetes that has been suggested, though not yet confirmed is malnutrition-related diabetes mellitus. This subtype is characterized by an early-onset non-ketotic state with high insulin requirements in underweight patients [12,13]; however, there is considerable debate as to whether this subtype of diabetes exists and more research is needed on the topic [14].

Type 1 diabetes also presents slightly differently in sub-Saharan Africa. Compared with European communities, the mean age of onset of Type 1 diabetes in African communities is almost 10 years later [15,16]. In resource-rich countries, Type 2 diabetes is primarily thought to be attributable to caloric over-nutrition and obesity [17,18]. This is in sharp contrast to the onset of diabetes in sub-Saharan Africa, where food insecurity has been described as one of the main factors contributing to the increase in cases of diabetes in this region [5].

Growing bodies of data have also suggested that malnutrition during pregnancy may contribute to the development of a child who is more prone to metabolic diseases, such as diabetes [19–21]. It is theorized that as the fetus and infant develops under conditions of malnutrition, they prioritize the blood glucose for the brain by making their muscles more insulin-resistant. The consequence of this is the development of diabetes later in life, especially if food resources become more plentiful [19].

Most studies looking at the association between food insecurity and diabetes have been in resource-rich settings [22,23]. Data on food insecurity and diabetes in sub-Saharan Africa are lacking even though the association between food insecurity and diabetes has been shown [5,24]. In the last 10 years, the nutritional status of all continents except Africa has improved. According to a food security assessment by the US Department of Agriculture of 70 developing countries around the world, sub-Saharan Africa has the highest increase in food-insecure people. This situation is projected to deteriorate up to 2018, while food security in Asia and Latin America is projected to remain steady or improve [25]. In sub-Saharan Africa, it was estimated that 169 million people were chronically hungry in 1990. This had increased by 22% in 2003 [26].

The purpose of the present study was to determine the proportion and characteristics of patients with diabetes who report food insecurity at Moi Teaching and Referral Hospital (MTRH) in Eldoret, Kenya and the surrounding diabetes clinic sites in the towns of Kitale and Webuye.

Materials and methods

The present study included routinely collected data from three diabetes clinics in western Kenya from 1 January 2006 to 24 September 2011. The three clinics are located within the MTRH, the Kitale District Hospital and the Webuye District Hospital. The MTRH in Eldoret is one of the two referral hospitals in Kenya and primarily serves the rural and urban communities in the surrounding areas of Eldoret, but also serves as the primary referral centre for all of western Kenya. Webuye and Kitale District Hospitals are located in the rural areas west of Eldoret and are two of the main hospitals that refer patients to the MTRH. All hospitals are public facilities and are subsidized by government funding.

All available data from eligible patients receiving care within the diabetes specialty clinics at these sites were included within this analysis. The specialty clinics manage all forms of diabetes, regardless of age, and provide care consistent with both international and national guidelines for diabetes. These clinics typically serve resource-constrained patients who frequently use public sector healthcare services as opposed to the more economically secure patients who use private sector healthcare services.

In the three clinics, all routine data are collected on standardized clinical forms. During the first encounter with the patient, an initial encounter form is filled out and contains questions pertaining to the patient's basic demographic data, including age (if the exact birth date is not known, the

estimated year of birth is obtained via self report), gender, self-reported age of diabetes diagnosis, weight, height, self-reported HIV status and testing history, any history of cigarette or tobacco product use (including a calculation of pack years for cigarette use and an assessment of consumption of locally available tobacco products), any history of past alcohol use or abuse based on the AUDIT-C questionnaire [27], the availability of a caretaker to assist in their diabetes care, past diabetes treatments, and their initial HbA1c concentration. All HbA1c concentrations were obtained by using the point-of-care DCA Vantage Analyzer (Siemens, Malvern, PA, USA) with the tests being performed by trained clinic staff. During the first encounter with each patient, the patient's height and weight is obtained using the scale provided and approved by the Ministry of Health for the clinic, together with a height-o-meter. The patient's BMI was calculated automatically by our database. In order to assess the food security of patients, a set of questions about the patient's diet and ability to obtain food are included in the initial encounter form that is administered when patients first attend the clinic. The questions are based on the Household Food Insecurity Access Scale (HFIAS), a measurement of food accessibility established by the US Agency for International Development and validated for use in resource-constrained settings [28]. At the end of each patient encounter, the data are entered into an electronic medical record system. These data are then used to assess each patient's food security.

