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PREVALENCE AND SEVERITY OF TYPE 2 DIABETES IN THE TAMALE METROPOLIS

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ABSTRACT

Comprehending the various factors contributing to type 2 diabetes is crucial for developing effective strategies for prevention, management, and intervention. The study investigates how various factors, including gender, age, occupation, education, residence, and weight, influence the prevalence and severity of type 2 diabetes in the Tamale Metropolis. Data on type 2 diabetes cases were obtained from the records of Seventh-Day Adventist Hospital, Tamale, serving as a secondary source. Both descriptive and inferential analysis were used to analyze the data. The study's findings revealed that age, education, occupation, residence, and gender are crucial predictors of diabetes severity. Findings show that the model predicted a 20.5% chance of severe condition for patients with normal type 2 diabetes, a 40.7% chance for those with mild condition, and a 47.6% chance for those with normal condition, emphasizing the need for targeted interventions to mitigate diabetes risk. The study concluded that there is a relationship between age, education, occupation, and gender in diabetes prevalence. The study further concluded that there is largely a chance of having severe type 2 diabetes among those with non-severe type 2 diabetes, with few chances of not having a severe condition.

Keywords: ***Type 2 diabetes, prevalence, risk factors***

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INTRODUCTION

Type 2 diabetes has become a significant global public health concern, with its occurrence steadily increasing in recent decades (International Diabetes Federation, 2019). Notably, urban areas face a higher burden of type 2 diabetes, influenced by lifestyle factors and socioeconomic conditions (World Health Organization, 2016). The issue of rising type 2 diabetes cases extends beyond developed nations, affecting developing countries as well, as highlighted in a report by the World Health Organization (2016). Atun (2017) emphasized the rapid surge in diabetes cases and discussed the challenges healthcare systems encounter in managing this epidemic. The numbers are staggering, with the global count of individuals with type 2 diabetes increasing from 108 million in 1980 to 463 million in 2019, and the prevalence among those aged 18 and above rising from 4.7% in 1980 to 9.3% in 2019 (Saeedi et al., 2019). During the COVID-19 pandemic, type 2 diabetes emerged as a significant risk factor, contributing to a harmful pro-inflammatory condition (Means, 2020). This highlights the heightened vulnerability of individuals with type 2 diabetes during health crises.

The consequences are profound; without the implementation of a comprehensive diabetes management framework, the world faces the risk of losing a significant number of lives to diabetes-related complications and subsequent infectious diseases. The International Diabetes Federation's (2021) research predicts a 134% increase in the rate of type 2 diabetes mellitus in Africa by 2045, with South-Central America and South-East Asia also experiencing substantial increases of 50% and 68%, respectively. This alarming projection places Africa, particularly Ghana, in a precarious position, necessitating immediate precautions and interventions.

In Ghana, the statistics are alarming, with 5,400 diabetes-related deaths recorded in 2019, making it the primary cause of Non-Communicable Diseases (NCDs) in the country (Owusu et al., 2019). Despite the severity of the situation, there has been insufficient research, education, and intervention for type 2 diabetes in the Tamale Metropolis. As a result, healthcare professionals and individuals in this region face numerous challenges in managing type 2 diabetes. These challenges encompass issues related to treatment adherence, lifestyle modifications, glycemic control, diabetes-related distress, limited access to healthcare services, disparities in diabetes knowledge and resources, low health literacy, and systemic inequalities, which have led to increased distress among individuals with type 2 diabetes in Tamale Metropolis. Previous research has also indicated that type 2 diabetes care providers have not

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consistently offered adequate support and care, often lacking proximity to their patients (Mwangome et al., 2017).

To address these critical issues and knowledge gaps, this study aims to investigate how various factors, including gender, age, occupation, education, residence, and weight, influence the prevalence and severity of type 2 diabetes in the Tamale Metropolis. Understanding the interplay of these factors is essential for developing effective strategies for the prevention, management, and intervention of this public health concern.

