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Assessing the Prevalence and Predictors of Type 2 Diabetes Mellitus among Rural Dwellers in Akamkpa/Biase Federal Constituency of Cross River, Nigeria.

Ekpe E.L.[1*], *Ekpe Edemekong*[2], *Omotoso A.J.*[3], *Inaku K.O.*[1]

[1]*Department of Chemical Pathology and Immunology, University of Calabar, Calabar, Nigeria*
[2]*Department of Mass Communication, University of Calabar, Calabar, Nigeria*
[3]*Department of Pathology, University of Calabar, Calabar, Nigeria*

Abstract

Background: The increased prevalence of diabetes mellitus (DM) continues to be a public health concern globally. DM data from the rural settings in Cross River State are scanty. This study aimed to determine the prevalence of DM and assess the predictors and factors enhancing the increased prevalence among rural dwellers in Cross River State of Nigeria.

Methodology: This study was a community-based cross-sectional study, comprising male and female adults aged 18 and 75 years, over a period of four months. Appropriate anthropometric measurements and blood samples were collected from willing recruited participants, and fasting plasma glucose and glycated hemoglobin (HbA1C) values were obtained after obtaining informed consent and ethical approval. Confidentiality was maintained throughout the study period, and data were analysed using the Statistical Package for Social Science (SPSS SPSS software.

Results: A total of 369 respondents participated in this study and were made up of 136(36.8%) males and 233(63.2%) females. The mean age(years) of respondents was 45±10.3. Using the ADA diagnostic criteria for diabetes mellitus and prediabetes, a prevalence of 6.8% and 12% respectively. The prevalence of DM obtained was higher in males (11.8%) than in females (3.8%) ($p<0.05$). Increased prevalence of DM was seen in those whose BMI was high ($p<0.005$). About 60% of the people found to be diabetic were not aware of their diabetic condition. Top predictors of the occurrence of DM among the participants were positive family history of DM (OR=3.99, CI=0.50-0.67,$p<0.001$), increasing age (OR=3.89; CI=0.73-9.21,$p<0.001$), increasing BMI/obesity (OR=3.87; CI=0.66-9.25,$p<0.001$), and family history of hypertension (OR=3.86; CI=0.45-7.89, $p<0.001$).

Conclusion: There is a high prevalence of DM in rural settings that tends to match urban prevalence, and many affected people are unaware of their situation. This calls for public health attention in this regard.

Keywords: rural, diabetes, prediabetes, predictors, prevalence, Nigeria

Introduction

Globally, contemporary medical practice is plagued with sustained and recurrent cases of non-communicable diseases (NCD)[1]. NCDs are major concerns because of their impact on mortality and morbidity. These include cancers, diabetes mellitus, cardiovascular diseases, chronic obstructive pulmonary diseases and others.[1,2]

Corresponding Author:

Lawson Ekpe
Department of Chemical Pathology and Immunology, University of Calabar, Calabar, Nigeria.

lawsonekpe2002@yahoo.com

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Diabetes mellitus (DM) is increasing at an alarming rate and has been recognized as one of the leading causes of death and disabilities worldwide.[3] DM was estimated to cause four million deaths globally in 2017.[4] Currently, about half a billion people are living with DM globally, and the number is projected to increase by 25% in 2030 and 51% by 2045.[5] DM is a major health problem in Nigeria and worldwide. In Nigeria, it is estimated that about 7-8% (11.2 million people) are living with DM, accounting for several deaths linked to NCD.[1,3,6] In this era of global attention to non-communicable diseases, diabetes mellitus (DM) stands out on the list, with more than 80% of these coming from low and medium-income countries of the world. One in two (50.1%) people living with DM do not know they have DM[7]. The high prevalence of diabetes, especially among the aging population, comes at a considerable cost. Between 2004 and 2010, an estimated 3.4 million people died as a result of the consequences of high blood glucose[2,8]. It is a major cause of blindness, kidney failure, heart attack, stroke, heart failure, coronary artery disease, and lower limb amputation.[9] More than two-thirds (69.2%) of adults are currently living with diabetes mellitus, and they are unaware of their condition.[7] The diabetes statistics of the International Diabetes Federation (IDF) show that Nigeria has the highest number of people living with diabetes and impaired fasting glucose in Africa[6]. Global prevalence of DM in rural areas is 7.2%[3,5].

These facts raise an urgent need to further assess the impact of diabetes on the lives of people living in rural areas. DM contributes to medical morbidity and mortality, especially in developing countries like Nigeria. This enormous scourge has found its bearing in rural villages in all the geo-political zones in Nigeria, as the prevalence of DM in most of these is at ceiling values.[8]

There is a sudden surge in the prevalence of diabetes among people living in rural areas.

Pooled estimates show a relatively high burden of diabetes in rural areas. This calls for urgent attention and intervention. One study showed that the prevalence of diabetes mellitus is approximately 17% higher in rural areas than in urban areas[11]. Again, further studies show that persons in rural areas with DM have higher morbidity from diabetes-related complications than urban persons with DM[10]. Unfortunately, many rural areas lack statistics to illustrate the extent of this problem. This is so, as little or no scientific study has been done in these areas to show this. This is the basis of the research, in a bid to uncover the medical statistics surrounding rural-based diabetes prevalence, with a view to enhancing early intervention. This high prevalence, if not checked, will lead to micro- and macro-vascular complications such as nephropathy, neuropathy, retinopathy, coronary artery disease, stroke, and death. This menace is causing an alarming rise in diabetes-related deaths. This appears as a time bomb waiting to explode, as most rural settings are already battling with a huge burden of communicable diseases.

Hence, it is important to plan urgent primary and secondary prevention strategies to minimize further increases in areas with a high prevalence of diabetes mellitus in rural settings. The paucity of data and research findings is the motivation for this research. We hypothesize that there could be a high prevalence of DM among adult residents of rural communities in Akamkpa/Biase Federal Constituency of Cross River State.

The aim is to determine the prevalence of DM in 8 rural communities of Akamkpa/Biase Federal Constituency and to locate the socio-demographic characteristics of the study participants, to determine the independent risk factors for T2DM, and to ascertain the risk factors involved. To the best of our knowledge, there is currently no study assessing the prevalence of DM in rural areas of Akamkpa/Biase Federal Constituency, hence the rationale for this study.

