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Prevalence, Risk Factors and Management of Type 2 Diabetes, and its Predictors among Patients Using Multinomial Logistic Modeling Approach: Case of a Semi-Urban Cameroonian

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Authors' contributions

This work was carried out in collaboration among all authors. Author KKG and TW conceived and designed the study. Authors MW, MI and CMB conducted the research including data collection. Authors TW and KKG were responsible for data management and analysis. MW interpreted the data and wrote the first draft of the manuscript. Authors KKG, AFA and MCM supervised and revised the manuscript for important and intellectual content. All authors read and approved the final manuscript.

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ABSTRACT

Background: Diabetes is a health problem worldwide. The prevalence of diabetes has been steadily increasing for the past three decades. Diabetes prevalence is growing most rapidly particularly in low- and middle-income countries. Areas undergoing rapid westernization and rapid nutrition transition are seeing the greatest increase in prevalence suggesting that environmental factors are important. Diabetes is known to have no cure but can be managed through diet and modification of lifestyles. The aim of this study was to evaluate the prevalence and the predictors of diabetes and its management in Kumba District Hospital (KDH).
Study Design: A retrospective, and a cross sectional survey was done where semi structured questionnaires were administered to subjects.
Methodology: Information from the hospital record for the past four years was used to evaluate the trend in the prevalence of diabetes. Information from questionnaires was used to assess the prevalence and management of the disease. Fasting plasma glucose was measured to know their diabetic status.
Results: The results revealed an increasing trend in the prevalence but the increase was not statistically significant. The results showed that, there was an association between diabetes prevalence and management. The overall prevalence of diabetes from the study was evaluated at 43.98%. Age, level of education, dietary habit and alcohol were found to influence the prevalence of diabetes significantly. Management with respect to therapeutic education, and monitoring of blood sugar were statistically significant. The significant predictive variables of the occurrence of diabetes base on Ordinary least squares were found to be age, level of education, therapeutic education, alcohol consumption, sex, and frequency of eating white rice.
Conclusion: The study revealed that, diabetes is highly prevalent among older persons and the less educated in KDH. Public health officials should educate the public on the risk factors of diabetes, and implement guidelines for adequate control and management.

Keywords: Type 2 diabetes; risk factors; prevalence; predictors; management; Kumba.

1. INTRODUCTION

Non-communicable diseases have gained worldwide attention within the last couple of decades, especially in low and middle-income countries, where they have been increasingly recognized and prevalent [1,2]. Among the non-communicable diseases, Diabetes mellitus has become a global health challenge. There are many different types of Diabetes depending on the aetiology but there exist essentially two types of Diabetes; Type 1 Diabetes mellitus (T1D) and Type 2 diabetes mellitus (T2D) [3]. T2D is a metabolic disorder that is known as one of the principal causes of mortality worldwide. It has been present in 90.0%-95.0% of diabetes cases, according to International Diabetes Federation (IDF), [4]. Type 1 is common in children and Type 2 in adults. Diabetes Type 2 represents 90% of cases of diabetes, affecting adults and an increasing number in children. Diabetes mellitus is characterized by a raised blood glucose level [5]. The level of blood glucose rises after a dietary intake and returns to normal post prandial level few hours after eating. The most commonly used metabolic measures for the diagnosis of diabetes in research and clinical setting is the plasma glucose level [6]. Most of these patients have been overweight or obese and also suffer from related diseases: hypertension; dyslipidemia; polycystic ovary syndrome and vascular diseases. T2DM can occur at any age, but it is usually diagnosed after the age of 40 [7]. According to Mbanya et al., [8] and Kengne et al., [9], diabetes has reached epidemic proportions worldwide with particularly rapid growth in Africa. Sub Saharan Africa just like other parts of the world is experiencing an increasing prevalence of diabetes and also poor management of the disease.

The prevalence of diabetes has been steadily increasing for the past three decades, mirroring an increase in the prevalence of obesity and overweight people. In particular, the prevalence of diabetes is growing most rapidly in low- and middle-income countries [10]. In recent decades, dramatic increase in the prevalence and incidence of type 2 diabetes has occurred in many parts of the world especially in newly industrialized and developing countries. Indeed, majority of the cases of T2D in the future will occur in developing countries with India and China having more cases than any other

country in the world [11]. This can be supported by Li et al., [12] which shown that in China for instance, diabetes has reached national epidemic proportions affecting approximately 12.5% of population. It was estimated that there were 451 million (18-99 years old) patients with diabetes worldwide in 2017 and that diabetes mortality among individuals 20-99years old was at 5 million. Global medical expenditure for patients with diabetes is estimated to be US$850 billion [13]. The exact cause of development of DM is unclear [14]. However, the prevalence of the disease is often associated with risk factors; obesity, excess weight, age, gender, certain ethnicities/race, family history of diabetes, history of gestational diabetes, sedentary lifestyle, dietary habit, urbanization and westernization lifestyle, fat, alcohol intake, dietary fibers and glycaemia index, and socioeconomic factors [15,16,2]. Increase urbanization and nature of work in Cameroon which is a low-income country also exposes their population to highly processed food, and fast food with high fat, salt and sugar, rich in calories, and sedentary lifestyles [17].

In addition, the increased incidence of people with T2D cannot be explained by demographic changes and lifestyle cause. In many countries in Europe, T2D are higher prevalence in low educational groups and are related to social deprivation associated with poverty [18]. Social determinants of health accounts for the economic and related social condition people live in, which influences their health. Even in developed economies such as many countries in Europe, difference in life expectancy can be linked to wealth as people who are less well-off develop more illnesses [19].

The true cost of diabetes includes indirect cost such as productivity losses, which can dramatically increase the cost associated with diabetes. Delay in diagnosis and treatment deficiencies ultimately make diabetes related complications more likely and will inevitably increase health cost in the future. Diabetes can reduce a household income which can lead to poverty, poor educational performance and in the wider economy can have a negative effect on gross domestic product [20].

As a result of diet diversity, Cameroon has several ecosystems in which the foods consumed are a function of what is available locally. In all the ecosystems, the diet is monotonous and based largely on starchy foods which must meet the essential nutritional needs [21] The data on food consumption and habits indicate that the diets in general are not balanced. Consequently, the diseases linked to nutrition (diabetes, hypertension, obesity, etc.) are on the rise in the country and the regional distribution is a reflection of the food habits of the population. As Cameroonians are increasingly living in an obesogenic society that drives the global pandemic of type 2 diabetes, the situation of the disease deserves to be given some attention [21]. Diabetes mellitus is a serious health threatening non-infectious disease affecting many people of South West Region, Cameroon [22]. Due to their feeding habits, sedentary lifestyles, physical inactivity, majority of the population is at risk. It is worth noting that some studies have been done in Cameroon but few information is documented about the management of T2D in Kumba, where a total prevalence of visual impairment among diabetics in the area is estimated to 17.8% [23]. Therefore, the aim of this study was determining the prevalence of Type 2 Diabetes mellitus, factors associated and its management in Kumba.

2. METHODOLOGY

2.1 Study Area

The study was carried out in Kumba municipality. Kumba is the divisional headquarters of Meme division of the South west region of Cameroon. Commonly called K-town, Kumba is located between latitude 4°38′ Nord and longitude 9°27′ East with an estimated population of about 400.000 inhabitants with about ¾ of this population falling within the youthful age group.

2.2 Study Population

A retrospective and cross-sectional study was carried out for a period of 3 months. The study was a hospital-based study carried out at the Kumba District Hospital. The secondary information of past recent years obtained from hospital record books alongside the present information obtained through laboratory test diagnosis for both hospitalized and outdoor patients as prescribed by Medical Doctors. 8265 patient's subjects were considered in this study from January 2013 to October 2018, time of data collection. 8099 samples were taken in KDH record book in order to determine the trend of diabetes for the past analyzed from the four

years. Out of the 8265 subjects, 166 subjects responded to questionnaire in the hospital under study. The population included both hospitalized and outdoor patients who came to the hospital for consultation and signed the consent form.

2.3 Inclusion and Exclusion Criteria of the Study

Eligibility criteria included a diagnosis of Diabetes mellitus confirmed by doing fasting blood glucose sugar test for both diagnosed and undiagnosed cases of diabetes; age greater than 20 years. Diabetics with significant co-morbidities, such as cancer, end-stage renal disease were excluded. It also included patients administered for less than 48 hours. Patients who had previously been tested for diabetes in this hospital. This study did not include pregnant women of reproductive age. Patients who could not participate because of cognitive impairment and active substance abuse/ psychosis were excluded from the study.

2.4 Determination of Sample Size

The sample size (N) was determined by using the Laurence Kuppers equation (Lawrence and Kerry, 1989).

$$N = \frac{Z^2 \times P(1-P)}{D^2} \quad (1)$$

Where N is the sample size, Z is the statistic for the level of confidence (95%) where Z value is 1.96, P is the expected prevalence and D is the precision (5%) i.e. 0.05.

2.4.1. Data collection

Information was collected retrospectively and also by completion of questionnaires by subjects under study.

