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ASSESSMENT OF THE CORRELATION BETWEEN BLOOD SUGAR LEVELS AND BLOOD PRESSURE IN TYPE 2 DIABETES MELLITUS PATIENTS AT THE NKWEN DISTRICT HOSPITAL BAMENDA

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) and hypertension frequently coexist, sharing common risk factors like obesity and insulin resistance, and together increase the risk of serious complications such as cardiovascular disease. The relationship between blood sugar levels and blood pressure in T2DM remains unclear and complex. Despite government initiatives in Cameroon to manage T2DM and hypertension, many patients still develop both conditions. This study aims to assess the correlation between blood sugar levels and blood pressure among T2DM patients at Nkwen District Health Center, Bamenda. **Methods:** This study was conducted at Nkwen District Hospital Bamenda, a secondary-level facility serving diverse urban and rural populations in the North West Region of Cameroon. A cross-sectional design was used to assess the correlation between blood glucose levels and blood pressure among 70 T2DM patients. Data was collected using structured questionnaires, blood pressure measurements, and laboratory analysis of fasting blood glucose and HbA1c levels. A simple random sampling method was used, and data analysis was done using SPSS with significance set at $p \leq 0.05$. Ethical clearance and participant consent were obtained prior to data collection. **Results:** The study included 70 participants, mostly females (57.1%), with the highest age groups being 50–69 and 70–89 years (40% each). Most respondents were married (65.7%) and had primary education (41.4%), with retired persons (31.4%) forming the largest occupational group. A strong, statistically significant positive correlation was found between blood glucose levels and systolic ($r = 0.815$, $p = 0.026$) and diastolic BP ($r = 0.777$, $p = 0.032$). Fasting blood sugar (FBS) showed significant associations with systolic BP ($X^2 = 4.44$, $p = 0.03$) and overall BP ($X^2 = 8.73$, $p = 0.03$), but not with diastolic BP ($p = 0.70$). Age was significantly associated with both FBS ($X^2 = 11.5$, $p = 0.003$) and BP ($X^2 = 18.9$, $p = 0.004$). Occupation was also significantly related to FBS ($X^2 = 18.2$, $p = 0.003$) and overall BP ($X^2 = 35.5$, $p = 0.002$). Marital status had a significant association with BP ($X^2 = 18.6$, $p = 0.02$), but not with FBS ($p = 0.36$). Gender and education level showed no significant association with FBS ($p = 0.88$ and $p = 0.1$ respectively) nor with BP ($p = 0.1$ and $p = 0.18$). These results emphasize the role of age, occupation, and marital status in influencing glycemic and blood pressure outcomes in T2DM patients. **Conclusion:** Routine monitoring and integrated management of blood glucose and blood pressure should be prioritized, especially among older adults and high-risk occupational groups.

KEYWORDS: Correlation, blood glucose levels, blood pressure, T2DM patients, Nkwen District Hospital

BACKGROUND

Type 2 diabetes mellitus (T2DM) is a long-term metabolic disorder marked by insulin resistance and hyperglycemia, and it frequently coexists with hypertension, affecting about 70% of diabetic patients globally.[1] In 2021, approximately 537 million adults worldwide were living with diabetes, representing 10.5% of the global adult population.[2] In Cameroon, the prevalence of diabetes varies between 5% and 8% in adults, with higher rates reported in urban populations.[3] Several factors including obesity[4], physical inactivity[5], poor diet[6], aging, and family history[7] contribute to its rising incidence. Likewise, hypertension is a growing concern, affecting an estimated 2.28 billion adults worldwide.[8] Africa has the highest prevalence, with

rates between 27–46%[9], and in Cameroon, estimates range from 20% to 30%.[10]

Elevated blood sugar levels in T2DM patients contribute to macroangiopathy through the formation of Advanced Glycosylated End Products (AGEs), which damage the blood vessel walls.[11] This process leads to vascular stiffness and plaque formation due to inflammatory reactions and deposition of cholesterol and fats, ultimately causing increased blood pressure. Such physiological changes illustrate the biochemical pathway from chronic hyperglycemia to hypertension.[11]

The coexistence of T2DM and hypertension significantly increases the risk of cardiovascular complications such as coronary artery disease, stroke, and kidney disease.[12] Individuals with high blood pressure are three times more likely to experience a heart attack, five times more likely to develop heart failure, and eight times more likely to suffer a stroke compared to those with normal blood pressure.[13] These statistics highlight the urgency of managing both conditions simultaneously.