MATERIALS AND METHODS

Study area

The research was conducted in the Tamale Metropolis, an administrative district located in Ghana's Northern Region, marked by its strategic geographical position. It shares borders with neighboring districts, including Sagnarigu to the West and North, Mion to the East, East Gonja to the South, and Central Gonja to the South-West. The metropolis spans approximately 646.90180 square kilometers and lies between 9º16 and 9º34 north latitude and 0º36 and 0º57 west longitude. With a population of 374,744 residents, nearly evenly split between women and men, the Tamale Metropolis constitutes about 16.2% of the Northern Region's total population and 1.2% of the national population. The metropolis comprises 89,011 households, with an average household size of 4.1 individuals, resulting in a population density of 825 people per square kilometer. In terms of literacy, while 60.1% of individuals aged 11 and above are literate, a gender disparity is notable, with higher female illiteracy. Additionally, a significant proportion of the population exhibits linguistic versatility, with proficiency in both English and Ghanaian languages. Most households (98.3%) rely on public dump containers for solid waste disposal, highlighting sanitation and environmental concerns. A notable demographic observation is the prevalence of female illiteracy, which exceeds that of males within the Tamale Metropolis. This gender disparity highlights the need for targeted educational interventions and strategies.

In summary, the Tamale Metropolis serves as the focal point for a study on the prevalence and severity of type 2 diabetes. Its unique geographical and demographic characteristics, including population density, literacy rates, and waste management practices, provide valuable context for addressing public health challenges in this dynamic urban area.

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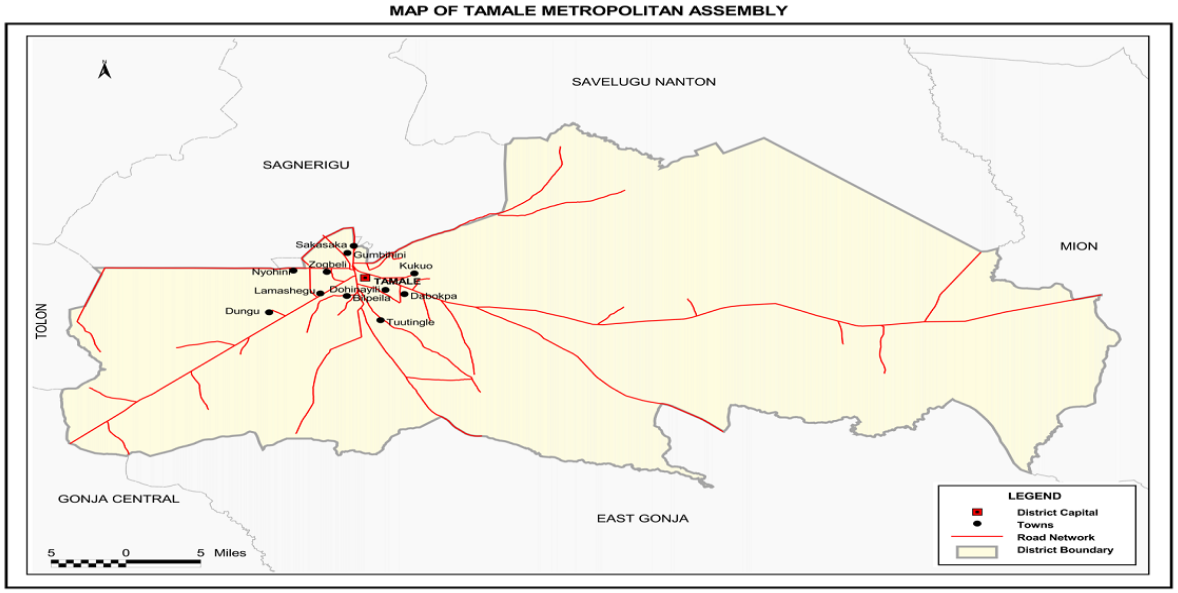

Source: Ghana Statistical Service, GIS

Figure 1: The map of Tamale Metropolitan Asssembly

Data and Source

Secondary source of data on type 2 diabetes cases were collected from the record books of Seventh-Day Adventist Hospital, Tamale.