2.4.1.1 Retrospective data collection

Demographic information for the study, was collected from the hospital record book for the past years alongside their result. The fasting blood sugar (FBS) results were also taken from the hospital book for hospitalised patients and those who had visited this hospital before the study.

2.4.1.2. Research survey

The survey made use of questionnaires carrying questions related to the prevalence, some risk factors, and assessing management of diabetes. Information for those visiting for the first time was obtain after doing a diagnostic test (FBS) through a questionnaire respondent and taking down the values for their FBS from their consultation booklet.

2.4.1.3. Anthropometric measurement

Anthropometric measurement of variables (independent variable) like height and weight were taken. Height was measured in meter using a graduated meter stick. Weight was measured using a balanced beam scale. The value obtained for the height and weight were used to calculate the body mass index.

2.4.1.4. Testing for fasting blood sugar

To test for diabetes, we used the fasting plasma glucose test by using a glucometer (One Touch®) and a non-coded test strip which makes use of capillary blood.

2.4.1.5. Evaluation of management

Questions were used to get information on management based on feeding habits, methods of cooking, types of food taken and how often subjects indulged in physical activities. Self-education on diabetes, monitoring of blood sugar, as well as therapeutic education was also used to assess management.

2.5 Data Analysis

The multinomial logit model was computed to determine the variables that influences the probability to be diabetic. It determines which factors are important, which factors can be ignored, and how these factors influence each other [24]. The probability to develop diabetes is calculated from equation 2.

$$P(Y < i) = \frac{\exp(Y_i - \beta_j)}{1+\exp(Y_i - \beta_j)} \quad (. 2)$$

Where Y is the response variable, i is the level of an ordered category of the response variable, Y is the cutpoints or thresholds to depict the variations among categories, and β is the vectors of regression coefficients for the j-the of diabetes status.

From the multinomial logit model, the marginal effects (ME) were computed to depict the impact of the change of one unit of the independent variable on the dependent variable. In addition,

the relative risk ratio (RRR) was computed to determine the likelihood that a respondent to develop diabetes in relation to the likelihood to those who will not have diabetes.

Moreover, empirical models such as generalized linear and ordinary least squares linear models performed to determine which model is more reliable to predict the occurrence of diabetes amongst the population. Hence, the incidence of diabetes is depicted by the equation 3.

$$\mathrm{ID_m} = \alpha + \mathrm{X_m}\Upsilon + \varepsilon_\mathrm{m} \quad (3)$$

Where, ID is the incidence of diabetes, α is the intercept, X_m is the vector of explanatory m variables, Y is the vector of regression coefficients, and ε m is the random error term.

The descriptive and univariate analyses were carried out using IBM SPSS Statistics version 25 (IBM Corporation., Armonk, NY, USA). The multinomial logit regression, ordinary least squares linear regression and generalized linear regression model were performed with Stata/IC version 15 (Stata Corporation, College Station, TX, USA).

3. RESULTS AND DISCUSSIONS

3.1 The Trend in the Prevalence of Diabetes

The trend in the prevalence of diabetes is presented on Table 1. This shows a slight increase from the year 2013 (33.26%), and 2014 (35.93%). From the above results, we realized that the prevalence of diabetes increased slightly in the first two years 2013 (33.26%) and 2014 (35.93%) and dropped greatly in 2015 (29.09%) and then started increasing again in 2017. Though Diabetes mellitus show an increase in the prevalence for the first two years, the increase is not statistically significant. This is contrary to studies carried out by most researchers who say that the trend is increasing and will continue to increase if nothing is done to curb the situation [12,5]. The result obtained shows that if this study could run till the end of the year, we may have recorded more diabetic cases for the year 2017 compare to the year before.

3.2 Socio-Demographic Information Linked to the Prevalence of Diabetes

3.2.1 Prevalence of diabetes with respect to age group

The prevalence of diabetes with respect to age group is presented in Fig 1. According to the results, these shows an increasing trend of diabetes with respect to increasing age groups, with subjects of age group≤30 with an incidence rate of 0.0%. Subjects of age group ≥ 60 recorded the highest prevalence with a percentage of 58.62% while those of age group from 30-39 recorded the least (29.17%). The results are statistically significant ($p<0.05$). The above result shows a significant association between diabetes prevalence and age groups ($p<0.01$, $r=0.292$). The same result was obtained by Mbanya et al., [8] which show that there is a strong association between increasing prevalence of diabetes with increasing age groups.

This may be due to the fact that the organs are getting worn out as age increases and so the pancreas cannot produce enough insulin to keep the blood sugar at normal level hence disorder ensue. Berhanie et al.,[25] in a study in Awi Zone, North West Ethiopia also found that male from sex, above 40 years from age, married from marital status were more susceptible for diabetes mellitus, contrary to females, 16-40 years and singles were lower risk of diabetic than other comparable categories. This is contrary to Alva et.al, [26] who observed

Table 1. Trend in the prevalence of diabetes from 2013-August 2017

Variable		Fasting blood sugar		χ^2 -test P-value
Year	Size	<120mg/dl (Non diabetic) n (%)	>120mg/dl (Diabetic) n (%)	
2013	1326	885 (66.74)	441 (33.26)	2864
2014	1929	1236 (64.07)	693 (35.93)	0.001
2015	3008	2133 (70.91)	875 (29.09)	
2017	2002	1395 (69.68)	607 (30.32)	

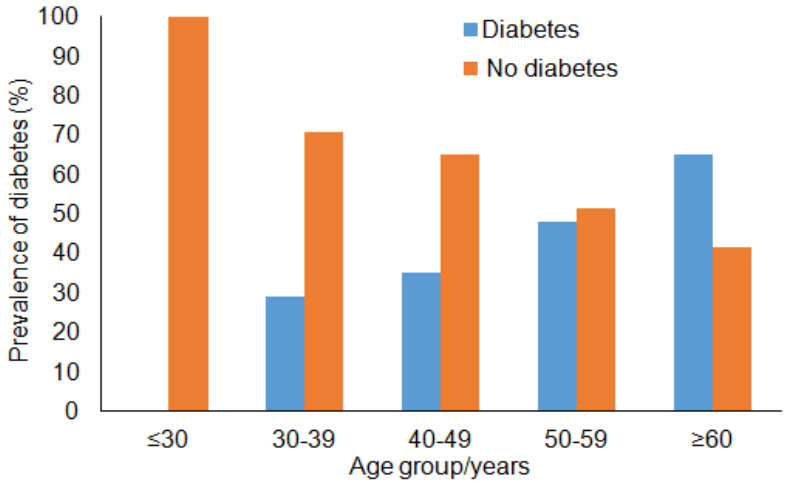

Fig. 1. Prevalence of diabetes by age groups

that the risk equations are more successful in middle-aged adults than in young and old populations. Debrah et al., [27] in a study at Kanungu District, Uganda found that females and patients aged 61-65 years were most affected by diabetes.

3.2.2 Level of education on the prevalence of diabetes

The results of the prevalence of diabetes with respect to level of education are presented in Fig 2. From the analysis of the data, the prevalence of diabetes varied among educational levels. Those with secondary level of education recorded the highest prevalence of 70.59% and those with tertiary level of education recorded the least prevalence of 23.08%. It was observed that, there were more diabetes cases in levels of education below secondary and less diabetes cases among those with high school and tertiary education. The result shows a statistical significant level ($p < 0.05$). The result reveals that, there is a strong association between the prevalence of diabetes and educational level, with more less educated suffering from diabetes compared to the highly educated. The same result was obtained by Maty et al., [28] which shows the association between educational attainment and incidence of diabetes and found that low education is significant predictor of T2D. This is because educational attainment promotes an interest in one's own health and acquisition of knowledge that strongly influence people's ability to reduce risk by successfully adopting a healthier life style. The reason for this increase in the prevalence of diabetes in less educated in this study may be due to the fact that, most of them are ignorant about dietary related diseases and also because the uneducated and less educated generally have poor nutritional knowledge hence bad eating habit which predisposes them to diabetes and other related diseases. The study found that diabetes was higher in least educated who were obese and inactive compared to the more educated. There was a strong association between level of education and BMI ($p<0.001$, $r=0.236$), level of education and job type ($p<0.001$, $r=0.335$). This study suggests that, educational attainment promote an interest in own health and acquisition of knowledge that strongly influence people's ability to reduce risk by successfully adopting a healthier lifestyle. In recent decades, a population attributable fractions estimates showed that 17.2% of the diabetes burden in men and 20.1% of the burden in women were attributed to lower educational levels in Sweden when combining all age groups, with a considerable burden of type 2 diabetes attributed to lower educational levels [29]. Braverman-Bronstein et al., [30] shown that in women, there was an inverse dose-response relationship between education and Type 2 diabetes but for men, in Argentina, Brazil, Colombia, Chile and Mexico they observed an inverse association. This is contrary to the study carried out Anisyah et al., [31], who found that there is no relationship between the level of education and the accuracy of insulin injection techniques through HbA1cvalues.