Again, further studies show that persons in rural areas with DM have higher morbidity from diabetes-related complications than urban persons with DM[8]. No current or previous study has been done in Akamkpa/Biase Federal Constituency of Cross River State, in this regard. The paucity of data and research findings is the motivation for this research. We hypothesize that there could be a high prevalence of DM among adult residents of rural communities in Akamkpa/Biase Federal Constituency of Cross River State.

Materials and methods

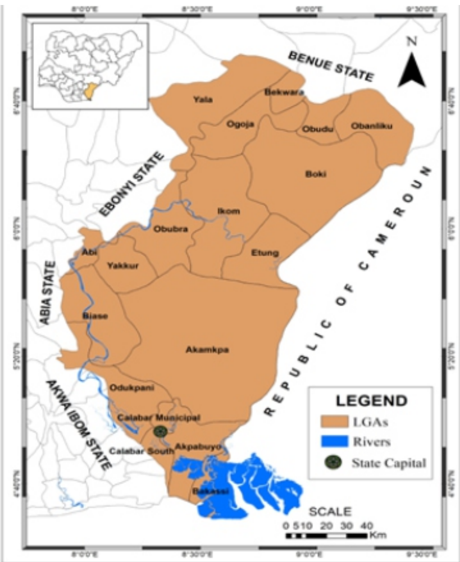
Study Design

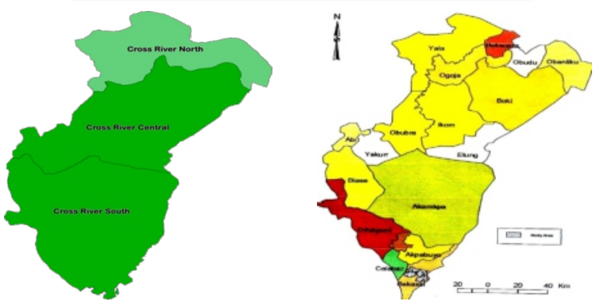
This study was a community-based cross-sectional study, comprising male and female adults aged 18 to 70 years residing in rural areas of the southern senatorial district of Cross River State of Nigeria. This was done between March 2025 and June 2025.

Study Area

The Akamkpa/Biase federal constituency lies in the southern senatorial district (see map)

These two towns are made up of several villages and settlements. Both Akamkpa and Biase indigenes are mainly peasant farmers and petty traders. A few folks here are known to be fishermen. These areas are highly underdeveloped, with many people living in poverty, ignorance, and have limited access to healthcare. They have a combined land mass of 9300 square meters and a combined population of about 548,000 people. Both experience high rainfall, with annual precipitation ranging from 1,963 to 3,143 mm.[12] The average annual temperature is between 27-33°C, and the relative humidity is high, ranging from 80-90%. Both also experience a tropical monsoon climate with distinct wet and dry seasons.[2] The most advanced form of medical care for this staggering population is the presence of one general hospital that covers the whole senatorial district, which is grossly inadequate.





Four rural villages each from Akamkpa and Biase towns, were selected using simple random sampling technique, making a total of 8 villages selected.

Blood sample collection

A total of 5 trained health workers were used for sample collection and testing: 2 phlebotomists,1 lab technician, and 2 research assistants. About 10 days before the field work, massive information sharing and sensitization were done via the village heads and chiefs, youth leaders, church leaders, and town criers. Various WhatsApp platforms for the educated people who had Android phones were fully mobilized as well. The aim was to boost the publicity and create optimal awareness regarding this exercise. After obtaining consent and observing an overnight fast of 9-12 hours as instructed the previous day, blood samples were collected from each participant using an aseptic technique. This involved swabbing the identified venous site (usually the cubital fossa). Using a 5ml syringe, 5ml of blood was collected by backflow pressure, and 2mls were put into a sample bottle containing fluoride oxalate for fasting plasma glucose analysis. And then 3mls were fixed in an EDTA bottle for glycated hemoglobin assay. All patients had urinalysis done on them to check for the presence of glycosuria. The blood samples were later transported to Calabar after 2hours, and each sample was centrifuged at 25degrees (room temperature), and at 3000 revolutions per minute for over 15 minutes to separate blood cells from plasma.

Measurement of the blood glucose and its interpretation

The glucose oxidase method was used in the glucose samples based on the principle that glucose oxidase is the most specific enzyme reactive with -D-glucose. It converts -D-glucose to glucuronic acid and hydrogen peroxide, which, on conjugation with peroxides, reacts with chloro-4-phenol and 4-aminoantipyrene to form a red quinomemine. The absorbance of the coloured complex is directly proportional to the amount of glucose in the sample. This was measured spectrophotometrically at a wavelength of 500nm. Using the America diabetes Association (ADA) criteria, a glucose value of 3.5-55 mmol/L was considered normal; 5.6-6.mol/L was considered to be impaired fasting glucose (IFG), which is a form of prediabetic condition. Furthermore, hemoglobin A1C values of between 5.7 and 6.4 were considered prediabetic according to the ADA. However, in making a diagnosis of diabetes mellitus, the ADA and World Health

Organization (WHO) reference cut-offs were set at 6.5% and 7%, respectively.[13] The presence of glucose in the urine defines glycosuria in affected patients.

Sample Size (Cochran formula)[14]

$N = Z^2Pq / D^2$

N = Minimum sample size

Z = Standard deviation set at 1.96, which corresponds to a 95% confidence level interval

P = Prevalence of DM (6.9%) among residents in Cross River from a previous Study[15,16]

Q = 1-P

D = Margin of unacceptable error or measure of precision (0.05)

This gives a total of 328 participants.

Giving an allowable 10% margin of error.

This gives a final total of 350 participants for this research.

A total of 390 participated in this study; however, only 369 participants completed the study

Anthropometry measurements

Measurements of weight (to the nearest 0.1kg), height (to the nearest millimetre), and blood pressure were done according to standard guidelines. Body mass index (BMI) was calculated from height and weight. A normal BMI was considered as a value of (18.5-24.9) Kg/m^2; overweight was a BMI of (25-29.9) Kg/m^2, and obesity was defined as a BMI value of ≥ 30 Kg/m^2. This was further classified into obesity class 1 1(30-34.50kg/m^2), obesity class 2(35-39.5kg/m^2), and obesity class3$\geq$40kg/m^2).

Ethical Clearance

Ethical approval was sought and obtained from the Ethical Committee of the Cross River State Ministry of Health(CRS/MH/HREC/2025/Vol 2/108). Informed consent and permission were obtained from all study participants and the local authority concerned, such as the local government leaders of Akamkpa and Biase, as well as the traditional chiefs of the various villages where this study was carried out. For all study participants, informed consent was obtained from them before being enrolled in the study, and each of them signed the consent form. The less educated ones/illiterate ones thumb printed the consent form as a way of approving of their consent. Confidentiality was maintained by excluding the use of participants' names. At the end of the study, those found to be diabetic were counseled and referred for expert management in appropriate health facilities.