Study Population

A total number of 275 patients with type 2 diabetes recorded in the medical record book of the Seventh-Day Adventist Hospital, Tamale, was used for the study.

Inclusion Criteria

The study involved outpatients with type 2 diabetes from Seventh-Day Adventist Hospital, Tamale.

Exclusion Criteria

The study excluded outpatients with conditions other than type 2 diabetes and patients with type 1 diabetes within the Seventh-Day Adventist Hospital in Tamale.

Analysis

Descriptive statistics was used to summarize the data collected. The prevalence of Type 2 diabetes was calculated, and logistic regression analysis was used to assess the effect of age,

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weight, occupation, residence, and gender on the occurrence and severity of Type 2 diabetes. The analysis was conducted using r console and open epi software.

Model Specification

The logistic regression model for modeling type 2 diabetes is formulated as follows:

p = the likelihood of type 2 diabetes

Age, gender, educational level, occupation, weight and place of residence are the predictor variables.

Model Equation:

$$\log\left(\frac{p}{1-p}\right) = \beta_\circ + \beta_1 * \text{Age} + \beta_2 * \text{Gender} + \beta_3 * \text{Weight} + \beta_4 * \text{Educational level} + \beta_5 * \text{Occupation} + \beta_6 * \text{Residence} \quad (1)$$

$$y = \begin{cases} 0 \text{ if } p < 0.5 \\ 1 \text{ if } p \geq 0.5 \end{cases}$$

where:

β_0 is the intercept of the model

β_1, β_2, β_3 , β_4, $\beta_5$and $\beta_6$are regression coefficients for age, gender, weight, educational level, occupation and residence respectively.

- Y is the outcome variable.

The main goal of the regression model is to find the values, for β_0, β_1,β_2, β_3 , β_4, $\beta_5$and β_6. These values help minimize the difference between the predicted instances of type 2 diabetes. The model calculates the probability of someone having type 2 diabetes by taking into account factors, like age, gender, weight, education level, occupation and where they live.

Hypothesis Testing of Model Inference

95% Confidence limits for prevalence of Type 2 Diabetes disease

The 95% Confidence Limits for prevalence of disease are a statistical tool used to determine the range of values within which the true population prevalence is expected to fall with 95% probability, based on a particular sample (Brownson *et al*., 2018).

In order to determine the 95% Confidence Limits for illness prevalence, the formula below is used:

$$\text{Lower limit: } \left(\frac{n}{N}\right) - (1.96) * \sqrt{\frac{\left(\frac{n}{N}\right)\left(1-\frac{n}{N}\right)}{N}} \quad (2)$$

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$$\text{Upper limit: } \left(\frac{n}{N}\right) + (1.96) * \sqrt{\frac{\left(\frac{n}{N}\right)\left(1-\frac{n}{N}\right)}{N}} \quad (3)$$

Where: $\frac{n}{N}$ = proportion of individuals in the population with the disease

The value of the z-score for a 95% confidence interval=1.96

The total number of people in the population (N)

The number of patients in the population (n).

Method of model diagnosis

Residual analysis

To determine whether the logistics model was adequate, residual analysis was performed to investigate the residuals. To evaluate the model's goodness of fit and spot potential problems such outliers, non-linearity, and heteroscedasticity, residual analysis in logistic regression is essential.

Multicollinearity test

Variance Inflation Factor (VIF) was the method used to test for multicollinearity. VIF quantifies how much the variance of an estimated regression coefficient increases if your predictors are correlated. A high VIF (typically above 10) indicates multicollinearity.

Sensitivity Analysis

The stability of the model estimates was investigated using sensitivity analysis. **Receiver Operating Characteristic (ROC) Curve** and the area under the curve (AUC) was used to assess the discrimination ability of the model.

Ethical Considerations

All data collected during the study will be kept confidential and will only be accessible to the research team. Participants' names and other identifying information will not be included in any reports or publications resulting from the study. Data will be stored securely and destroyed after the study is completed. Ethical approval was obtained from the Seventh-Day Adventist Hospital before the study was conducted.