Using the set of HFIAS questions from the initial encounter form for each patient, responses are given a score that ranges from 0 to 1 or 1 to 3, depending on the question. Based on the response to each question, an overall determination of food security, using a categorization scheme provided in the HFIAS, is given to each patient. The categorization terms assigned are food-secure, mildly food-insecure, moderately food-insecure, and severely food-insecure (Figs 1 and 2 [28]).

For the present study, the statistics used included the Wilcoxon rank-sum and Mann–Whitney test for non-parametric data and Fisher's exact test for dichotomous data. Somer's D test was used to compare food security vs BMI and weight, while controlling for potential confounders, such as HIV. Statistical analyses were designed to identify clinical and demographic differences between patients with any level of food insecurity and food security. A P value <0.05 was considered to indicate statistical significance.

Prior to the investigation of this population, institutional review board approval was obtained from the local institutional review and ethics committee at MTRH and the Indiana University-Purdue University Indianapolis Institutional Review Board.

Results

Data were gathered from a total of 1867 patients. Of these patients, 1733 (92.8%) had sufficient data to characterize their food security and were included in the analysis. Patients who did not answer all the HFIAS questions and those patients who failed to indicate an approximate age were not included in the results.

Now consider what happened in the last 30 days (1 month): For each of the following questions, please answer whether this happened never, rarely (once or twice), sometimes (3–10 times), or often (more than 10 times) in the *last month*. (Consider this for questions 1–9)

1. Did you worry that your household would not have enough food?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

2. Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

3. Did you or any household member eat just a few kinds of food day after day due to a lack of resources?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

4. Did you or any household member eat food that you preferred not to eat because of a lack of resources to obtain other types of food?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

5. Did you or any household member eat a smaller meal than you felt you needed because there was not enough food?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

6. Did you or any other household member eat fewer meals in a day because there was not enough food?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

7. Was there ever no food at all in your household because there were not resources to get more? (Were your household food stores ever completely empty and there was no way of getting more?)
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

8. Did you or any household member go to sleep at night hungry because there was not enough food?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

9. Did you or any household member go a whole day without eating anything because there was not enough food?
□ Never (0) □ Rarely (1) □ Sometimes (2) □ Often (3)

FIGURE 1 Initial encounter food security questions based on the Household Food Insecurity Access Scale [28].

Overall, the number of patients presenting to these three clinics who were food-secure was 1179 (68.0%), while the number of patients with mild-to-severe food insecurity was 554 [32.0% (Table 1)]. These data show that approximately one-third of the patients with diabetes who presented to these clinics in western Kenya had some degree of food insecurity during their initial encounter, with the majority of those being severely food-insecure (n = 451, 81.4%). In all three clinics, the majority of patients reported that they were food-secure with the highest proportion of food-secure patients, 75.2% (n = 539), being reported at the Kitale District Hospital. Despite serving different tribal communities, all three clinics displayed similar trends in the distribution of patients with and without food insecurity.

The overarching demographic characteristics of this population can be seen in Table 2. The mean (range) age of patients at the time of enrolment into the district hospital clinics was 53 (4–92) years while their mean age at the time of diabetes diagnosis was 46 years. The mean BMI was 27.2 kg/m^2 with 38.1% (n = 440) having a BMI <25 kg/m^2.

Despite the availability of a free HIV screening service at the hospital, only 513 patients were aware of their HIV

Household Food Insecurity Access Scale category	
Food-secure	If [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]
Mildly food-insecure access	If [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]
Moderately food-insecure access	If [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0]
Severely food-insecure access	If [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]

FIGURE 2 Household Food Insecurity Access Scale categorization score for food insecurity [28].