Inclusive Criteria

Individuals aged 18years and above in the selected communities, who gave consent for participation, were recruited. They all lived permanently in the areas. Visitors to these areas were excluded from the study

Exclusion Criteria

-Pregnant women

-Age less than 18 Years

-Those who were not residents of these locations.

Residents of these places was defined as those who had lived there consistently for up to one year and still lived there at the time of this study.

Data analysis

The completed questionnaires were manually sorted, coded, and analyzed using the Statistical Package for Social Science (SPSS, Version 20.0, IBM Corp, Chicago, USA). Quantitative data that were normally distributed were expressed as means and standard deviations while categorical data were summarized as frequencies and percentages. The primary outcome variable was blood glucose, while socio-demographic characteristics served as the independent variables. Frequency distribution tables were created, and cross-tabulations were performed to examine the relationships between categorical variables. The level of awareness was analyzed in percentages. Univariate analysis was conducted to assess the relationship between various socio-demographic characteristics and DM. Qualitative/categorical variables were compared using Chi-square or Fisher's exact tests. A p-value of less than 0.05 was considered statistically significant. Risk factors associated with DM (significant p-value (<0.05) in binary univariate logistic regression analysis) were included in a multivariable logistic regression model to identify predictors of DM. The results were presented in tables and charts.

Results

A total of 390 agreed and enrolled to participate in this study, 375 completed the study, while 6 of the questionnaires had incompletely filled data and so were discarded, leaving only 369 participants. This was made up of 136(36.8%) males and 233(63.2%)females(see figure1). The mean age of the participants was 45±10.3 years with an age range of 18-72years. The mean age of the male participants was significantly higher than that of the females (48.4± 11.2 years versus 44.6± 11.4 years ,$p<0.05$).

The age group largely represented in the study was between 40 and 49 years(see Table 1). Study participants showed different educational levels. Most of the participants (132) had primary school attainment as the highest form of education, representing 35.8 % of the study population. Few others had attempted secondary and tertiary education (see Table 1).

Table 1: Sociodemographic Characteristics of Study Population (N = 369)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)			
	<20	7	1.9
	20 29	99	26 8
	30-39	41	11
	40-49	111	30
	50-59	76	20.6
	60-69	35	9.4
	>70	1	0 27
Sex			
	Male	136	36.9
	Female	233	63 1
Education Status			
	Primary	132	35.8
	Secondary	127	34 4
	Tertiary	110	29.8
Monthly Income (Naira)			
	<100.000	158	42.8
	100.000-500.000	132	35.8
	>500.000	79	21 4
Access to Healthcare			
	Yes	112	30.4
	No	257	69 6

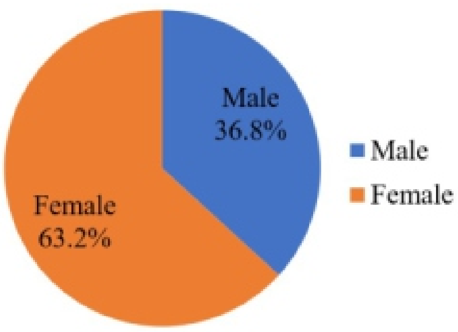


Figure 1: Pie Chart showing the distribution of study participants

Table 2: Clinical Characteristics of Respondents by Glycemic Status

Variable	Normal Glucose	Pre-diabetes	Type 2 Diabetes	p-value
	(n 299)	(n 45)	(n 25)	
	Mean ± SD	Mean ± SD	Mean ± SD	
Demographics				
Age (years)	45.2 ± 16.8	48.6 ± 15.2	52.1 ± 14.9	0.002*
Glycemic Parameters				
Fasting Glucose (mmol/L)	4.8 ± 0.6	6.2 ± 0.4	9.8 ± 4.2	<0.001*
HbA1c (%)	4.6 ± 0.8	6.1 ± 0.6	7.2 ± 3.1	<0.001*
Metabolic Parameters				
BMI (kg/m²)	23 1 ± 4 0	24 2 ± 4 6	24 8 ± 4 8	0 012
Systolic BP (mmHg)	138.5 ± 28.5	145.8 ± 30.1	151.2 ± 32.4	0.003*
Diastolic BP (mmHg)	84.2 ± 16.8	88.6 ± 17.9	91.4 ± 18.2	0.006
Overweight/Obese, n (%)	36 (19.4)	28 (43.8)	42 (35.3)	0.001*

ANOVA for continuous variables, Chi-square for categorical variables.
*statistically significant

On the socioeconomic scale, a large proportion of them(42.8%) earned less than N100,000 (<$65)per month, and more than 69.6% of the study participants had no access to health. The highest form of health care at the time of this research was a Cottage Hospital, located at Akpet in Biase, while Akamkpa has a General Hospital . Of these participants, 220(59.7%) were from Biase LGA and 149(40.3%) were from Akamkpa.

Table 2 shows the means of the ages in the normal, prediabetes, and diabetes groups to be 45±16.8,48.6±15.2, and 52.1±14.9 years, respectively. There was a statistically significant difference among the 3 different groups (p=0.002). A strong observation here is that increasing age tends to switch the participants from normal to prediabetes to diabetes mellitus. Also, the values of the fasting plasma glucose (4.8±0.6,6.2±0.4,9.8±4.2mmol/L) and the glycated hemoglobin (4.6±0.8,6.1±0.6,7.2±3.1%) tend to rise in value from the normal to prediabetic conditions to diabetes mellitus. Both were statistically significant ($p<0.05$ in each case). The systolic blood pressure also tended to be higher in the prediabetic and the diabetic group than in the normal participants(p=0.003). The BMI of the prediabetic and the diabetic groups was more than in

Table 3: Prevalence of Diabetes Mellitus and Pre-diabetic States by Diagnostic Criteria

Diagnostic Criteria	Normal	Pre-diabetes	Diabetes mellitus	Total
Fasting Plasma Glucose (mmol/L) ADA and WHO criteria	3.5-5.5 299(81.3%)	5.5-6.9 45(12%)	≥7.0 25(6.8%)	369(100%)
HbA1C Levels (%) ADA criteria	<6.5 305(82.6%)	5.7-6.4 38(10.2%)	>6.5 27(7.3%)	369(100%)
HbA1C levels (%) WHO criteria	<7.0 299(81%)	5.7-6.4 42(11.4%)	>7.0 28(7.6%)	369 (100%)