Although several studies have examined the relationship between blood glucose and blood pressure in T2DM patients, results have been inconsistent. Some found a positive correlation between fasting blood glucose and systolic blood pressure[14], while others associated higher HbA1c levels with elevated systolic and diastolic blood pressure.[15] However, one study found no significant association between casual blood sugar and blood pressure values.[16] These conflicting outcomes justify further investigation, such as this study at Nkwen District Health Center.

The relationship between T2DM and hypertension is multifactorial, involving insulin resistance, activation of the sympathetic nervous system and the renin-angiotensin-aldosterone system, inflammation, and oxidative stress.[17] These mechanisms not only raise blood sugar levels but also contribute directly to increased blood pressure. Although poor glycemic control has been linked to elevated blood pressure[14], some evidence also suggests that effective blood pressure management may improve glycemic outcomes.[15]

To address the dual burden of T2DM and hypertension, the Cameroonian government, in collaboration with the World Diabetes Foundation, established the Cameroon National Diabetes Programme. This initiative improved healthcare access, provided subsidized medications, and promoted public awareness through community campaigns.[15] Despite these efforts, a large proportion of diabetes patients still develop hypertension in Cameroon. Most existing studies focus on broader cardiovascular outcomes, and few explore the specific correlation between blood sugar and blood pressure.[18,19] This study aims to bridge that gap by assessing the correlation between blood sugar levels and blood pressure (systolic and diastolic) in T2DM patients at the Nkwen District Health Center Bamenda.

METHODS

The study was conducted at Nkwen District Hospital (PMI) in Bamenda, North West Region of Cameroon, a secondary-level healthcare facility serving both urban and rural populations. A hospital-based cross-sectional study was carried out from May 1 to May 31, aimed at assessing the correlation between blood sugar levels and blood pressure among 70 freely consented adult patients (≥18 years) diagnosed with Type 2 Diabetes Mellitus (T2DM), and sampled through the convenience sampling technique. Excluded from this study were patients with other types of diabetes, cognitive impairment, incomplete questionnaires, failure to have fasted for 8 hours, or refusal to give consent. Data collection involved structured questionnaires for socio-demographics, medical history, lifestyle and medication adherence. Blood pressure was measured using an automated blood pressure machine (Omron HEM 7140T1). 2mls of venous blood samples were collected into fluoride oxalate tubes and analyzed for fasting blood glucose (FBG) using the Accu-Check Guide Me Meter and glycated hemoglobin using the HbA1c machine (Suresign Finecare HbA1c) following standard procedures. Data was analyzed using SPSS version 21. Chi-square and correlation tests were used to assess associations, with statistical significance set at $p \leq 0.05$. Ethical clearance was obtained from the Regional Delegation of Public Health, with permissions from institutional authorities. Informed consent was obtained from all participants, and data confidentiality was ensured.

RESULTS

Demographic Characteristics of Respondents

Table 1 below represents the socio-demographic characteristics of the respondents in this study. A total of 70 individuals participated in the study. Of these 70 participants, majority were females (40), giving a percentage of 57.1% and the rest (30) were males with a percentage of 42.9%. Per the age group, majority were between the ages 50-69 and 70-89 giving percentages of 40% each and these were followed by those between the ages 30-49 with 20%. According to the reported marital status of the respondents, 65.7% (46 participants) reported to be married, followed by 19 who reported to be widowed (27.1%), 3 being divorced (4.3%) and lastly 2 being single (2.9%). Also, according to educational level of the participants, 29 of them (41.4%) reported to have ended at the level of the primary education, 17 of them (24.3%) reported to have had no education and another 17 of them (24.3%) reported to have ended at the level of secondary education which was lastly followed by 7 participants (10%) who reported to have ended at the level of tertiary education. However, with respect to the occupation of the participants, 22 of them (31.4%) reported to be retired workers, 19 of them (27.1%) business men, 14 reported to be farmers (20.0%), 11

teachers (15.7%), 2 drivers (2.9%) and 2 equally reported to be housewives with a percentage of 2.9% (table 4.1)

Table 1: Distribution of respondents according to their demographic characteristics.

Characteristic	Category	Frequency	Percentage (%)
Age	30-49 Years	14	20.0
	50-69 Years	28	40.0
	70-89 Years	28	40.0
	Total	**70**	**100.0**
Gender	Male	30	42.9
	Female	40	57.1
	Total	**70**	**100.0**
Marital status	Single	2	2.9
	Married	46	65.7
	Divorced	3	4.3
	Widowed	19	27.1
	Total	**70**	**100.0**
Educational level	No formal education	17	24.3
	Primary	29	41.4
	Secondary	17	24.3
	Tertiary	7	10.0
	Total	**70**	**100.0**
Occupation	Retired	22	31.4
	Business	19	27.1
	Driver	2	2.9
	Teacher	11	15.7
	Farmer	14	20.0
	Housewife	2	2.9
	Total	**70**	**100.0**

1.1 Correlation of blood glucose levels to the systolic and diastolic Blood pressure of the participants

Table 2 below presents the correlation of blood glucose levels to the systolic and diastolic Blood pressure of the participants. The r-values (~0.78–0.82) indicate a strong positive correlation, suggesting that participants with higher blood glucose levels also tended to have higher systolic and diastolic blood pressure. Both correlations were statistically significant ($p < 0.05$), underscoring the robustness of this association.