Table 1 Number of patients with food insecurity at Moi Teaching and Referral Hospital and Kitale and Webuye District Hospitals

	Moi Teaching and Referral Hospital, *N* = 553	Kitale, *N* = 717	Webuye, *N* = 463	Overall, *N* = 1733
Food-secure, *n* (%)	346 (62.6)	539 (75.2)	294 (63.5)	1179 (68.0)
Mildly food-insecure	8 (1.5)	18 (2.5)	5 (1.1)	31 (1.8)
Moderately food-insecure	51 (9.2)	11 (1.5)	10 (2.2)	72 (4.2)
Severely food-insecure	148 (26.8)	149 (20.8)	154 (33.3)	451 (26.0)

status, with 27 patients being HIV-positive (5.2%). The proportion of patients who consumed cigarettes/tobacco or any alcohol was 3.1% ($n = 56$) and 8.7% ($n = 153$), respectively. Consumption of alcohol included individuals who consumed any amount of alcohol, even as low as one drink per month, as nobody was positively screened for abuse using the AUDIT-C questionnaire. The majority of patients reported having a caretaker available; 71.3% ($n = 1223$) of the overall population reported that they had somebody at home to help them take care of their diabetes-related needs. Table 2 also shows the typical blood glucose control observed upon enrolment in the district hospital clinics with a mean HbA1c concentration of 81 mmol/mol (9.6%). Stratification of the HbA1c concentrations shows that 49.6% ($n = 755$) of the population had an initial HbA1c >130 mmol/mol ($\geq$14%). In addition, 42.7% ($n = 670$) of the overall population reported current or past insulin use.

Comparative analysis of food-secure vs food-insecure patients showed a statistically significant difference in weight, BMI, the presence of a caretaker, and absence of insulin use between the two groups. All three variables were lower in the food-insecure group. The significant association of food insecurity with a lower weight and BMI remained after controlling for the other potential confounders, including HIV, in Somer's D test. Of all the patients with diabetes, 61.9% were overweight (BMI $\geq$ 25 kg/m^2) and 30.0% were obese (BMI $\geq$30 kg/m^2). Patients who were classified as obese constituted 32.1% ($n = 257$) of food-secure patients and 25.4% ($n = 90$) of food-insecure patients. The food-insecure population also displayed a predisposition towards having a higher percentage of patients with a lower BMI as 44.5% of the population have a BMI <25 kg/m^2 compared with 35.2% of the food-secure population.

In analysing the overall population, 42.7% required insulin at some point in their care with a greater percentage requiring insulin in the food-insecure population (46.9 vs 40.8%, $P = 0.02$).

Discussion

The present study examined the food-security status of patients with diabetes in western Kenya, specifically in the regions surrounding MTRH in Eldoret, Kenya, and the farming regions of Kitale and Webuye. The prevalence of food insecurity in this patient population in these three regions was 32.0%. Despite the traditional association of diabetes with caloric over-nutrition in resource-rich settings, the largely rural population in western Kenya demonstrated a particularly high frequency of food insecurity within its diabetes population. This high frequency of food insecurity is