*Pre-diabetes if fasting plasma glucose of 5.6-6.9 mmol/L OR HbA1C 5.7-6.4%, ADA=American Diabetes Association, WHO=World Health Organization

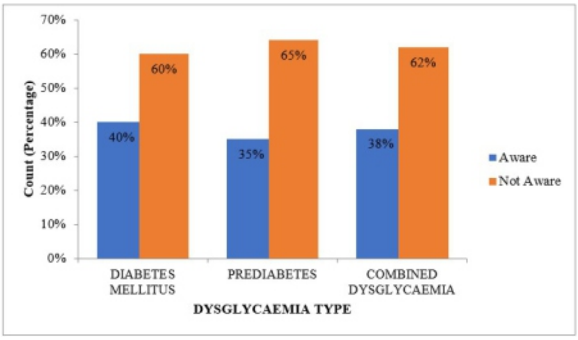


FIGURE 2: Bar Chart showing participants' awareness of their dysglycemic condition

Table 4: Prevalence of Diabetes Mellitus by sex and age

Variable	Frequency (%)
Sex	
Male (n=136)	16 (11.8)
Female (n=233)	9 (3.8)
Both Males and Females (n=369)	25 (6.8%)
Age (years)	
<20 (n=7)	0 (0)
20 – 29 (n=99)	2 (2.0)
30 39 (n 41)	2 (4.8)
40 – 49 (n=111)	6 (5.4)
50 – 59 (n=76)	14 (18.4)
60 69 (n 35)	1 (2.9)
70 (n=1)	0(0)

the normal group(p=0.001). The difference in both were statistically significant.

From the study, using the ADA and WHO diagnostic criteria for both prediabetes and diabetes mellitus, it was found that 25 people (6.8%) out of the total participants were found to be diabetic(FPG was greater than 7mmol/L/L). In the same vein, using HbA1C as the diagnostic criterion, this gave a prevalence of 7.3%(accounting for 26 people), while the WHO criterion gave a prevalence of 7.6%(accounting for 28people)(See Table 3). Similarly, the prevalence of prediabetes(using FPG), was 12%, while it was 10.2%(Using HbA1C under ADA criteria) and 11.4%(using HbA1C under WHO criteria)(See Table 3). Hence, the prevalence of DM was 6.8%(using fasting plasma glucose) and 7.3% (using glycated hemoglobin), while the prevalence of prediabetes was 12% and 10.2% respectively, using fasting plasma glucose and glycated hemoglobin(Table 3).This prevalence of DM was significantly higher in males(11.8%) than in females(3.8%)($p<0.05$)(See Table4). The age bracket affected most by this high prevalence of DM and prediabetes was 50-59 years(See Table 4 and Table 5). Increased prevalence of DM was seen in those whose BMI was high, but more in situations with higher BMI-35-39.9kg/m^2, and those 40kg/m^2(In each case, the prevalence of DM was 28%).

Despite this high prevalence, it is shown in this study that 60% of the people found to be diabetic were not aware of their dysglycemic condition, also,

Table 5: Demographic Factors and the Risk of Diabetes of Participants

Age	Diabetic	Non-diabetic	p-value
	n, (%)	n, (%)	
20 – 29	0 (0)	5 (97.9)	p<0.05*
30 – 39	2 (2.0)	97 (98.0)	
40 – 49	2 (4.8)	35 (85.4)	
50 – 59	6 (5.4)	62 (87.4)	
60 – 69	14 (18.4)	34 (97.2)	
70	1 (0.0)	1 (100.0)	
Sex			
Male	16 (64.0)	120 (34.9)	P<0.05*
Female	9 (36.0)	224 (65.1)	
BMI			
18.5 – 24.9 (Normal)	0 (0.0)	161 (43.8)	P<0.001*
25 – 29.9 (Overweight)	2 (8.0)	90 (24.5)	
30 (Obesity)	4 (16 0)	10 (10 8)	
30 34 5 (Obesity class I)	5 (20 0)	26 (7 1)	
35 39 (Obesity class 2)	7 (28 0)	30 (8 1)	
≥40(Obesity class 3)	7 (28 0)	22 (5 9)	

*=statistically significant p value

Table 6: Regression Statistics to determine the common predictors and risk factors of DM in the study

Variable	DM (n 25), (%)	Normal (n 344), (%)	Odds Ratio	95% CI	p-value
Age (Years)					
<40yrs	4 (16)	143 (41.6)	3.89	(0.73–9.21)	p<0.001*
> 40	21 (84)	201 (58.4)	Ref		
Sex					
Male (n=136)	16 (64)	120 (34.9)	2.3	0.75–7.45	p<0.001*
Female (n=233)	9 (36)	224 (65.1)	Ref		
BMI (kg/m^2)					
<25	2(8)	367	Ref	0.66–9.25	p<0.001*
≥ 25	23 (92)	346	3.87		
Hypertension					
YES	18 (72)	110 (298)	3.86	0.45–7.89	p<0.001*
NO	7 (28)	259 (70.2)	Ref		
Sedentary lifestyle or Physical Inactivity					
YES	15 (60)	267 (72.4)	2.53	0.60–6.79	p<0.05*
NO	10 (40)	102 (27.6)	Ref		
Excess Alcohol Intake					
YES	3 (12)	76 (20.6)	1.15	0.31 5.31	p 0.340
NO	22 (88)	293 (79.4)	Ref		
Stress					
YES	10 (40)	120 (32.5)	2.2	0.63–8.62	p<0.05*
NO	15 (60)	240 (67.5)	Ref		
Family History of DM					
YES	5 (26)	30 (9.1)	3.99	0.50 7.92	p<0.001*
NO	20 (50)	300(90.9)	Ref		
Smoking					
YES	1 (4)	5 (1.4)	1.21	0.13–5.93	p=0.467
NO	24 (96)	364 (98.6)	Ref		

Ref Reference values; * significant p value another 60% were not aware that they had prediabetes, and about 62% were not aware of their combined dysglycemic condition. They were being diagnosed with these conditions for the first time.