3.2.3 Diabetes prevalence in relation to sex, level of income, ethnic group and job type

Sex, level of income, ethnic group, and job type were evaluated with the prevalence of diabetes and were not statistically significant. The characteristic of respondents by diabetes are displayed on the Table 2. From the result it is observed that there were more males with diabetes compared to females. Even though the prevalence of diabetes varied with sex, there was no statistical significance. This is in line with the study of King et al., [11] which show that, the prevalence and incidence of T2D vary to some extend between sexes from population to another, but these differences are relatively small and appear to be accounted by differences in other risk factors such as obesity and physical inactivity as opposed to the study carried out by Berhanie et al., [25] which show a significant association between sex, age, marital status, blood group and Rh factors with diabetes mellitus in Awi Zone, North West Ethiopia. This result might be due to the fact that the males here are more exposed to urbanization and westernization lifestyle. These factors encourage sedentary lifestyle and increase consumption of processed food. The level of income was analysed with respect to the prevalence of diabetes**.** It was observed that the prevalence was highest among high income earners and lowest among middle income earners. 50% of the middle-income earners were diabetic, 48.45% of low-income earners, 40.43% of those with no income and 30% of middle income earners were diabetic **(**Table 2). The results were not statistically significant. The results obtain showed that there is no association between the prevalence of diabetes and level of income. This is contrary to the study carried out by Doreen et al., which revealed that poverty is associated with shorter life expectancies and increased mortality particularly cardiovascular mortality. Diabetes may be two times more prevalent in low-income population than wealthy population. Even in developed economies such as many countries in Europe, difference in life expectancy can be linked to wealth as people who are less well-off develop more illnesses [19]. Tanya et al*.,* [32] suggested that the powerful commercial, socioeconomic political factors shaping Cameroonian society encourage individual choices that lead to a sedentary and unhealthy lifestyle. The reason for the high prevalence among the high-income earners in our study may be linked to the fact that, high income earners may be leaving a western life style with decreased Mediterranean diet which is marginalizing traditional values in favor of western diets and lack of exercise. Among the different ethnic groups, the results **(**Table 2) show that indigenes of the east region recorded 100% non-diabetic cases while foreigners recorded the highest number of diabetic cases (71.43%).

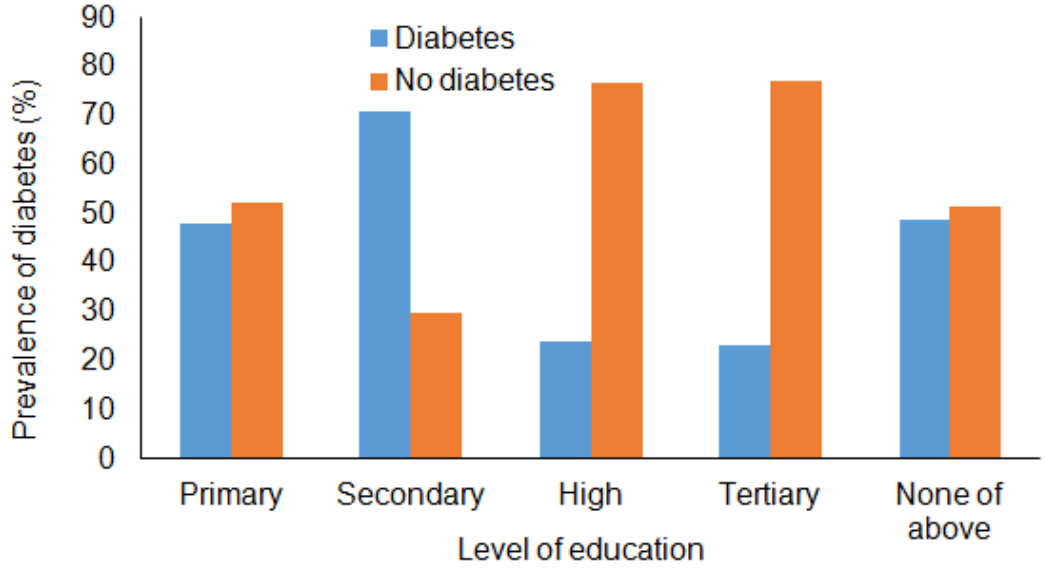

Fig. 2. Prevalence of diabetes by level of education

Table 2. None statistically significant socio-demographic variables with respect to diabetes

Variables		Fasting blood sugar		χ^2 -test P-value
		<120mg/dl (Non diabetics) (%)	>120mg/dl (Diabetics) (%)	
Sex	Male	34 (50.00)	34 (50.00)	1.222
	Female	59 (60.20)	39 (39.80)	0.269
Level of income	Low	50 (51.55)	47 (48.45)	4.218
	Middle	14 (70.00)	6 (30.00)	0.239
	High	1 (50.00)	1 (50.00)	
	None	28 (59.57)	19 (40.43)	
Ethnic group	South West	44 (53.66)	38 (46.34)	10.035
	West	17 (80.95)	4 (15.05)	0.074
	North West	26 (50.98)	25 (49.02)	
	Littoral	3 (75.00)	1 (25.00)	
	East	1 (100.00)	0 (0.00)	
	Far North	0 (0.00)	0 (0.00)	
	North	0 (0.00)	0 (0.00)	
	Center	0 (0.00)	0 (0.00)	
	Adamawa	0 (0.00)	0 (0.00)	
	South	0 (0.00)	0 (0.00)	
	Foreigner	2 (28.57)	5 (51.43)	
Job type	Manual	56 (55.45)	45 (44.55)	0.316
	Sedentary	37 (56.92)	28 (43.08)	0.574

This was closely followed by indigenes of the North West Region with percentage 49.02%**.** Though the foreigners recorded the highest percentage prevalence, there was really no statistical significance between the values. Ethnic groups like, Far North, North, Center Region, Adamawa, and South Region were not represented in the studies and the results relied mostly on those ethnic groups that were represented. The results obtained show variation in the prevalence among different ethnic group. This can be supported by the studies carried out by King et al., [12] which show that, diabetes prevalence varies considerably among population of different ethnic origin living in similar environment. This observation supports the idea that genetic factors contribute to disease predisposition [33]. Unlike the study carried out by Cooper et al., [34] who showed that, the prevalence of diabetes appears to be substantially higher in African origin population living abroad than in indigenous Africans. In our study, the reason for this variation may be due to hereditary and socioeconomic factor. The analysis of job type reveals that, there is a slight difference in the prevalence of diabetes with respect to job type. People who are manual workers had a diabetic prevalence of 44.55% compared to sedentary workers with percentage of 43.08 %. (Table 2). The prevalence in diabetic manual worker was higher than the percentage prevalence in sedentary workers though the difference is not statistically significant. The study does not show any association between job type and the prevalence of diabetes. This is contrary to the study carried out by Sobngwi et al., [35] which show a very strong association between sedentary worker and diabetes. This might mean that, either the subjects have a family history of diabetes, a poor dietary habit, or they are ignorant about their status. The presence of family history for diabetes, overweight, and being obese increases the chances of acquiring type 2 diabetes [27].

3.3 Risk Factors Linked to the Prevalence of Diabetes

3.3.1 Dietary habit

Fig. 3 presents the results on prevalence with to dietary habit, Base on this, the prevalence of diabetes was highest among people who rarely consume sugars and lowest in people who consume it daily giving the percentages 74.07% and 22.22% respectively. The result shows a significant association between dietary habit and the prevalence of diabetes. There was a correlation between diabetes prevalence and dietary habit ($p<0.001$, $r=0.001$). The result obtained is contrary to the studies carried out by Malik et al., [36] through a meta-analysis of

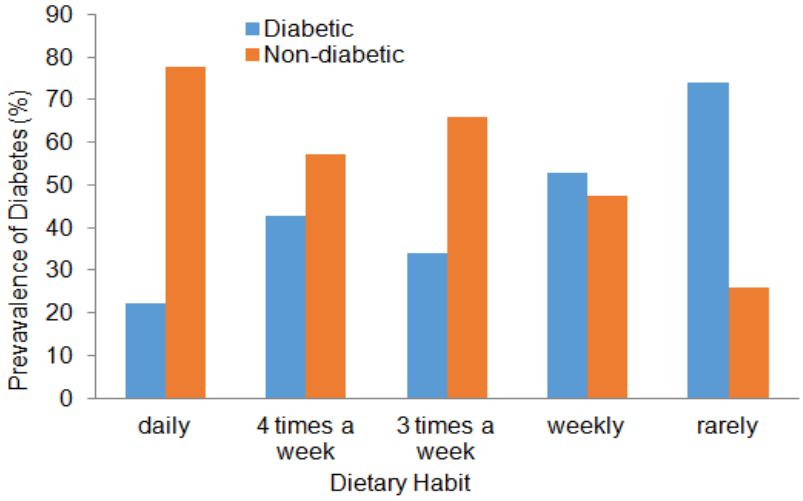

Fig. 3. Prevalence of diabetes by dietary habit

11 prospective studies of more than 300,000 people who found that, those who consume one to two sweetened beverages per day had a 26% greater risk of developing T2D than those who consume less than one serving per month. The reason for increase prevalence of diabetes among those who rarely consume refine sugar may be due to the fact that, they were more conscious of their status and so turn to reduce the consumption of refine sugars while those who consume refine sugar daily were unaware of the effect of refine sugars to their health.