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RESULT

Demographic characteristics of type 2 diabetes patients

Table 1: Demographic characteristics of the type 2 diabetes patients from SDA Hospital

Variable	N	%
Age (Years)		
20-40	18	6.6
41-61	119	43.4
62-82	95	34.7
83+	35	12.8
Weight (Kg)		
19-39	11	4.0
40-60	89	32.5
61-81	135	49.3
82+	40	14.6
Gender		
Male	89	32.5
Female	185	67.5
Blood Glucose level		
Normal	133	48.5
Severe	141	51.5
Occupation		
Unemployed	74	27.0
Informal employee	186	67.9
Formal Employee	11	4.0
Pensioner	3	1.1
Educational level		
None	184	67.2

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Primary	35	12.8
JHS	23	8.4
SHS	24	8.8
Tertiary	8	2.9
Location		
Kpandai	10	3.6
Saboba	17	6.2
Sagnarigu	90	32.8
Savelugu	5	1.8
Yendi	7	2.6
Tamale	145	52.9

Table 1 presents a comprehensive overview of the socio-demographic attributes of a cohort of 275 individuals diagnosed with type 2 diabetes at the SDA Hospital. Within this dataset, it is evident that majority of individuals in the sample are between the ages of 41-61 and 62-82. A substantial portion of the individuals has a weight ranging from 61-81 kg. The distribution of gender within this patient cohort demonstrates that a significant majority (67.5%) comprises females, with males constituting the remaining 32.5%. he dataset also reveals that a notable proportion (51.5%) of these patients display severe blood glucose levels, while a smaller subset (48.7%) exhibits normal blood glucose levels. Concerning occupational categorization, a substantial majority (67.9%) of the patients belong to the informal employee group, in contrast to a minority (1.1%) who are classified as pensioners.

Examining the educational backgrounds of these patients, it becomes apparent that a majority (67.2%) have not pursued formal education, with only a small fraction (2.9%) having attained tertiary education. Regarding their geographical locations, a significant majority (52.9%) of type 2 diabetes patients reside within the Tamale Metropolis, while a smaller portion (1.8%) live in Savelugu.

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Table 2: Factors influencing the severity of type 2 diabetes in the SDA hospital

Coefficients	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.010934	1.115991	-0.906	0.365009
Age	-0.035162	0.008971	-3.920	8.87e-05 ***
Weight	0.016565	0.009876	1.677	0.093498
Education	-0.299869	0.129354	-2.318	0.020438 *
Occupation	0.736230	0.261268	2.818	0.004834 **
Residence	0.156170	0.085505	1.826	0.067784
Gender	1.047685	0.302069	3.468	0.000524 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The logistic regression analysis on diabetes risk reveals crucial socio-economic factors. The intercept of -1.010934 signifies the log-odds of diabetes when all predictors are zero. Age exhibits a significant negative association, indicating that as age increases, the likelihood of diabetes decreases ($p < 0.001$). Weight, while positively affecting diabetes likelihood, lacks statistical significance ($p = 0.093498$). Higher education significantly reduces diabetes odds ($p = 0.020438$). Certain occupations are strongly linked to higher diabetes risk ($p = 0.004834$), and specific residential areas show a positive trend, though not statistically significant at the conventional level ($p = 0.067784$). Gender plays a significant role, with females having substantially higher diabetes odds ($p = 0.000524$). These findings emphasize the intricate interplay of age, education, occupation, and gender in diabetes prevalence, underscoring the need for targeted interventions addressing these socio-economic factors to mitigate diabetes risk in the population.

Table 3: Effect of the Socio-economic predictors on the occurrence and severity of type 2 ***diabetes***

Normal	Severe
0.3568956	0.2056147
0.4366061	0.1279783

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0.2216797	0.4073898
0.1870608	0.4761344

The predicted probability in the table above represents the probability of being in the level of interest given the values of the predictor variables: age, Weight, occupation, residence, and gender. From the result shown, it can be interpreted that if a patient has normal type 2 diabetes, there is 20.5% chance of getting severe condition given the predictor variables in the model. Again, the model also predicts that, a type 2 diabetes patient with mild condition has 40.7% chance of getting severe condition than normal condition. The model furthermore, predicts that for a type 2 diabetes patients having normal condition there is 47.6% chance of having a severe condition.