In this study, top predictors of the occurrence of DM among the participants were positive family history of DM(OR=3.99, CI=0.50-0.67,p<0.001), increasing age(OR=3.89; CI=0.73-9.21,p<0.001), increasing BMI/obesity(OR=3.87; CI= 0.66-9.25,p<0.001), and family history of hypertension(OR=3.86; CI=0.45-7.89,p<0.001) whose odds ratios are very high and predict the outcome of diabetes of almost four times in each of the mentioned conditions above(p<0.001). Physical inactivity (OR=2.5; CI=0.6-6.79), male sex(OR=2.3; CI=0.75-7.45), and stress (OR=2.2; CI=0.63-8.62) were able to predict the outcome of DM twice as independent risk factors(p<0.05). Tobacco smoking and alcohol intake were not so pronounced as independent risk factors (p=0.467 and 0.340, respectively)(see Table 6).

Discussion

In recent times, staggering statistics about diabetes mellitus have been emerging with a surging trend globally. DM is the 7th leading cause of death globally. In Nigeria, the prevalence of DM in both urban and rural dwellings is at an alarming rate. Though regional differences exist about the prevalence of DM in Nigeria, however, some locations have recorded as high as 11% while others have a very safe margin[17]. The prevalence is considered to be very high in South-South Nigeria and then reduced in the Northern part of Nigeria [6,18,19]. Much has been documented about DM in urban settings, with little written about DM in rural environments. This study, therefore, focuses on diabetes in rural settings.

From this study, most people tend to have a high prevalence of DM and prediabetes in the 4th decade of life. Our study showed that the trends agree with many other previous studies regarding this. Increasing age has been very much associated with an increasing tendency or risk factor for DM and prediabetes.[20,21,22,23] Local studies done in Nigeria also agree with this trend of increasing age leading to an increased possibility of becoming diabetic.[24,25,26]

Also, from the study, many of the participants did not go beyond primary school. Usually, a poor educational background is associated with ignorance, lack of awareness, and poverty, which may all contribute in the long run to poor health status, including DM. This notion agrees with other authors who also suggest that a lower educational level is directly linked to DM.[27,28] However, other authors do not agree with this belief. They say that educational attainment has no impact on glucose control.[29] Yet, other researchers opine that higher education level attainment is associated with a greater likelihood of early DM, enhancing the incidence of complications.[29]

There was also an increased blood pressure among some diabetic patients. Increased blood pressure has been known to be associated with DM. Many DM patients have hypertension.[30,31,32]

In the same vein, most of the DM patients were obese. This agrees with the fact that increased BMI is linked to a high incidence of DM[33,34,35]. Gupta et al acknowledged a very strong correlation between increased BMI and link to increased incidence of DM by as much as 1.5 times and concluded that there is a strong link between obesity and DM or prediabetes when compared to non-overweight persons.[36]

In this study, the prevalence of Diabetes and Prediabetes was found to be 6.8% and 12% respectively. This prevalence is high when compared to values obtained in some areas in Northern Nigeria (2%)[37], West Africa(6.2%)[38], the United States(5.8%)[39], in rural North central Nigeria (4.1%)[40], and Ekiti(6.5%)[41]. But it is lower than the prevalence obtained from South-South Nigeria(9.8%)[6], Delta(7%)[42], Southeast(20.14%)[43], and Gombe(8%)[44] but the same as that obtained by Nwafor et al in southern Nigeria(6.5%)[45] and Osuji et al in Owerri, Southeast Nigeria (6.7%)[25]. The prevalence obtained for DM in this rural setting of Akamkpa /Biase is the same prevalence obtained by other researchers in a high-brow city like Port Harcourt (6.8%).[18] This goes to buttress the point that even those in rural settings are experiencing a surge in the incidence of DM compared to a town setting. In the same manner, the recorded prevalence of prediabetes was 12%. This value is lower than values obtained from previous studies, like that of Nwatu et al (21.5%)[46], Osarenmwinda et al(23.7%)[47], Enejobo et al(16.6%)[48], but higher than values obtained by Zaidu et al(8.5%)[49], Akintayo(9.4%)[50], Aladeniyi(11.7%)[51], and Ajayi et al (29.5%)[52]. It was similar to that obtained by Basir et al (13.2%)[53]. The age of peak prevalence, just like DM, was 40-60 years, as found in other studies, suggesting they have the same etiology and pathophysiology. In this study, the prevalence of DM was higher in males than females (11.4% vs 3.8%) as evidenced by other studies of Balogun et al[54], Kautzky-Willer et al[55], Sujata et al.[56]

Contrary to this, some others believe that females have a higher prevalence of DM than males

Some researchers think that there is a same sex propensity, and the gender effect is equal. Hence, no clear consensus has been reached because of these varying results.

The top independent predictors associated with DM were noted as follows-positive family history of DM, increasing age, increasing body mass index, physical inactivity, positive family history of hypertension, and stress. The strongest predictor noted in this study was a positive family history of DM with an odds ratio(OR) of 3.99. It was an independent factor after adjusting for other covariates. Other authors consider this predictor as a strong factor in predicting the occurrence of DM.[57,58,59,60,61] A positive family history is largely associated with reduced insulin secretion and sensitivity, and is a non-modifiable risk factor for DM. Its presence increases the occurrence of DM by 2-4 times when both parents have DM. Zhang et al reported that people with a family history have a 3-4 fold risk of being diabetic than those without the history.[62]

Age is another strong predictor of DM. Increasing advancing age leads to reduced insulin secretion and subsequent insulin resistance. Most people with DM (especially type 2DM) are usually in the age range of 40-64-just like in this study, age affects both gender and has no variation with ethnicity in predicting DM occurrence. Fazelli et al agree that advancing age (especially after 40 years) is associated with increased DM prevalence.[63] BMI is also a strong predictor of DM. Both BMI and DM have a direct relationship. Even moderately elevated BMI is associated with DM occurrence, as opined by some researchers. This implies that increased BMI is a strong risk factor for DM(see Tables 5 and 6). Increased BMI causes insulin resistance with subsequent DM outcome.[64]

Stress, another independent predictor, is known to cause chronic hyperglycemia, which eventually leads to DM. Also, blood glucose responses to hormonal changes following stress can lead to DM. Some authorities have confirmed stress as a strong DM predictor.[65] Hypertension history is also considered a strong predictor of DM.[30-32] In this study, alcohol ingestion and tobacco use did not provide a strong relationship in predicting DM, as agreed by some researchers.[66]

Conclusion

The prevalence of 6.8% and 12% for DM and prediabetes shows that the disease is growing at an alarming rate in the rural areas. This may be due to enhanced civilization, poor dietary habits, lack of regular health checks, and a sedentary lifestyle. It therefore implies that some rural DM prevalence is way higher than in some urban areas based on the identified independent risk factors. This is a huge public health concern that calls for attention.