3.3.2 Alcohol consumption

The results for the prevalence of diabetes with respect to alcohol consumption are presented in Fig. 4. The results show that the prevalence of diabetes was at its peak for those who consumed alcohol and stopped (73.33%) followed by those who drink alcohol (39.06%) and those who do not drink alcohol had the least prevalence (12.5%). It was realized that there was a statistical significant difference with significant level of p=0.001. The result, reveals a strong association between alcohol consumption and diabetes prevalence and this can be supported by ADA [6] which says that alcohol will contribute to hyperglycaemia and hyperlipidemia, especially if consume in excess amount that is greater than or equal to 3 or more drinks per day. Alcohol stimulates appetite, which can cause you to over eat and may affect your blood sugar control. Alcoholic drinks often have a lot of calories, making it more difficult to lose excess weight. Alcohol may also increase triglyceride levels. Volaco and Ercolano,[37] in a recent study found that the ingestion of moderate amounts of alcohol might not just decrease diabetes mellitus development risk, but also be associated to better metabolic control, decrease in some microvascular complications (retinopathy and nephropathy), decrease in macrovascular events and mortality. Our result obtained can be explained because those who consumed alcohol and stopped alongside those who currently drink alcohol consumed greater amount of alcohol, and too much alcohol can cause chronic inflammation of the pancreas (pancreatitis) which can impair its ability to secrete insulin and ultimately lead to diabetes. Moderate alcohol consumption is associated with a decreased incidence of diabetes mellitus and a decreased incidence of heart disease in persons with diabetes [38].

3.3.3 Diabetes history, cigarette smoking, frequency of eating daily, frequency of eating white rice, and body mass index

History of diabetes, cigarette smoking, and frequency of eating daily, frequency of eating white rice and BMI from the analysis show no statistical significance to prevalence of diabetes. The results of this analysis are displayed in Table 3. The result shows a great difference in family history of diabetes. The study indicated that a higher proportion of adults who had diabetes did not know their family history of diabetes (52.78%), followed by those with history of diabetes in their family with a percentage of 44.68%. Those with no history of

diabetes in their family recorded the least percentage of diabetics given by 39.76%. Though the result shows an increasing trend with history of diabetes, there was no statistically significant relationship between family history of diabetes and diabetes prevalence. This is in line with the study of Levitt et al., [39] in Cape Town in which family aggregation was not an independent risk factor. Mohan et al., [40] shows that the prevalence of undiagnosed diabetes is approximately equal to or greater than diagnosed cases. The presence of family history for diabetes increases the chances of acquiring type 2 diabetes [27]. The reason for our result may be associated to the fact that many people do not go for diagnosis and may only realize they are diabetic when faced with complications coupled to the fact that, hyperglycaemia develops gradually and its earlier stages are often not severe for the patient to notice any of the classic symptoms of diabetes. Most people don't care about chronic diseases and only turn to attend to medical attention when they can no longer proceed with their day-to-day activities. Besides, ignorance about the disease and family diabetes status may be the attributed to the prevalence of undiagnosed diabetes.

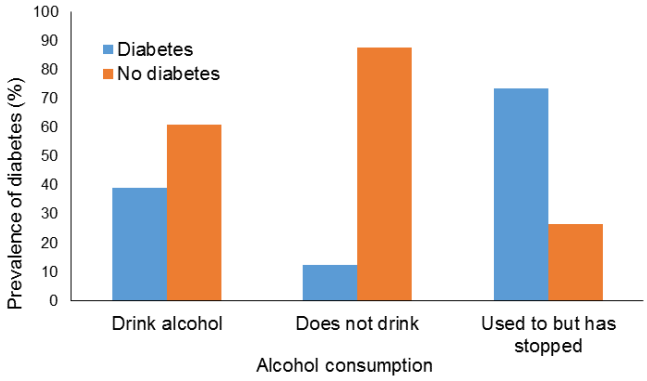

Fig. 4. Prevalence of diabetes by alcohol consumption

Table 3. Risk factors with respect to diabetes prevalence which show no significance

Variable		Fasting blood sugar		χ^2 -test P-value
		<120mg/dl (Non diabetics) N (%)	>120mg/dl (Diabetics) N (%)	
Diabetes history	Yes	26 (53.32)	21 (44.68)	2.228
	No	50 (60.24)	33 (39.76)	0.328
	No idea	17 (47.22)	19 (52.78)	
Cigarette smoking	Smoke	4(36.36)	7 (63.64	2.904
	Does not smoke	79 (58.96)	55 (41.04)	0.234
	Smoke and stop	10 (47.62)	11 (52.38)	
Daily eating frequency	One	1 (16.67)	5 (83.33)	5.267
	Two	36 (54.55)	30 (45.45)	0.261
	Three	38 (55.88)	30 (44.12)	
	>3	18 (69.23)	8 (30.77)	
Frequency of eating white rice	Daily	3 (100.00)	0 (0.00)	2.762
	Frequently	62 (54.39)	52 (45.61)	0.251
	Seldom	28 (57.14)	21 (42.86)	
BMI	<18.5	0 (0.00)	4 (100.00)	9.088
	18.5–25	29 (56.86)	22 (43.14)	0.106
	25.1–30	38 (57.58)	28 (42.42)	
	30.1–35	21 (63.64)	12 (36.36)	
	35.1–40	4 (57.14)	3 (42.86)	
	>40	1 (20.00)	4 (80.00)	

For cigarette smoking, it was observed that those who smoke had the highest percentage prevalence of diabetes followed by those who smoked and stop and those who do not smoke had the least percentage of diabetes given by 63.64%, 52.38% and 41.04% respectively. The results were not statistically significant. The results reveal that there is no significant association between smoking and diabetes prevalence. This can be supported by the study carried out by Ronnemaa et al., [41] who stated that smoking has been shown to cause elevations in blood glucose concentration and may increase insulin resistance. Smokers also turn to have higher blood concentration of glycosylated haemoglobin than do non-smoker. This may be due to the fact that most of the subjects were manual workers and believed that, when they smoke, they are able to work effectively, while some believe that when they smoke, it gives them some moments of delight and frees them from their troubles. This is contrary to Eliasson, [42] who showed that Cigarette smoking increases the risk for diabetic nephropathy, retinopathy, and neuropathy, probably via its metabolic effects in combination with increased inflammation and endothelial dysfunction. This association is strongest in type 1 diabetic patients. The development of type 2 diabetes is another possible consequence of cigarette smoking, besides the better-known increased risk for cardiovascular disease. Cigarette smoking increases the risk for type 2 diabetes incidence. Nicotine, acknowledged as the major pharmacologically active chemical in tobacco, is responsible for the association between cigarette smoking and development of diabetes [43]. From the study, it was observed that those who eat once a day had the highest percentage prevalence of 83.33% and those who eat more than three times a day had the least percentage prevalence of 30.77%. Those who eat twice and trice a day had a percentage prevalence of 45.45% and 44.12% respectively. The results were not statistically significant. There was no statistically significant data to justify that there is an association between diabetes prevalence and frequency of eating. This may be due to the fact that the people have a busy schedule during the day and so turn to skip meals and rely on street food and fast food whose caloric value are not known. This may also be likened to their level of income as those who are better off can afford for quality and more square meals a day. With respect to white rice consumption, it was realized that those who consume white rice daily did not have diabetes (100%), but those who frequently consume white rice had a high percentage compared to those who seldom consume white rice with percentages 45.61% and 42.86% respectively. The results were not statistically significant. The result from the data shows that there is no association between the prevalence of diabetes and the consumption of white rice. This might be likening to other factors like history of diabetes.

The analysis of BMI reveals that, out of the 4 peoples with BMI ≤18.5, all the 4 had diabetes (100%). Those with BMI ≥ 40 had a percentage of 80% and those with BMI between 3 0-35 had the lowest percentage prevalence of 36.36%. The results were not statistically significant. Our results show no association between the prevalence of diabetes and increasing BMI mean while studies have shown that, BMI is one of the most potent risk factors for the development of diabetes. This is contrary to the study carried out by Levitt et al., [39], which shows an increasing trend in diabetes prevalence with respect to increasing BMI. The reason for this result may be due to the fact that, the cases with BMI less than 18.5 were newly diagnosed and presented signs and symptoms of weight loss, since type II diabetes which is the most frequent type of diabetes has an asymptomatic phase with actual diabetes hyperglycemia before clinical diagnosis which has been estimated to last at least 4 to 7 years. Weight loss occur when calories is loss by losing sugar through frequent urination. The increase prevalence among those with BMI greater than 40 in our study may be liken to their dietary habit, frequency of eating daily and how often they indulge in physical exercise.