Table 2 Overall patient characteristics

	Food-secure	Food-insecure	*P*
Mean (95% CI) age at time of initial enrolment, years N_{fs} = 1212; N_{fi} = 554	53.1 (52.2–53.7)	52.5 (51.1–53.9)	0.32
Male gender, *n* (%) N_{fs} = 1212; N_{fi} = 554	565 (46.6)	231 (41.7)	0.49
Mean (95% CI) age at diabetes diagnosis, years N_{fs} = 1212; N_{fi} = 554	46 (44.8–46.7)	45 (44.1–46.9)	0.61
Mean (95% CI) no. of years of having diabetes N_{fs} = 1212; N_{fi} = 554	7.4 (7.0–7.8)	7.0 (6.5–7.6)	0.56
Mean (95% CI) weight, kg N_{fs} = 1016; N_{fi} = 451	71.2 (70.3–72.2)	68.6 (67.2–70.0)	<0.01
Mean (95% CI) height, cm N_{fs} = 793; N_{fi} = 343	163 (161.8–163.5)	163 (161.5–164.1)	0.65
Mean (95% CI) BMI kg/m^2 N_{fs} = 800; N_{fi} = 355	27.5 (27.4–27.7)	26.3 (26.0–26.5)	<0.01
BMI, *n* (%)			
<16 kg/m^2	5 (0.6)	6 (1.7)	
16–19 kg/m^2	62 (7.8)	43 (12.1)	
20–24 kg/m^2	215 (26.9)	109 (30.7)	
25–29 kg/m^2	261 (32.6)	107 (30.1)	
30–34 kg/m^2	179 (22.4)	63 (17.8)	
35–39 kg/m^2	55 (6.9)	21 (6.0)	
≥40 kg/m^2	23 (2.9)	6 (1.7)	
HIV status N_{fs} = 330; N_{fi} = 183			
Positive	14 (4.2)	13 (7.1)	0.16
Negative	316 (95.8)	170 (92.9)	
History of cigarette/tobacco use, *n* (%) N_{fs} = 1205; N_{fi} = 551			
Yes	37 (3.1)	19 (3.5)	0.67
No	1168 (96.9)	532 (96.6)	
History of alcohol, *n* (%) N_{fs} = 1200; N_{fi} = 546			
Yes	102 (8.5)	51 (9.3)	0.56
No	1098 (91.5)	495 (90.7)	
Caretaker, *n* (%) N_{fs} = 1180; N_{fi} = 536			
Yes	872 (73.9)	351 (65.5)	<0.01
No	308 (26.1)	185 (34.5)	
Diabetes treatment, *n* (%) N_{fs} = 1074; N_{fi} = 495			
Never on insulin	636 (59.2)	263 (53.1)	0.02
On insulin or had used insulin in the past	438 (40.8)	232 (46.9)	
Mean (95% CI) HbA1c concentration, mmol/mol (IFCC) N_{fs} = 1040; N_{fi} = 483	80 (78–83)	83 (79–86)	0.45
HbA1c concentration, *n* (%)			
<53 mmol/mol	126 (12.1)	53 (11.0)	
53–85 mmol/mol	219 (21.1)	110 (22.8)	
86–130 mmol/mol	179 (17.2)	81 (16.8)	
>130 mmol/mol	516 (49.6)	239 (49.5)	
Mean (95% CI) HbA1c concentration,% (DCCT) N_{fs} = 1040; N_{fi} = 483	9.5 (9.3–9.8)	9.7 (9.4–10.0)	0.45
HbA1c concentration, *n* (%)			
<7%	126 (12.1)	53 (11.0)	
7–9.9%	219 (21.1)	110 (22.8)	
10–14%	179 (17.2)	81 (16.8)	
>14%	516 (49.6)	239 (49.5)	

N_{fs}, total no. of food-secure patients; N_{fi}, total no. of food-insecure patients. IFCC, International Federation of Clinical Chemistry and Laboratory Medicine; DCCT, Diabetes Control and Complications Trial.

only one of many factors that complicate the treatment and management of diabetes in this population. The majority of research carried out in the management of diabetes is completed in settings with the traditional presentation of Type 1 or Type 2 diabetes in resource-rich countries.

The unique features of diabetes in this resource-constrained setting presents challenges in understanding the dynamics of this growing burden of diabetes. Although one-third of food-secure patients and one-quarter of food-insecure patients were obese, this risk factor does not appear to be as

prominent a driver of diabetes in resource-constrained settings as it is in resource-replete settings. This is in stark contrast to the analysis of the US-based National Health and Nutrition Examination Survey, which found that 80.3% of patients with diabetes were overweight and 49.1% of obese adults had diabetes in the USA according to the National Health and Nutrition Examination Survey 1999–2006 [29].

While the present study did not assess the role of malnutrition during pregnancy on the subsequent development of diabetes, it is hypothesized that this may be one of the contributory risk factors fuelling the diabetes epidemic. It is also postulated that this unique risk factor leads to the unique phenotype of diabetes seen from patients receiving care in similar settings throughout sub-Saharan Africa [15, 16, 19–21].