Based on this research, we recommend that a government hospital be sited in Biase LGA, massive screening of subjects at risk of DM should be done, with increased health campaigns. Also, increased government policies on health care of citizens, as well as intensification of health -related care and projects by the youths and community leaders concerned.

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References

1. Odunyemi, A., Rahman, T. & Alam, K. Economic burden of non-communicable diseases on households in Nigeria: evidence from the Nigeria living standard survey 2018-19. *BMC Public Health* 23, 1563 (2023). https://doi.org/10.1186/s12889-023-16498-7
2. Mathers CD, Loncar D. Projection of global mortality and burden of disease from 2002 to 2030. *PLOS Med* 2006;3(11): e442
3. World Health Organization (WHO). Non-Communicable Diseases Country Profile, World Health Organization, Geneva, Switzerland, 2018.
4. International Diabetes Foundation (IDF). Diabetes Atlas. 8th edition. Brussels, Belgium: International Diabetes Federation 2017.
5. King H, Aubert RE, Herman W.H. Global Burden of Diabetes, 1995 – 2025. Prevalence, numerical estimates and Projections. *Diabetes Care*. 1998;27:1414-31
6. Uloko AE, Musa BM, Ramalan MA, Gezawa ID, Puepet FH, Uloko AT, et al. Prevalence and Risk Factors for Diabetes Mellitus in Nigeria: A Systematic Review and Meta-Analysis. *Diabetes Ther*. 2018 9(3):1307-1316. doi: 10.1007/s13300-018-0441-1. Epub 2018 May 14.
7. Omoregiuwu A, Oaikhena GA, Okioya P, Akubueze D, Owubu E, Enahoro I. Diabetes Mellitus Prevalence among University Staff in Southern Nigeria and Attitude towards Glaucoma/Glycomena. *Int J. Biomedical and Health Sciences*. 2010: 6(1): 23-29.
8. Chinenye S, Ogbera AO. Socio-cultural aspects of diabetes mellitus in Nigeria. *J. Soc. Health Diabetes*. 2013; 1(1): 15-21.
9. Bolin J, Ferdinand A. The Burden of Diabetes in Rural America. *Rural Health Research Gateway*, 2021.
10. Geiss LS, Pan L, Cadwell B, Gregg EW, Benjamin SM, Engelgou MM. Changes in Incidence of Diabetes in US Adults. 1999 – 2019. *Am. J Prev. Med* 2006;30: 371 – 377.
11. Sairam K, Kulinskaya E, Boustead GB, Hanbury DC, McNicholas TA. Prevalence of undiagnosed diabetes mellitus in male erectile dysfunction. *BJU Int*. 2001 Jul;88(1):68-71. doi: 10.1046/j.1464-410x.2001.02260.x. PMID: 11446849.
12. Sate pouluation,2006-Nigeria data Portal retrieved 2025 August
13. American Diabetes Association Professional Practice Committee; 2. Diagnosis and Classification of Diabetes: Standards of Care in Diabetes—2024. *Diabetes Care 1 January* 2024; 47 (Supplement_1): S20–S42. https://doi.org/10.2337/dc24-S002
14. Cochran (2016). Modified Cochran's sample size determination formula for cross-sectional studies in human populations.
15. Otu, A., Akpan, M., Effa, E,Umoh V., Enang,O. Prevalence of type 2 diabetes mellitus in Southern Cross River: a cross-sectional observational survey. *Int J Diabetes Dev Ctries* 2018;38, 450–455 https://doi.org/10.1007/s13410-018-0606-5
16. Dorathy, C. Okpokam, E. Echonwere-Uwikor, Beauty, O. Opara, Chukwuka, and O. Emeribe Anthony. Relationship Between Fasting Blood Sugar and Some Haematological Parameters in Diabetic Patients Attending Nigerian Navy Reference Hospital Calabar, Cross River State, Nigeria. *Journal of Advances in Medical and Pharmaceutical Sciences* 2021;23 (12):12-18. https://doi.org/10.9734/jamps/2021/v23i1230273.
17. Akinkugbe OO, Akinyanju OO (1997) Final Report. National survey on non-communicable diseases in Nigeria. Lagos: Federal Ministry of Health 64-90
18. Nyenwe EA, Odia OJ, Ihekwaba AE, Ojule A, Babatunde S. Type 2 diabetes in adult Nigerians: a study of its prevalence and risk factors in Port Harcourt, Nigeria. *Diabetes Res Clin Pract*. 2003;62(3):177–185. doi: 10.1016/j.diabres.2003.07.002.