Table 2: Correlation of blood glucose levels to the systolic and diastolic Blood pressure of the participants.

Variable Pair	r (Correlation Coefficient)	p-value
Blood Glucose – Systolic BP	0.815	0.026
Blood Glucose – Diastolic BP	0.777	0.032

Association analysis

Table 3 below shows that there is a relatively significant association between the fasting blood glucose levels of the participants and their systolic BP levels, with a Chi square (X^2=4.44) and p-value (p=0.03). It equally shows a significant association between FBS levels and the overall BP of the participants (X^2=8.73, and p=0.03). But however, it shows no significant association between fasting blood sugar levels of the participants and their diastolic blood pressure levels (p-value=0.7), (table 3).

Table 3: The association of FBS and BP levels.

Characteristics	Category	FBS levels		Total	X^2	p-value
		Normal	Elevated			
Systolic BP	Normal	9	7	16	4.44	**0.03***
	Elevated	15	39	54		
Total		**24**	**46**	**70**		
Diastolic BP	Low	1	2	3	0.71	0.7
	Normal	8	11	19		
	Elevated	15	33	48		
Total		**24**	**46**	**70**		
Overall BP	Normal	10	8	18	8.73	**0.03***

	Elevated	6	6	12		
	Stage1 hypertension	2	11	13		
	Stage2 Hypertension	6	21	27		
Total		**24**	**46**	**70**		

***-statistically significant at 0.05 significance level**

The association of demographic factors with FBS and BP levels

Age shows a significant association with FBS (X^2=11.5, p=0.003) and overall BP (X^2=18.9, p=0.004). Occupation equally shows a statistical significance (X^2=18.2, p=0.003 for FBS) and (X^2 =35.5, p-values= 0.002 for overall BP). Furthermore, marital status equally proved a statistically significant association with BP, recording a X^2=18.6, and p=0.02 (table 4).

Table 4: Association of demographic characteristics with FBS and BP levels.

		FBS control		Total	X^2	p-value	Overall BP				Total	X^2	p-value
		Normal	Elevated				Normal	Elevated	Stage1 hypertension	Stage2 Hypertension			
Age [years]	30-49	7	7	14	11.5	**0.003***	4	7	1	2	14	18.9	**0.004***
	50-69	14	14	28			9	4	4	11	28		
	70-89	3	25	28			5	1	8	14	28		
Total		**24**	**46**	**70**			**18**	**12**	**13**	**27**	**70**		
Gender	Male	10	20	30	0.02	0.88	7	7	2	14	30	6.18	0.1
	Female	14	26	40			11	5	11	13	40		
Total		**24**	**46**	**70**			**18**	**12**	**13**	**27**	**70**		
Educational level	No formal education	7	10	17	6.09	0.1	6	1	4	6	17	12.5	0.18
	Primary	8	21	29			6	7	8	8	29		
	Secondary	4	13	17			3	4	1	9	17		
	Tertiary	5	2	7			3	0	0	4	7		
Total		**24**	**46**	**70**			**18**	**12**	**13**	**27**	**70**		
Marital status	Single	0	2	2	3.15	0.36	0	2	0	0	2	18.6	**0.02***
	Married	18	28	46			12	9	7	18	46		
	Divorced	0	3	3			0	0	0	3	3		
	Widowed	6	13	19			6	1	6	6	19		
Total		**24**	**46**	**70**			**18**	**12**	**13**	**27**	**70**		
Occupation	Retired	11	11	22	18.2	**0.003**	7	3	8	4	22	35.5	**0.002**
	Business	0	19	19			0	4	3	12	19		
	Driver	0	2	2			0	0	0	2	2		
	Teacher	5	6	11			4	0	0	7	11		
	Farmer	6	8	14			5	5	2	2	14		
	Housewife	2	0	2			2	0	0	0	2		
Total		**24**	**46**	**70**			**18**	**12**	**13**	**27**	**70**		

***-statistically significant at 0.05 significance level**

Association analysis to further explain the hypothesis shows that there is a statistically significant association between FBS and BP levels, with X^2=8.73, and p=0.03 (table 5).

Table 5: Presentation of the Hypothetic outcome.