Table 4: Prevalence of type 2 diabetes among the patients of SDA hospital

95% Confidence Limits			
Variables	**Lower CL**	**Proportion as Percent**	**Upper CL**
Gender			
Male	27.70	33.00	38.64
Female	61.36	67.00	72.30
Occupation			
Unemployed	22.37	27.33	32.75
Informal	61.36	67.00	72.30
Formal	1.84	3.66	6.46
Pensioner	0.73	2.00	4.30
Education			
None	62.56	68.00	73.10
Primary	9.41	13.00	17.34
JHS	4.92	7.66	11.28
SHS	5.74	8.66	12.44
Tertiary	1.15	2.66	5.18

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Location			
East Gonja District	1.61	3.33	6.04
Saboba	3.59	6.00	9.31
Sagnarigu	28.02	33.33	38.98
Savelugu	0.54	1.66	3.84
Yendi	1.15	2.66	5.18
Tamale Metropolis	46.85	52.66	58.43

Table 4 reveals the prevalence of types 2 diabetes among the people of Tamale Metropolis as with regards to their socioeconomic characteristics. The prevalence of type 2 diabetes was higher in females (67.00%, 95% CI: 61.36–72.30) compared to males (33.00%, 95% CI: 27.70–38.64). Patients within the informal employee class (67.00%, 95% CI: 61.36–72.30) had a significantly high prevalence of type 2 diabetes compared to Pensioner (2.00%, 95% CI: 0.73–4.30) diagnosed with the disease. Furthermore, patients without any formal education had a prevalence of 68.00% (95% CI: 62.56–73.10) whereas those who have had their tertiary education had a prevalence of 2.66% (95% CI: 1.15–5.18). This indicated that the lowest level or no level of education was observed with the highest prevalence of type 2 diabetes. Moreover, patients residing within Tamale Metropolis had higher prevalence (52.66%, 95% CI: 46.85–58.43) compared to compared to patients from other districts.