19. Sabir AA, Isezuo SA, Ohwovoriole AE. Dysglycaemia and its risk factors in an urban Fulani population of Northern Nigeria. *West Afr J Med.* 2011;30(5):325–330.
20. Ibrahim, Usman Muhammad; Karkarna, Mustapha Zakariyya1 Babura, Salisu Muazu. Prevalence of Dysglycaemia and Diabetes Mellitus amongst Adults in High-burden Kidney Disease Areas of Jigawa State, Nigeria. *Nigerian Journal of Medicine* 2023 (5):487-494, 2023. | DOI: 10.4103/NJM.NJM_131_2
21. Bolin J, A. The Burden of Diabetes in Rural America. *Rural Health Research Gateway Ferdinand*, 2021.
22. Zhang, HJ., Feng, J., Zhang, XT. Zhang H.O. Age at type 2 diabetes diagnosis and the risk of mortality among the US population. *Sci Rep* 2014, 29155 https://doi.org/10.1038/s41598-024-80790-8
23. Chuhwak, Evelyn K. Okeahialam, Basil N. Ogbonna, Chika Pam, Salem D. Diabetes in elderly Nigerians: A survey of a rural area in north-central Nigeria. *Journal of Medicine in the Tropics* 2019;21(2):51-55. | DOI: 10.4103/jomt.jomt_26_1
24. Adeloye D, Ige JO, Aderemi AV, Adeoye D, Ige J, Adeoye D,Estimating the prevalence, hospitalisation and mortality from type 2 diabetes mellitus in Nigeria: a systematic review and meta-analysis. *Open* 2017;7:e015424. doi: 10.1136/
25. Osuji, C., A. Nzerem, B. , E. Dioka, C., C. Meludu, S., and I. Onwubuya, E. Prevalence of diabetes mellitus in a group of women attending “August meeting” at Naze South East Nigeria. *Journal of Diabetes Mellitus* 2012; 321-326. doi: 10.4236/jdm.2012.23050.
26. Yan Z, Cai M, Han X, Chen Q, Lu H. The Interaction Between Age and Risk Factors for Diabetes and Prediabetes: A Community-Based Cross-Sectional Study. *Diabetes Metab Syndr Obes*. 2023;16:85-93. doi: 10.2147/DMSO.S390857. PMID: 36760587; PMCID: PMC9843502.
27. Whitaker SM, Bowie JV, McCleary R, Gaskin DJ, LaVeist TA, Thorpe RJ Jr. The Association Between Educational Attainment and Diabetes Among Men in the United States. *Am J Mens Health*. 2014;8(4):349-56. doi: 10.1177/1557988313520034.
28. Mathisen, J., Jensen, A.K.G., Andersen, I. et al. Education and incident type 2 diabetes: quantifying the impact of differential exposure and susceptibility to being overweight or obese. *Diabetologia* 2020;63:1764–1774.
29. Kowall B, Rathmann W. Combined effects of Diabetes and Education on decline of cognitive performance in the older Population: the Survey of Health, Ageing, and Retirement in Europe. *Gerontology*. 2023;69:172–80.
30. Bello-Ovosi BO, Asuke S, Abdulrahman SO, Ibrahim MS, Ovosi JO, Ogunsina MA, Anumah FO. Prevalence and correlates of hypertension and diabetes mellitus in an urban community in North-Western Nigeria. *Pan Afr Med J*. 2018;29:97. doi: 10.11604/pamj.2018.29.97.1419.
31. Adeniyi OA, Eniade OD, Olarinmoye AT, Abiodun BA, Okedare OO, Eniade AA, Atolagbe JE. Prevalence and associated factors of hypertension among type 2 diabetes mellitus patients in Lautech teaching Hospital, Osogbo, Nigeria. *Afr Health Sci.* 2023;(4):324-332. doi: 10.4314/ahs.v23i4.34
32. Kim MJ, Lim NK, Choi SJ, Park HY. Hypertension is an independent risk factor for type 2 diabetes: the Korean genome and epidemiology study. *Hypertens Res*. 2015;38(11):783-9. doi: 10.1038/hr.2015.72. Epub 2015 Jul 16.
33. Affi Ayuba, Dalili shabbal Mohammed, longwap AS, Solomon mercy Gunat, Daniel Aina Olagoke (2022). Overweight and Type II Diabetes among the Elderly Middle Belt Nigerians. *East African Scholars J Med Sci*. 5(7):205-209.
34. Klein S, Gastaldelli A, Yki-Järvinen H, Scherer PE. Why does obesity cause diabetes? *Cell Metab*. 2022;34(1):11-20. doi: 10.1016/j.cmet.2021.12.012. PMID: 34986330; PMCID: PMC8740746.
35. Ding, YF., Deng, AX., Qi, TF, Yu H,,B,Zhang H.B. Burden of type 2 diabetes due to high body mass index in different SDI regions and projections of future trends: insights from the Global Burden of Disease 2021 study. *Diabetol Metab Syndr* 2025;17:23 https://doi.org/10.1186/s13098-024-01554-y

36. Gupta S, Bansal S. Does a rise in BMI cause an increased risk of diabetes?: Evidence from India. PLoS One. 2020 Apr 1;15(4):e0229716. doi: 10.1371/journal.pone.0229716. Erratum in: *PLoS One*. 2021;16(2):e0247537. doi: 10.1371/journal.pone.0247537. PMID: 32236106; PMCID: PMC7112218.
37. Dahiru T, Jibo A, Hassan AA, Mande AT. Prevalence of diabetes in a semi-urban community in Northern Nigeria. Nigerian Journal of Medicine : Journal of the National Association of Resident Doctors of Nigeria. 2008;17(4):414-416. DOI: 10.4314/njm.v17i4.37423.
38. Issaka A, Stevenson C, Paradies Y, Houehanou YCN, Bosu WK, Kiwallo JB, Wesseh CS, Houinato DS, Nazoum DJP, Cameron AJ. Association between urban-rural location and prevalence of type 2 diabetes and impaired fasting glucose in West Africa: a cross-sectional population-based epidemiological study. *BMJ Open*. 2023 Sep 21;13(9):e063318. doi: 10.1136/bmjopen-2022-063318.
39. Mary R. Rooney, Michael Fang, Katherine Ogurtsova, Bige Ozkan, Justin B. Echouffo-Tcheugui, Edward J. Boyko, Dianna J. Magliano, Elizabeth Selvin; Global Prevalence of Prediabetes. *Diabetes Care* 2023;46(7):1388–1394. https://doi.org/10.2337/dc22-2376
40. Etukumana EA,Puepet FH,Obadofin MO. Prevalence of diabetes mellitus among adults in rural north central Nigeria. *Highland Med Res J* 2013;13(2):98-100
41. Oluwadiya KS, Raimi TH, Dada SA, Dele-Ojo BF, Adeoti AO, Solomon OO, Amu E, Awoleke JO. Uncovering the Burden of Diabetes in Ekiti State, Nigeria: Insights From a Statewide, Household-Based, Cross-Sectional Study. *Cureus*. 2023 Dec 17;15(12):e50686. doi: 10.7759/cureus.50686. PMID: 38229802; PMCID: PMC10791138.
42. Olamoyegun, MA., Alare, K., Afolabi, S.A,Ademola N. Ademola N.A,Adeyemo T. Systematic review and meta-analysis of the prevalence and risk factors of type 2 diabetes mellitus in Nigeria. *Clin Diabetes Endocrinol* 2024;10:43. https://doi.org/10.1186/s40842-024-00209-1
43. Edeh, A. J., Eze, B. U., Ohayi, S. R., Anekpo, C. C., Okoloagu, N. N., Aliozo, C. C., & Soronnadi, C. N. Prevalence of Diabetes among Adults in Agbani South East, Nigeria: A Population-Based Study. *European Journal of Clinical Medicine*, 2022;3(4):17–20. https://doi.org/10.24018/clinicmed.2022.3.4.222
44. Afolalu, T., Wada, O., Olawade, D., Suntai, A. Prevalencia de la diabetes mellitus entre los residentes adultos de la comunidad rural de Tinda, Nigeria. *Journal of Biosciences and Medicines*, 2020;8:107-116. doi: 10.4236/jbm.2020.811010
45. Nwafor, C. E., Edeogu, J., Stanley, R., Enyichukwu, B., & Ogomegbunam, M. Prevalence of Diabetes Mellitus Among the Adult Population Within a Southern Nigerian Community. *European Journal of Medical and Health Research*, 2024;2(1):131-137. https://doi.org/10.59324/ejmhr.2024.2(1).22
46. Nwatu, C.B., Ofoegbu, E.N., Unachukwu, C.N. et al. Prevalence of prediabetes and associated risk factors in a rural Nigerian community. *Int J Diabetes Dev Ctries* 2016;36:197–203. https://doi.org/10.1007/s13410-015-0401-5
47. Osarenmwinda MI, Erah PO, Eromhonsele PE. Incidence of Undiagnosed Diabetes Mellitus in Rural Community, Edo South, Benin City, *Indian Journal of Pharmacy Practice*, 2020;13(3): 232 – 239
48. Ejenobo, Osaro E1; Chike-Ezue, Eunice2; Eregie, Aihanuwa3; Edo, Andrew3. Prediabetes and its correlates in a suburban community in South-South Nigeria. *African Journal of Endocrinology and Metabolism* 2022;12(2):77-83 | DOI: 10.4103/ajem.ajem_5_23
49. Zaidu Musa, A., Isa Umar, U., Ngozi Obiagwu, P., & Ibrahim, M. School-based Study of the Prevalence and Associated Factors of Prediabetes Among Adolescents in Kano, Nigeria: https://doi.org/10.60787/NMJ-64-1-161. *Nigerian Medical Journal* 2023;64(1):43–53. https://doi.org/10.60787/nmj.v64i1.161
50. Akintayo-Usman NO, Okanlawon FA, Usman SO. Prevalence of pre-diabetes and risk factors among secondary school adolescents in Osogbo Local Government Area, Osun State, Nigeria.