The association of diabetes with respect to other nutritional related diseases show that, 30.43% of those with cardiovascular diseases were diabetic, 42.22% of obese respondent were diabetic,42.86% suffering from other diseases were diabetic and 48.35% who do not have any of the above disease were diabetic. The results were not statistically significant, and show no association between diabetes and other related diseases.

3.4 Management of Diabetes

3.4.1 Therapeutic education

Management of diabetes with therapeutic education is illustrated in Fig. 5**.** From the result,

it was observed that 65.75% of diabetics do not attend therapeutic programs and 34.25% attend it, with 4.11% who attend regularly**.** There is a strong significant correlation between diabetes management and therapeutic education ($p<0.001$, $r=0.282$). Those who attend therapeutic education better manage the disease compared to those who do not. This result is in line with that of Pimouguet et al., who stated that more than 50% of diabetics receive limited education on diabetic self-care management or none. Only through education and empowerment can people's awareness of their self-care abilities be improved leading to a better quality of life [44]. In our case, the result obtained may be due to the fact that, people who leave in Kumba typically do not obtain sufficiently comprehensives medical information. Due to issues such as pressure of time, lack of awareness of the need to get therapeutic education, lack of available staff, and lack of communication and counselling skills among health professionals.

3.4.2 Monitoring blood sugar level frequency

Management of diabetes by frequency of monitoring blood sugar level is illustrated in Fig 6**.** Among the 73 who were diabetics, 49.32% monitor their blood sugar only when prescribed by the Medical Doctor, and those who monitor their blood sugar after 2 days have the least proportion (1.37%)**.** The result showed a strong association between diabetes management and blood sugar monitoring. We found that diabetes management significantly correlates with blood sugar level monitoring ($p<0.001$, $r=0.353$). The observation in our study is in line with 2 epidemiological surveys conducted in Taiwan, which shows that, only 30% of people with diabetes have performed self-monitoring of blood sugar or Urine sugar, indicating that, people with diabetes may lack skills or have low involvement in self-care activities [44]. A Taiwanese study found that, still only 9.4% of patients with age less than 65 years and 14% of patients with age greater than 65 years had HbA1c values within the optimal range (HbA1c < 6.5%) [45]. In our case, it may be due to the fact that those who monitor their blood sugar only when prescribed by the Medical Doctor, were surely newly diagnosed cases, and are not knowledgeable about management of the disease. For the others, may be life is too busy and demanding to take the time for regular monitoring, and lack of a personal glucometer on the part of the patients to regularly monitor their blood sugar when needed.

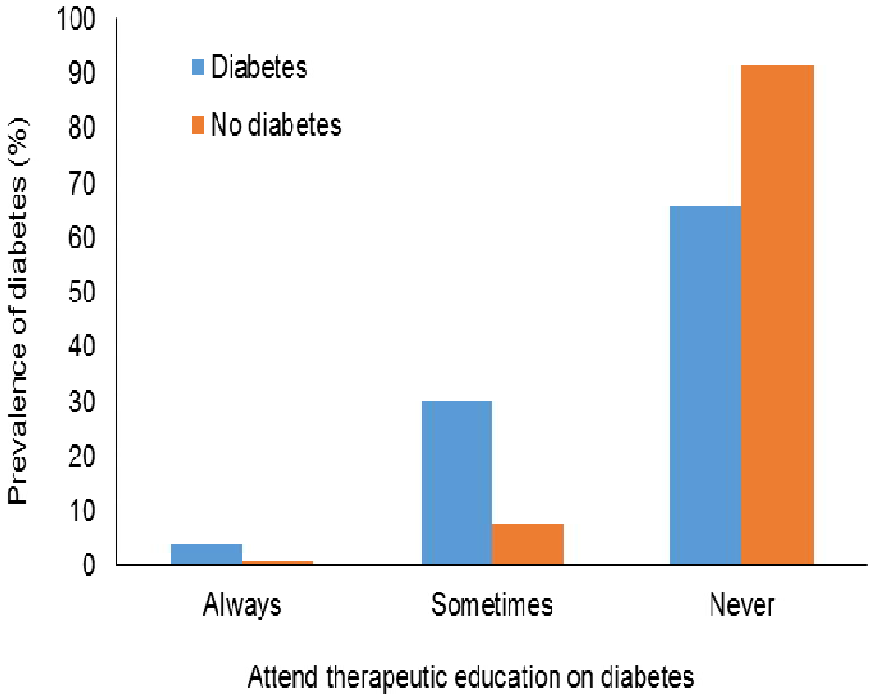

Fig. 5. Management of diabetes by attending therapeutic education on diabetes

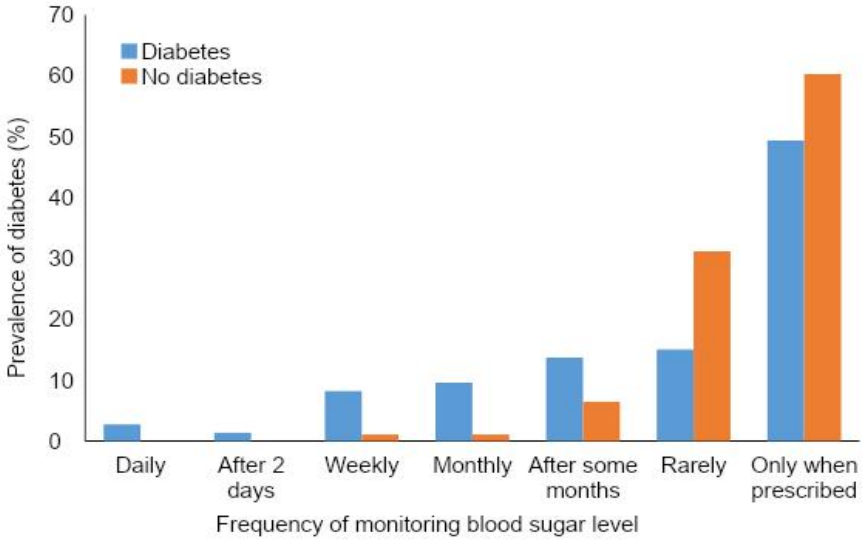

Fig. 6. Diabetes management by frequency of monitoring blood sugar level

3.4.3 Frequency of exercise, self-education on diabetes and food habit

The results of these variables with diabetes management are displayed in Table 4**.** In the study, diabetes management in relation to frequency of exercise shows that, among the 73 persons with diabetes, 69 .86% never do exercise and 2.72% do exercise monthly. Those who poorly manage the disease by exercise were highest and those who better manage the disease had the least percentage. The result shows variation in the frequency of exercise among diabetics but the results were not statistically significant. There was no association between management by frequency of exercise among diabetics. This is contrary to the study carried out by Polikandrioti et al., [46] which showed that, the low frequency recommended is 3 times per week. Usually, low intensity and long duration exercise programs are considered the most appropriate and safe patterns for patients with diabetes. The reasons for this result may be due to the fact that physical inactivity is common in urban regions of Cameroon because urban populations rely on the use of machines for house whole chores; motorised transport for transportation. More so, due to the fact that business is the time occupying even of the people, make them to have little or no time to indulge in exercise.

Concerning the frequency of eating fruits and vegetables, out of the 83.56% of diabetics who eat fruits and vegetables, 58.90% consumed fruits and vegetables regularly and 16.44% rarely consume fruits and vegetables. The results were not statistically significant and there was no association between management and frequency of eating fruits and vegetables. This may be due to availability of varieties of fruits and vegetables to the population. These fruits and vegetables contain dietary fibers which play a role in insulin sensitivity and insoluble fibers decreases intestinal tract time reducing time for the carbohydrates to be absorbed in the jejunum, thereby helping to maintain blood sugar. With respect to self-education on diabetes it was realised that, among the diabetics, 53.42% diabetics had no idea about the disease and 46.58% had an idea about the disease. The variation in the result was not statistically significant and did not show any association. Those with self-education could better manage the disease compared to those without self-education; this is in line with the study of Gagliardino et al., [47] which shows that, self-education training of diabetes provides knowledge and skills to optimize self-management, favoring HbA1c target attainment relationships between Type 1 diabetes education. Moreover, the study suggested a positive effect of weblog based self-management on enhancing quality of life, which can be due to increased awareness of diabetic patients about its risks as well as the ways to control and treat it [48]. Contrary to this, Hailu et al., in a study carried out in Ethiopia showed that there were no differences within or between the groups in other self-reported diabetes self-care behavior

regimens or in diabetes self-efficacy. Without appropriate education, people cannot make the complex daily medical decision required for good health, quality of life, and survival.