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Model diagnosis

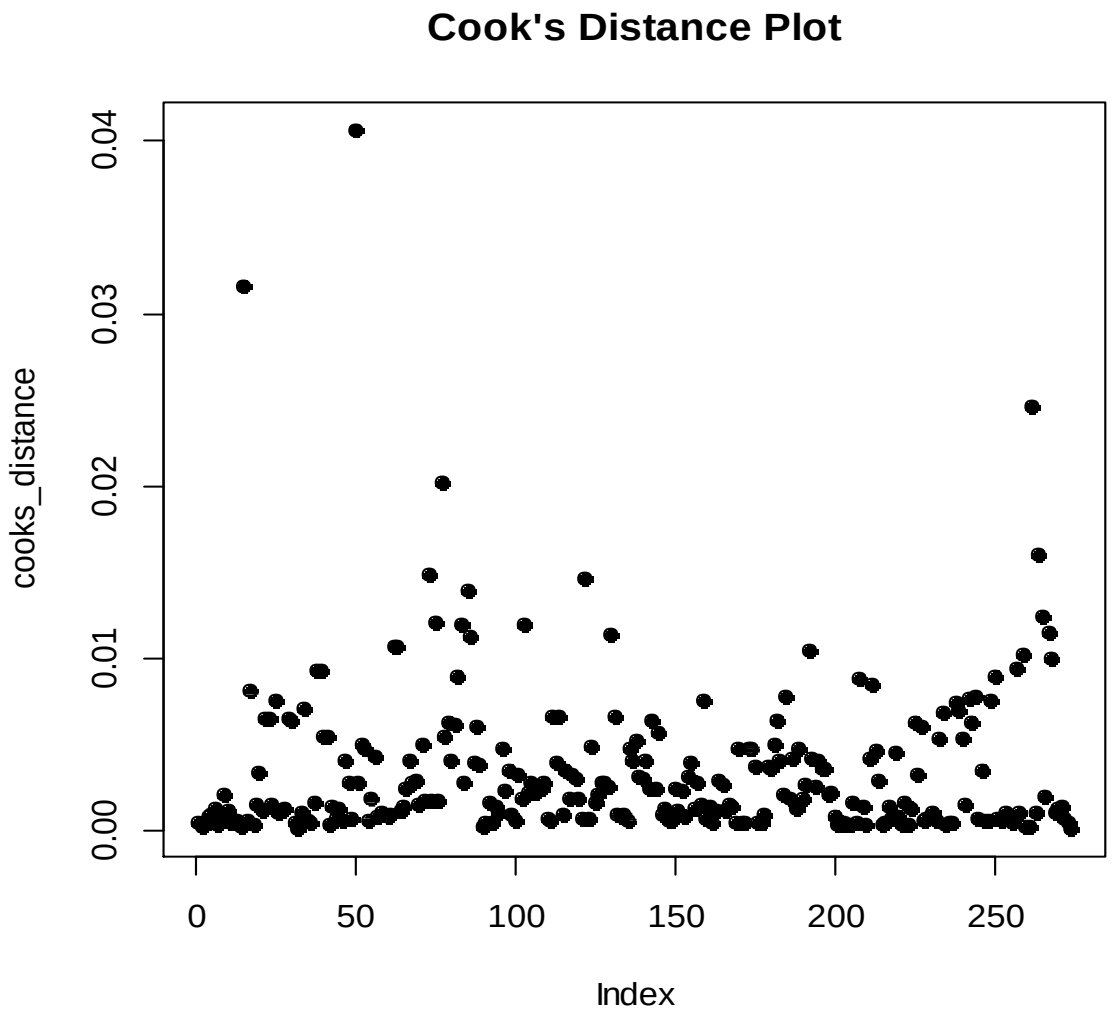

Figure 2: Cook's Distance Plot

Influential observations are those having Cook's Distance values that are noticeably higher than those of the other observations (usually more than 1). Only a few observations from the Cook's Distance plot are far from zero, and these points do not significantly affect the regression coefficients or the overall model fit.

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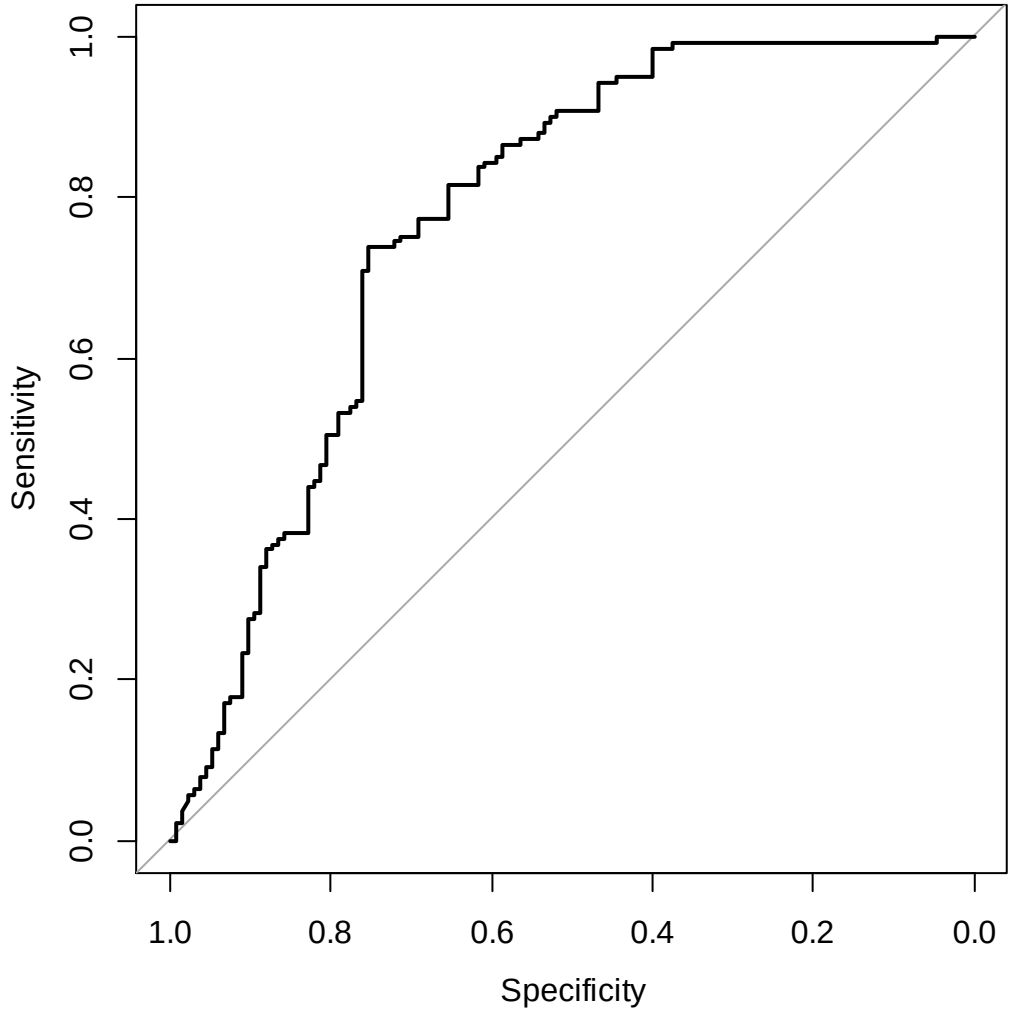