Characteristic	Category	Counts	FBS control		Total	X^2	p-value
			Normal	Elevated			
Overall BP	Normal	Observed Count	10	8	18	8.73	**0.03***
		Expected Count	6.2	11.8	18.0		
		% of Total	**14.3%**	**11.4%**	**25.7%**		
	Elevated	Observed Count	6	6	12		
		Expected Count	4.1	7.9	12.0		
		% of Total	**8.6%**	**8.6%**	**17.1%**		
	Stage1 hypertension	Observed Count	2	11	13		
		Expected Count	4.5	8.5	13.0		
		% of Total	**2.9%**	**15.7%**	**18.6%**		
	Stage2 Hypertension	Observed Count	6	21	27		
		Expected Count	9.3	17.7	27.0		

		% of Total	**8.6%**	**30.0%**	**38.6%**		
Total		Observed Count	24	46	70		
		Expected Count	24.0	46.0	70.0		
		% of Total	**34.3%**	**65.7%**	**100.0%**		

***-statistically significant at 0.05 significance level**

DISCUSSION

The results of this study reveal a strong and statistically significant positive correlation between blood glucose levels and both systolic and diastolic blood pressure among patients with Type 2 Diabetes Mellitus (T2DM) at the Nkwen District Hospital. Specifically, the correlation coefficients were r = 0.815 for systolic BP and r = 0.777 for diastolic BP, both significant at $p < 0.05$. These values suggest that as blood glucose levels rise, blood pressure tends to increase proportionately, highlighting the interlinked nature of glycemic control and vascular health in diabetic patients.

These findings are supported by regional and international studies. For example, a Nigerian study by Oguejiofor et al. found a moderate yet significant correlation between fasting blood glucose and systolic BP (r = 0.42), reinforcing the hypothesis that poor glycemic control contributes to increased blood pressure.[20] A similar study conducted at Bamenda Regional Hospital observed correlations of 0.36 for systolic and 0.29 for diastolic BP in relation to fasting blood glucose, which, although weaker than in the present study, point toward the same conclusion.[21] The stronger correlations identified in our study could stem from differences in healthcare access, lifestyle habits, or disease severity among the study population.

Further support for these findings comes from a study in Indonesia, where researchers reported similar positive associations between blood glucose and blood pressure, particularly in rural settings with limited access to structured chronic disease management programs.[22] These consistent observations lend credence to the theory that insulin resistance, endothelial dysfunction, and renin-angiotensin system activation play critical roles in the co-existence and mutual reinforcement of hyperglycemia and hypertension.[23]

This study also highlights the significant influence of demographic factors on the association between fasting blood glucose (FBG) and blood pressure in patients with T2DM. The socio-demographic profile comprising mostly middle-aged adults, a slightly higher proportion of females, and a predominance of married individuals, is consistent with previous reports that diabetes is most common in individuals aged 20–79 years.[24]

A statistically significant association was found between FBG and systolic BP, as well as with overall BP, emphasizing the intertwined pathophysiology of glucose metabolism and cardiovascular regulation.[25] This supports the concept that elevated FBG is an early marker of insulin resistance, which not only predisposes individuals to diabetes but also contributes to vascular rigidity and elevated BP.

Moreover, the data revealed notable associations between age, occupation, and marital status with both blood glucose and blood pressure levels. Older age groups were particularly prone to elevated values for both parameters, suggesting that aging is a strong risk factor for metabolic and cardiovascular diseases.[26,27] The relationship between occupation and FBG/BP could be explained by differences in lifestyle behaviors, such as physical activity levels and diet, across occupational categories, consistent with findings from other regional studies.[28,29]

CONCLUSION

There is a strong positive correlation between blood glucose levels and both systolic and diastolic blood pressure among T2DM patients at the Nkwen District Health Center, with correlation coefficients of r = 0.815 and r = 0.777 respectively.

This study also confirms a significant association between fasting blood glucose, blood pressure, and demographic factors among participants. The findings align with existing literature, reinforcing the link between glucose metabolism and cardiovascular health. Age, occupation, and marital status emerged as important predictors of metabolic and blood pressure variations. These associations highlight the vulnerability of older adults to both hypertension and hyperglycemia.

AUTHOR'S CONTRIBUTION

LHS, Study conception and design, writing of the manuscript; BR, Data collection and critical revision of the manuscript; LHS/BR, Study design, supervision of data collection and critical revision of manuscript; LHS/BR, Data analysis and critical revision of manuscript; TLM/WEC, Study design, acquisition and interpretation of data, critical revision of manuscript; WEC/CNT/NBAA, Study conception and design, supervision of data collection and critical revision of manuscript. All authors gave their consent for publication. All authors read and approved the final manuscript.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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