As what concern meat preparation (Table 4), it was observed that, 95.89% of diabetics prepare their meat whole without removing the skin, while 4.11% of diabetics peel off the skin of their meat before preparation. The result was not statistically significant and showed no association between management and meat preparation. This may be due to the fact that, patients lack dietary knowledge on the effect of saturated fat found on the skin of these animals to their health. In relation to food type, the results shows that, subjects whose food types is mostly vegetable, protein, with small carbohydrate food had the highest prevalence giving a percentage of 35.62% and those who manage their status mostly with carbohydrates, protein and fat had the least prevalence given by 15.07%. Even

Table 4. Characteristic variables for management of diabetes

Variables		Fasting blood sugar		χ^2 -test P-value
		<120mg/dl (None diabetics) (%)	>120mg/dl (Diabetics) (%)	
Frequency of exercise	Daily	6 (6.45)	8 (10.96)	2.151
	Weekly	17 (18.28)	12 (16.44)	0.542
	Monthly	4 (4.30)	2 (2.74)	
	Never	66 (70.97)	51 (69.86)	
Frequency of eating fruits and vegetables	Daily	5 (5.38)	0 (0.00)	6.969
	Regularly	41 (44.09)	43 (58.90)	0.073
	Weekly	29 (31.18)	18 (24.66)	
	Rarely	18 (19.35)	12 (16.44)	
Self-education on diabetes	Pre-knowledge	34 (36.56)	34 (46.58)	1.101
	No idea	59 (63.44)	39 (53.42)	0.294
Cooking method	Boiling, frying	46 (49.46)	32 (43.84)	0.131
	Roasting, boiling	5 (5.38)	11 (15.07)	0.429
	Baking, Boiling, frying	10 (10.75)	4 (5.48)	
	Combination of all	32 (34.41)	26 (35.62)	
Frying and cooking oil	Palm	74 (79.57)	50 (68.49)	4.527
	Bleached palm	9 (9.68)	10 (13.70)	0.210
	Soy beans	3 (3.23)	4 (5.48)	
	Margarine	2 (2.15)	0 (0.00)	
	Others	5 (5.38)	9 (12.33)	
Meat preparation	Peel –off the skin	3 (3.23)	3 (4.11)	0.010
	Prepare it whorl	90 (96.77)	70 (95.89)	0.922
Source of protein	Mostly fish, plant protein	39 (41.94)	40 (54.79)	2.870 0.412
	Red meat and fish	5 (5.38)	2 (2.74)	
	Meat, plant and fish	44 (47.31)	29 (39.73)	
	Poultry, plant and fish	5 (5.38)	2 (2.74)	
Eat whole bread and whole grain cereals	Always	6 (6.45)	2 (2.74)	1.067
	Sometimes	16 (17.20)	19 (26.03)	0.587
	Never	71 (76.34)	52 (71.23)	
Food types	Most carbohydrates, protein and fat	23 (24.73)	11 (15.07)	7.221 0.065
	Balance diet	27 (29.03)	19 (26.03)	
	Mostly vegetable, protein & small carbohydrate	19 (20.43)	26 (35.62)	
	Mostly carbohydrates and small protein	24 (25.81)	17 (23.29)	
	Others	0 (0.00)	0 (0.00)	

Table 5. Multinomial logit regression model of Type 2 diabetes schemes

Model		**I**			**II**			**III**		
Independent variables		ME	RRR	*p*-value	ME	RRR	*p*-value	ME	RRR	*p*-value
Age		0.84	2.31	***	0.83	2.30	***	0.87	2.38	***
Level of education		-0.21	0.81		-0.21	0.81		-0.26	0.77	*
Sex		-1.06	0.35	*	-1.08	0.34	*	-1.02	0.36	*
Level of income		-0.15	0.86		-0.13	0.87		-0.11	0.90	
Dietary habit		0.07	1.08		0.03	1.03		-0.02	0.98	
Alcohol consumption		0.77	2.16	*	0.79	2.20	**	0.78	2.18	**
Diabetes history in family		0.44	1.56		0.49	1.63		0.53	1.70	
Smoking		-0.87	0.42		-0.92	0.40	*	-0.97	0.38	*
Eating frequency		-0.54	0.58		-0.57	0.57	*	-0.55	0.58	*
Frequency of eating white rice		-1.24	0.29	*	-1.14	0.32	*	-1.08	0.34	*
BMI		0.19	1.20		0.23	1.25		0.24	1.28	
Therapeutic education		-1.32	0.27	*	-1.34	0.26	*	-1.15	0.32	*
Monitoring Blood sugar level		-0.46	0.63	*	-0.41	0.66		-0.35	0.70	
Exercise frequency		0.00	1.00		0.16	1.18				
Frequency of eating fruits or vegetable		-0.25	0.78		-0.12	0.89				
Diabetes self-education		0.29	1.33		0.33	1.39				
Cooking method		0.11	1.12		0.11	1.12				
Ethnic group		0.12	1.12		0.12	1.13				
Job type		0.05	1.05		-0.04	0.96				
Kind of oil used		0.20	1.23							
Poultry preparation		-0.54	0.58							
Source of protein		-0.23	0.79							
Eating whole		0.99	2.70							
Food type		0.02	1.02							
_cons		7.02	1116.13		7.31	1501.05		7.51	1818.69	
	Prob > chi^2	0.00			0.00			0.00		
	Pseudo R^2	0.31			0.29			0.27		
	AIC	219.30			214.51			206.75		
	BIC	298.99			278.25			251.38		

*LR Test model I vs model II (LR chi^2 = 5.21, p = 0.39); LR Test model I vs model III (LR chi^2 = 9.45, p = 0.58); LRTestmodelIIvsmodelIII(LRchi^2 =4.25,p =0.64) *, **, and *** indicate p < 0.05, p < 0.01, p < 0.001 significant levels, and non-significant, respectively (Z-test); ME (Marginal effect), RRR (relative risk ratios), AIC (Akaike's information criterion), and BIC (Bayesian information criterion) Note: No diabetes was select as the base outcome*

Table 6. Ordinary least squares and generalized linear model of the diabetes incidence

Model	OLS			GLM		
	Coef.	SE	*p*-value	Coef.	SE	*p*-value
Age	0.14	0.03	***	0.06	0.01	***
Level of education	-0.05	0.02	**	-0.02	0.01	**
Sex	-0.16	0.07	*	-0.06	0.03	*
Alcohol consumption	0.13	0.04	**	0.05	0.02	**
Smoking	-0.14	0.08		-0.06	0.03	
Eating frequency	-0.08	0.05		-0.03	0.02	
Frequency of eating white rice	-0.18	0.07	*	-0.07	0.03	*
Therapeutic education	-0.25	0.08	**	-0.10	0.03	**
_cons	3.73	0.42		1.40	0.17	
AIC	217.16			691.92		
BIC	245.85			720.61		

though the results were not statistically significant, it was observed that diabetics better manage the disease with respect to food type. This result is in line with studies carried out by Post et al., [49] which suggest that increasing dietary fiber in the diet of patients with type 2 diabetes is beneficial and should be encouraged as a disease management strategy. The reason for our result may be due to the fact that, there is the availability of a wide range of variety of vegetables which is sold at a cheaper cost in the local markets. More so, with respect to eating whole bread and whole grain cereals (Table 4), it was observed that, 71.23% do not eat whole bread and whole grain cereals and 28.77% of the diabetics eat whole bread and whole grain cereals. Out of this 28.77%, 2.27% eat whole bread and whole grain cereals. This may be due to lack of knowledge on the role of fibers within insulin sensitivity and glucose tolerance, and the impact on intestinal tract time. Management of diabetes with cooking oil (Table 4) shows that, 68.49% manage their status with consumption of palm oil, 13.70% use bleached palm oil, 12.33% use other oils and 5.48% (least) used soy beans oil. It was observed that majority managed the disease with consumption of palm oil, and a minority with consumption of vegetable oil. This may be due to the fact that, palm oil is readily available and the cost of purchase is less hence making it available to all groups of people. An Iran case-control study of 300 middle-aged participants found that high intakes of fruits and vegetables, or total fruit intake decreased the odds of developing prediabetes [50]. Another Chinese cross-sectional study showed that, diets rich in vegetables and moderate animal-sourced food items related to a lower prevalence of glucose tolerance abnormality in Chinese adults [51]. Furthermore, according to ADA [52] palm oil contains saturated fat whose intake must be reduced so as to maintain a reduced plasma low density lipoprotein cholesterol level.