The high percentage of patients requiring insulin at some point in their care reveals another unique feature of this population. The increased need for insulin combined with food insecurity presents a challenge in managing insulin use, as patients are at a heightened risk for hypoglycaemia in the outpatient setting owing to a lack of food after injecting. Blood glucose monitoring is not a commonly used method of care in resource-constrained settings because of the expense of purchasing a glucometer and test strips, which also increases the risk of hypoglycaemia [30,31]. A challenge is presented for clinicians, who are trying to manage each patient's condition through medication and lifestyle modifications, when there is the larger underlying problem of somewhat unpredictable access to food. Other factors, such as the lower prevalence of obesity, challenges in the use of insulin owing to the risk of hypoglycaemia, and varying subtypes of diabetes in this population compared with resource-rich settings, point to the need to study and evaluate other causes of diabetes and the management of these differences in order to prevent the increasing prevalence of diabetes in a resource-constrained setting.

These challenges have guided the scheme to develop a comprehensive home glucose monitoring programme where patients receive weekly phone calls and medication titration based on blood glucose measurements performed at home [32].

Another potential intervention currently in development is the integration of a diabetes-focused nutritional support programme for food-insecure patients. Studies have demonstrated the relationship between food insecurity and HIV in sub-Saharan Africa where 33.5% of patients with HIV seen throughout western Kenya are food-insecure. The HIV programme has demonstrated great success in improving outcomes for these patients through the development of a nutrition support programme, and it is hoped that this infrastructure can also be used to benefit food-insecure patients with diabetes [33–36].

The findings from the present paper also highlight many unique attributes of this overarching population which merit additional investigation. Of great concern is the relatively high initial HbA1c concentrations of the population and high percentage of patients with markedly elevated HbA1c concentrations of >130 mmol/mol (14%). This disturbing phenomenon has been partially addressed by the integration of the aforementioned home glucose monitoring programme into the care of high-risk patients but this underscores the delayed presentation of patients to clinic and the importance of early identification and linkage into effective care.

One of the main limitations of the present study is that data were only collected at three sites in Kenya. For a more representative picture of the food-security status of patients with diabetes, a broader sample needs to be taken into consideration. Also, this study only looks at routinely collected data within the public sector and does not include diabetes patients from the private sector. Another limitation is that patients often do not present to the hospital until they have severe complications related to previously undiagnosed diabetes, particularly those who do not have the economic means to see a physician regularly. The district hospital-based care provided at the clinics included within this analysis tends to be slightly more expensive than the basic care patients receive at local facilities. This factor could lead to a gross underestimation of the number of food-insecure patients as the present analysis only included patients who had the financial means to attend diabetes clinic at the three district hospital clinics. In addition, this study was not designed to look at the characteristics of this patient population at the time of original diagnosis or screening, which limits interpretation of their status on initial presentation. As part of the Academic Model Providing Access to Healthcare's (AMPATH) overarching efforts to bring care to the patient's door, AMPATH has initiated a door-to-door screening programme for HIV, tuberculosis, diabetes, hypertension and pregnancy, where the population will be screened every 3 years to proactively identify patients and also to investigate healthcare trends in this setting.

Future studies are needed to characterize the different subtypes of diabetes seen in sub-Saharan Africa. Several studies have already demonstrated that there are many differences in the presentation and type of diabetes found in sub-Saharan Africa compared with elsewhere in the world [12–16]; however, there is still a great lack of knowledge on the pathogenesis and treatment of these subtypes of diabetes, as well as what relation these different subtypes of diabetes have to food insecurity and malnutrition. With the lack of data on the various types of diabetes, it is difficult to find a solution to this problem. More focused investigations are needed on new methodologies in screening, prevention and treatment to address these different subtypes in sub-Saharan Africa in order to help stave off the growing burden of disease.

Conclusion

In the present study, approximately one-third of patients with diabetes in western Kenya had some degree of food

insecurity. Despite the widely recognized contribution of caloric over-nutrition to the development of diabetes, this study highlights the high prevalence of food insecurity amongst patients with diabetes in rural resource-constrained settings, as well as the unique features of diabetes in this setting.

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Competing interests

Sonak Pastakia has received fees for serving as a speaker and consultant for Abbott within the last three years.

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