Figure 3: Receiver Operating Characteristic (ROC) Curve

Area under the curve: 0.773

The graph of sensitivity and specificity flattening at almost 1, coupled with an Area Under the Curve (AUC) of 0.773, suggests that the diagnostic model evaluated is performing relatively well. An AUC of 1 represents a perfect model, while an AUC of 0.5 signifies a model performing no better than random chance. In this case, an AUC of 0.773 indicates that the model has a good ability to distinguish between positive and negative cases.

The model has a high true positive rate (sensitivity) and a low false positive rate (1-specificity), according to the flattening of the sensitivity and specificity curves towards 1. This indicates that the model is very effective at correctly classifying individuals as having the illness (low false positive rate) as well as at avoiding false alarms, i.e., diagnosing healthy individuals as having the ailment (high sensitivity).

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Table 5: Multicollinearity test

Variable	VIF
Age	1.049255
Weight	1.061792
Education	1.009286
Occupation	1.019599
Residence	1.029335
Gender	1.016904

The values for the predictor variables' Variance Inflation Factors (VIF) show that the regression model has little to no multicollinearity. Age, in particular, has a VIF of 1.049255, showing minimal multicollinearity, while Weight, Education, Occupation, Residence, and Gender all show low multicollinearity (VIF = 1.061792, 1.009286, 1.019599, 1.029335, and 1.016904, respectively). These variables have low correlations with one another, as indicated by VIF values that are near to 1, which suggests they can be used as largely independent predictors in the model.

DISCUSSION OF RESULTS

The results of this study are in agreement with those of Abagre et al. (2022), who discovered a prevalence of 68.6% of metabolic syndrome among patients attending diabetic clinics in two sub-urban hospitals in Ghana, with a greater prevalence among women. Various investigations, including those by Afaya et al. in 2020, Abagre et al. in 2022, and Mogre et al. in 2017, indicated that characteristics such age, gender, education, and occupation play a role in the prevalence and severity of type 2 diabetes in Ghana, which is in agreement with the results of this study. According to Afaya et al. (2020), type 2 diabetes is more common in Tamale Metropolis residents who are women, low-skilled workers, and those with less education. These findings are consistent with the results of our study.

CONCLUSION

The study concluded that there is a relationship between age, education, occupation, and gender in diabetes prevalence. The study further concluded that there is largely a chance of having severe type 2 diabetes among those with non-severe type 2 diabetes, with few chances of not having a severe condition. Finally, the study concluded that socioeconomic factors play a role in determining the prevalence and severity of type 2 diabetes among residents of Tamale Metropolis, as type 2 diabetes is more common in women, uneducated employees, and people with less education who live in Tamale Metropolis.

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