3.4.4 Multivariable multinomial logistic model

The outcomes of the Multinomial logit regression showing the impact of the explanatory variables on the likelihood that respondent have diabetes are showed in Table 5. The conceptual model was revised based on the results of this model and significant predictors. The factors that had statistically significant association with diabetes. However, stronger associations were observed for some of the predictors of diabetes. Models I, II and III comprised the same covariates variables excluding the occurrence of Job type, Kind of oil used, Poultry preparation, Source of protein, Eating whole and Food type for models II and III, as well as Exercise frequency, Frequency of eating fruits or vegetable, Diabetes self-education, cooking method, Ethnic group and Job type for model III. Based on the AIC and BIC, the model III, including 13 variables was found to be the most suitable to depict the current relationship between the socio-economic, health and demographic characteristics and the occurrence of diabetes. This statement was buttressed by the non-significance of the likelihood ratio test amongst the three models. This shows that adding variables on the model I is not statistically needed to determine the variables that are most significant for the occurrence of diabetes in the population. Therefore, as shown in Table 5 the estimated marginal effects revealed that the increase in age (Marginal effect (ME=0.84; $p < 0.001$) and alcohol consumption (ME=0.77; $p<0.05$) were significantly positively associated to the incidence of diabetes. Whereas, the level

of education, the sex, smoking, frequency of eating white rice, eating frequency, Monitoring Blood sugar level and therapeutic education significantly reduce the likelihood of being diabetic ($p < 0.05$). According to this study, the more you are getting older, the more you possess the risk of having diabetes. From the analysis result of Monitoring Blood sugar level, it is observed that the higher education one has, the more he/she checks blood glucose level. Hence, older people are 2.38 times more likely to develop diabetes, whereas the level of education reduce of 0.77 odds the probability to have diabetes. This may be due to the fact that educated people tend to belong to "rich" group and their job is usually desk-based. Moreover, alcohol consumption is 0.77 time to increase the risk to develop diabetes. A prevalence study in Florida [53] estimates of self-reported diabetics to be 10.4% (95% confidence interval [95% CI]: 9.8, 11.1). This finding is consistent with reports by the CDC 2015 illustrating an increasing trend in prevalence of both conditions over the past decade. Increase in age increases the frequency of checking blood glucose level. Furthermore, diabetes patients having higher body weight have more tendencies to check their glucose level [54].

The results of the generalized linear model (GLM) and Ordinary least square model (OLS) models computed to investigate the relationship between the incidence of diabetes and population's socio-economic, health and demographic characteristics are presented in Table 6. Based on the AIC and BIC performed using the estat ic based on the likelihood, the OLS (217.16 and 245.85) was noted to be the most adequate to determine the population's features mainly responsible for incidence of diabetes compare to GLM (691.92 and 720.61). Hence the significant predictive variables of the occurrence of diabetes were found to be age, level of education ($p<0.001$), therapeutic education, alcohol consumption ($p<0.01$), sex, and frequency of eating white rice ($p<0.05$). This agrees with the founding of Okwechime et al [55] who showed that the risk of diabetes increased with increasing age, lower income, in males, and physical inactivity. Insufficient physical activity had no significant association with the risk of diabetes or pre-diabetes.

4. CONCLUSION

Our findings indicate that, the overall prevalence of diabetes in the study was 43.98%. The results show that, there was an increasing trend in the prevalence of diabetes but the increase was not statistically significant. Age, level of education, dietary habit, and alcohol consumption were found to influence the prevalence of diabetes with significant levels. Though sex did not influence the prevalence of diabetes, it was observed that there were more diabetic males than females. The results show a correlation between level of education and BMI, level of education and job type. However, management of diabetes with respect to education on the disease and monitoring of blood sugar were found to be statistically significant and showed a strong correlation with diabetes prevalence. Education being the back bone of management of diabetes helps subjects to understand the role of exercise to the body, and also to choose their food type wisely, monitor their glucose sugar level to keep it at normal range, thereby helping in the management of the disease. The research variables that have significance, influence and contribution to Multinomial Logistic Modeling are height variables (age, level of education, therapeutic education, alcohol consumption, sex, and frequency of eating white rice) and the rest of the variables have neither significance nor effect. The study have proven that, therapeutic education, and monitoring of blood sugar has a great effect on diabetes management, and so people with diabetes should attend therapeutic programs to be able to have self-care management which is reflected in glycaemia control and thereby hopefully also in morbidity and mortality.

DISCLAIMER

The products used for this research are common and predominantly used in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

Ethical approval and permission were obtained from the National Ethics Committee of Cameroon and the Regional Delegation of Public Health of South West, Cameroon, where an ethical administrative clearance was obtained. All information taken from participants was kept confidential.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Miranda JJ, Barrientos-Gutiérrez T, Corvalan C, Hyder AA, Lazo Porras M, Oni T, Wells J CK. Understanding the rise of cardiometabolic diseases in low- and middle-income countries. Nature Medicine. 2019;25(11):1667-1679.
Available: https://doi.org/10.1038/s41591-019-0644-7.
2. Avilés-Santa ML, Monroig-Rivera A, Soto-Soto A, Lindberg NM. Current state of diabetes mellitus prevalence, awareness, treatment, and control in Latin America: Challenges and innovative solutions to improve health outcomes across the continent. Current Diabetes Reports. 2020;20:62.
Available:https://doi.org/10.1007/s11892-020-01341-9
3. Cristian C. Bases Physiopathologique de la Diététique. Second Edition. Lavoisier;2004.
4. International Diabetes Federation. IDF Diabetes atlas. 7th Edition. Brussels, Belgium: International Diabetes Federation;2015.
5. Milibari AA, Matuure EY, Gadah EM. Prevalence, Determinants and Prevention of Type 2 Diabetes Mellitus (T2DM) in Arabic Countries: A Systematic Review Study. Health Sci J. 2020;14(2):701.
Available:https://doi.org/10.36648/1791-809X.14.2.701
6. American Diabetes Association, ADA. Standard of medical care in Diabetics. Diabetes care. 2010;33:S11-S61.
7. Ceriello A, Colagiuri S. International Diabetes Federation guideline for management of postmeal glucose: a review of recommendations. Diabet Med. 2008;25:1151-1156.
Available:https://doi.org/10.1111/j.1464-5491.2008.02565.x
8. Mbanya JC, Kengne AP, Assah F. Diabetes care in Africa. Lancet. 2006;368(9548):1628-1629.
Available:https://doi.org/10.1016/s0140-6736(06)69673-6
9. Kengne AP, Fezeu L, Sobngwi E, Awah PK, Aspray TJ, Unwin NC, Mbanya JC. Type 2 diabetes management in nurse-led primary healthcare settings in urban and rural Cameroon. Primary Care Diabetes. 2009;3:181-188.
Available:https://doi.org/10.1016/j.pcd.2009.08.005
10. WHO. Global Status Report on Non communicable Disease 2010. Geneva WHO;2011.
Available:https://www.who.int/nmh/publications/ncd_report2010/en/
11. King H, Rewers M. Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. WHO Ad Hoc diabetes reporting group. Diabetes Care. 1993;16(1):157-177.
Available:https://doi.org/10.2337/diacare.16.1.157
12. Li Y, Teng D, Shi X, Qin G, Qin Y, Quan H, Shi B, Sun H, Ba J, Chen B, Du J, He L, Lai X, Li Y, Chi H, Liao E, Liu C, Liu L, Tang X, Tong N, Wang G, Zhang J, Wang Y, Xue Y, Yan L; Yang J, Yang L, Yao Y, Ye Z, Zhang Q, Zhang L, Zhu J, Zhu M, Ning G, Mu Y, Zhao J, Shan Z, Teng W, The highest prevalence of diabetes recorded in mainland China: A national epidemiologic survey. SSRN Electronic Journal;2019.
Available:http://dx.doi.org/10.2139/ssrn.3411053
13. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, Malanda B. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes research and clinical practice. 2018;138:271-281.
Available:https://doi.org/10.1016/j.diabres.