Afr Health Sci. 2021;21(3):1301-1309. doi: 10.4314/ahs.v21i3.41.

51. Aladeniyi I, Adeniyi V, Fawole FA,Adeolu M.Prevalence and correlates of prediabetes and diabetes among public category workers in Akure, Nigeria. *The Open Public Health Journal* 2017;10:167-176
52. Ajayi IO, Balogun WO, Olopade OB, Ajani GO, Soyoye DO, Bolarinwa OA, Olamoyegun MA,. Prevalence of haemoglobin A1c based dysglycaemia among adult community dwellers in selected states in Nigeria: a descriptive cross-sectional study. *Front Endocrinol (Lausanne)*. 2023 Jul 20;14:1192491. doi: 10.3389/fendo.2023.1192491. PMID: 37547317; PMCID: PMC10399573.
53. Bashir MA, Yahaya AI, Muhammad M, Yusuf AH, Mukhtar IG. Prediabetes Burden in Nigeria: A Systematic Review and Meta-Analysis. *Front Public Health.* 2021;9:762429. doi: 10.3389/fpubh.2021.762429.
54. Balogun WO, Akinyemi Balogun WO, Akinyemi JO, Ajayi IO, Olamoyegun MA, Olopade OB, Bolarinwa OA, Alatishe-Muhammad BW, Salisu OA, Ajani GO, Soyoye DO. Rural-urban differences in risk factors for prediabetes and undiagnosed diabetes among adult residents in selected Yoruba-speaking regions of Nigeria: A glycated hemoglobin-based population screening. *West Afr J Med.* 2024 ;41(5):583-591
55. Kautzky-Willer A, Leutner M, Harreiter J. Sex differences in type 2 diabetes. Diabetologia. 2023 Jun;66(6):986-1002. doi: 10.1007/s00125-023-05891-x. Epub 2023 Mar 10. *Erratum in: Diabetologia*. 2023 ;66(6):1165. doi: 10.1007/s00125-023-05913-8.
56. Sujata, Thakur, R. Unequal burden of equal risk factors of diabetes between different genders in India: a cross-sectional analysis. *Sci Rep* 2021;11:22653 https://doi.org/10.1038/s41598-021-02012-9
57. Denton, J.J., Cedillo, Y.E. Investigating family history of diabetes as a predictor of fasting insulin and fasting glucose activity in a sample of healthy weight adults. *Acta Diabetol* 2023;60: 535–543. https://doi.org/10.1007/s00592-023-02030-1
58. Ndetei, D.M., Mutiso, V., Musyimi, C. Association of type 2 diabetes with family history of diabetes, diabetes biomarkers, mental and physical disorders in a Kenyan setting. *Sci Rep* 2024;14: 11037. https://doi.org/10.1038/s41598-024-61984-6
59. Alharithy, M. K., Alobaylan, M. M., Alsugair, Z. O., & Alswat, K. A. Impact of family history of diabetes on diabetes control and complications. *Endocr. Pract.* 2018;24(9):773–779.
60. Zhang J, Yang Z, Xiao J, Xing X, Lu J, Weng J, et al. Association between Family History Risk Categories and Prevalence of Diabetes in the Chinese Population. *PLoS ONE* 2015;10(2): e0117044. https://doi.org/10.1371/journal.pone.0117044
61. Papazafiropoulou, K. A., Papanas, N., Melidonis, A. & Maltezos, E. Family history of type 2 diabetes: Does having a diabetic parent increase the risk? *Curr. Diabet. Rev.* 2017;13(1):19–25
62. Zhang J, Yang Z, Xiao J, Xing X, Lu J, Weng J, et al. Association between Family History Risk Categories and Prevalence of Diabetes in the Chinese Population. *PLoS ONE* 2015;10(2): e0117044. https://doi.org/10.1371/journal.pone.0117044
63. Fazeli PK, Lee H, Steinhauser ML. Aging Is a Powerful Risk Factor for Type 2 Diabetes Mellitus Independent of Body Mass Index. *Gerontology.* 2020;66(2):209-210. doi: 10.1159/000501745. Epub 2019 Sep 10.
64. Gray N, Picone G, Sloan F, Yashkin A. Relation between BMI and diabetes mellitus and its complications among US older adults. *South Med J.* 2015;108(1):29-36.
65. Surwit RS, Schneider MS, Feinglos MN. Stress and diabetes mellitus. *Diabetes Care*. 1992;15(10):1413-22. doi: 10.2337/diacare 15.10.1413.
66. Koppes, L. L., Dekker, J. M., Hendriks, H. F., Bouter, L. M., Heine, R. J. Moderate alcohol consumption lowers the risk of type 2 diabetes: a meta-analysis of prospective observational studies. *Diabetes Care* 2005;28: 719–725.