2018.02.023
14. Danish Health Technology Assessment (DHTA). Type 2 Diabetes Health Technology Assessment of screening, Diagnosis and Treatment; 2005. Available:https://database.inahta.org/article/5447
15. Peter A, Katleen M, Botham M. Lipid transport and storage. Harpers illustrated Biochemistry. 26th Ed McGraw Hill. 2003;25:205.
16. Hendrickson D, Smith C, Eikenberry N. Fruit and vegetable access in four low-income food deserts communities in Minnesota. Agriculture and Human Values. 2006;23:371-383. Available:https://doi.org/10.1007/s10460-006-9002-8
17. Echouffo-Tcheugui J, Kengne AP. Chronic non-communicable diseases in Cameroon-burden, determinants and current policies. Globalization and Health. 2011;7:44. Available:http://www.globalizationandhealth.com/content/7/1/44
18. Mackenbach JP, Stirbu I., Roskam AR. Schaap M, Menvielle G, Leinsalu M., and Kunst AE. Socioeconomic Inequalities in Health in 22 European Countries. The New England Journal of Medicine. 2008;358(23):2468-2481.
19. Wilkinson RG, Pickett KE. Income inequality and population health: a review and explanation of the evidence. Social Science & Medicine. 2006;62(7):1768-1784. Available:https://doi.org/10.1016/j.socscimed.2005.08.036
20. Busse R, Blumel M, Scheller-Kreinsen D, Zentner A. Tackling chronic diseases in Europe, strategies, Interventions and challenges;2010.
21. Tanya ANK, Lantum DN, Tanya VN. Nutrition and puplic health in Cameroon; combating the crises. Cameroon Academy of Sciences, Yaounde, Cameroon;2011.
22. Awah KP. Treating Diabetes in Cameroon: A comparative study n Medical anthropology. PhD Thesis University of Newcastle upon Tyne;2005.
23. Nkongho AE, Kumah D, Mohammed AK. Prevalence of visual impairment among diabetic patients in the Kumba urban area, Cameroon. International Journal of Innovation and Applied Studies. 2016;(15):872-876.
24. Böhning, D. Multinomial logistic regression algorithm. Annals of the institute of Statistical Mathematics. 1992;44(1):197-200.
25. Berhanie H, Mihretie Z, Anandapandian KT. Association between socio-demographic factors and blood groups with risk of diabetes mellitus in Dangila hospital, Awi Zone, North West Ethiopia. Indian J Med Sci. 2019;71(2):82-7. DOI:10.25259/IJMS_21_2019
26. Alva ML, Hoerger TJ, Zhang P, Gregg EW. Identifying risk for type 2 diabetes in different age cohorts: does one size fit all? BMJ Open Diabetes Research and Care. 2017;5:e000447. Available:http://dx.doi.org/10.1136/bmjdrc-2017-000447
27. Debrah A, Godfrey O. M, Ritah K, Prevalence and Risk Factors Associated with Type 2 Diabetes in Elderly Patients Aged 45-80 Years at Kanungu District", Journal of Diabetes Research. 2020;2020(5152146):5. Available:https://doi.org/10.1155/2020/5152146
28. Maty SC, Everson-Rose SA, Haan MN, Raghunathan TE, Kaplan GA. Education income, occupation, and the 34years incidence (1965–99) of T2D in the Alameda country Study. Journal of Internal Epidemiology. 2005;34(6):12741281. Available:https://doi.org/10.1093/ije/dyi167
29. Agardh EE, Sidorchuk A, Hallqvist J, Ljung R, Peterson S, Moradi T, Allebeck P. Burden of type 2 diabetes attributed to lower educational levels in Sweden. Popul Health Metrics 2011;9:60. Available:https://doi.org/10.1186/1478-7954-9-60
30. Braverman-Bronstein A, Hessel P, González-Uribe C, Kroker MF, Diez-Canseco F, Langellier B, Lucumi DI, Rodríguez Osiac L, Trotta A, Diez Roux AV.. Association of education level with diabetes prevalence in Latin American cities and its modification by city social environment. J Epidemiol Community Health. 2021;jech-2020-216116. Available:https://doi.org/10.1136/jech-2020-216116
31. Anisyah A. Fatchur RLS Wanda F O, Laksmi S. The relationship between the level of education and accuracy of insulin injection techniques in DM patients with measurement of HbA1c values. Journal of Basic and Clinical Physiology and Pharmacology. 2019;30:6.

Available:https://doi.org/10.1515/jbcpp-2019-0303

32. Tanya V.N. and Mbah D.A. Exploring opportunities to reduce food insecurity in the Sudano-sahelian zone of Cameroon. Forum Summary, Cameroon Academy of Sciences, Yaounde, Cameroon;2009.
33. Kumar Das S and Elbein S C. The genetic bases of type 2 diabetes; Cell science. 2006;2(4):100-131.
Available:https://dx.doi.org/10.1901%2Fjaba.2006.2-100
34. Cooper R, Rotimi C, Kaufman J, Owoaje E, Fraser H, Forester T, Wilks R, Riste LK, Cruikshank JK. Prevalence of NIDDM among Populations of the African Diaspora. Diabetes Care. 1997;20:343-348.
Available:https://doi.org/10.2337/diacare.20.3.343
35. Sobngwi E, Mbanya JC, Unwin NC, Porcher R, Kengne AP, Fezeu L, Minkoulou EM, Tournoux C, Gautier JF, Aspray TJ, Alberti K. Exposure over the life course to an urban environment and its relation with obesity, diabetes, and hypertension in rural and urban Cameroon. Int J Epidemiol. 2004 ;33(4):769-776.
Available:https://doi.org/10.1093/ije/dyh044
36. Malik, V. S., Popkin, B.M., Bray, G.A., Pespres, J. P., Willet, W. B., Hu, F. B. Sugar sweetened beverage and risk of metabolic syndrome and type 2 diabetes. A meta-analysis. Diabetes care. 2010;33(11):2477-2483.
Available:https://doi.org/10.2337/dc10-1079
37. Volaco A, Ercolano CR. Alcohol consumption and its relationship to diabetes mellitus: friend or foe? Endocrinol Metab Int J. 2018;6(1):28-31.
Available:https://doi.org/10.15406/emij.2018.06.00150
38. Howard A.A., Arnsten J H., Gourevitch M N. Effect of Alcohol Consumption on Diabetes Mellitus. A Systematic Review. Annals of Internal Medicine. 2004; 140(3):211-219.
Available:https://doi.org/10.7326/0003-4819-140-6-200403160-00011
39. Levitt NS, Katzenellenbogen JM, Bradshaw D, Hoffman MN, Bonnici F. The prevalence and identification of risk factors for NIDDM in urban Africans in Cape Town, South Africa. Diabetes Care. 1993;16(4): 601-7.
Available:https://doi.org/10.2337/diacare.16.4.601
40. Mohan V, Shanthirani CS, Deepa M, Deepa R, Unnikrishnan RI, Datta M. Mortality rates due to diabetes in a selected urban south Indian population--the Chennai Urban Population Study [CUPS-16]. J Assoc Physicians India. 2006;54:113-117.
41. Ronnemaa, T., Puukka, P., Pyorala, K and Laakso, M. Smoking is independently associated with high plasma insulin levels in nondiabetic men. Diabetes care. 1996;19(11):1229-1232.
Available:https://doi.org/10.2337/diacare.19.11.1229
42. Eliasson B. Cigarette smoking and diabetes. Prog Cardiovasc Dis. 2003; 45(5):405-413.
Available:https://doi.org/10.1053/pcad.2003.00103
43. Xie XT, Liu Q, Wu J, Wakui M. Impact of cigarette smoking in type 2 diabetes development. Acta Pharmacol Sin. 2009;30(6):784-787.
https://dx.doi.org/10.1038%2Faps.2009.49
44. Chuang LM, Tsai ST, Huang BY, Tai TY. The DIACARE (Taiwan) study group. The current state of diabetes management in Taiwan. 2001;54Suppl1:S55-65.
Available:https://doi.org/10.1016/s0168-8227(01)00310-2
45. Tai ES, Goh SY, Lee JJ, Wong MS, Heng D, Hughes K, Chew SK, Cutter J, Chew W, Gu K, Chia KS, Tan CE. Lowering the criterion for impaired fasting glucose: impact on disease prevalence and associated risk of diabetes and ischemic heart disease. Diabetes care. 2004;27(7):1728-1734.
Available:https://doi.org/10.2337/diacare.27.7.1728
46. Polikandrioti M, Dokoutsidou H. The role of exercise and nutrition in type II diabetes mellitus management. Health Sci J. 2009;3:216-221.
47. Gagliardino JJ, Chantelot JM, Domenger C, Ramachandran A, Kaddaha G, Mbanya J C, Shestakova M, Chan J. Impact of diabetes education and self-management on the quality of care for people with type 1 diabetes mellitus in the Middle East (the International Diabetes Mellitus Practices Study, IDMPS). Diabetes Research and Clinical Practice. 2019;147:29-36

Available:https://doi.org/10.1016/j.diabres.2018.09.008

48. Rasoul AM, Jalali R, Abdi A, Salari N, Rahimi M, Mohammadi M. The effect of self-management education through weblogs on the quality of life of diabetic patients. BMC Med Inform Decis Mak. 2019;19:205.
Available:https://doi.org/10.1186/s12911-019-0941-6
49. Post RE, Mainous AG. 3rd, King DE, Simpson KN. Dietary fiber for the treatment of type 2 diabetes mellitus: a meta-analysis. Journal of the American Board of Family Medicine: JABFM. 2012;25(1):16-23.
Available:https://doi.org/10.3122/jabfm.2012.01.110148.
50. Safabakhsh M, Koohdani F, Bagheri F, Siassi F, Khajehnasiri F, Sotoudeh G. Fruit and vegetable intake and pre-diabetes: a case–control study. Eur J Nutr. 2018;57(8):2953–2962.
Available:https://doi.org/10.1007/s00394-017-1569-x
51. He Y, Ma G, Zhai F, Li Y, Hu Y, Feskens EJM, Yang X. Dietary patterns and glucose tolerance abnormalities in Chinese adults. Diabetes Care. 2009 ;32(11):1972–1976.
Available:https://doi.org/10.2337/dc09-0714
52. American Diabetes Association, ADA. Medical care in Diabetes. Position statement Diabetes Care.2007; 30(Supplement.1):S4– S41.
53. Logan H, Guo Y, Dodd VJ, Muller K, Riley J. The burden of chronic diseases in a rural North Florida sample. BMC Public Health. 2013;13:906.
Available:https://doi.org/10.1186/1471-2458-13-906
54. Mohammad AU. Exploring the Risk Factors of Diabetes in Dhaka City: Negative Binomial Regression & Logistic Regression Approach. Saudi Journal of Medical and Pharmaceutical Sciences. 2020;753-758.
DOI:10.36348/sjmps.2020.v06i12.006
55. Okwechime IO, Roberson S, Odoi A. Prevalence and Predictors of Pre-Diabetes and Diabetes among Adults 18 Years or Older in Florida: A Multinomial Logistic Modeling Approach. PLoS One. 201:5; 10(12):e0145781.
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