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Comparative Analysis of Stroke Prevalence and Predictors in Non-Diabetic, Prediabetic and Diabetic Patients: Insight From A Stroke Riskometer Application.

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ABSTRACT

Objective: This study aimed to determine the prevalence and predictors of stroke among individuals aged 30 years and older with varying glycemic statuses (non-diabetic, prediabetic, and diabetic). We also sought to estimate 5-year and 10-year stroke risk using a stroke riskometer.

Methodology: This study was conducted at the Erode Tertiary Care Hospital over six months. The sample size was 391 individuals, meeting specific criteria. We employed a cross-sectional design. The inclusion criteria included age, sex, and glycemic status, while the exclusion criteria involved pregnant women and individuals with psychiatric disorders.

Results: This study revealed an 11.76% stroke prevelence. Individuals with prediabetes and diabetes and a history of high systolic blood pressure and alcohol consumption had increased odds of stroke. non-diabetic individuals with high systolic blood pressure and a history of smoking also had elevated stroke risk. Diabetic patients with comorbidities had the highest average stroke risk (5-year: 7.71%, 10-year: 17.09%). non-diabetic patients with comorbidities also had a significant risk of stroke (5-year: 7.59%, 10-year: 16.6%).

Discussion: These findings emphasize the need for tailored preventive strategies and healthcare interventions for different patient subgroups. Targeted risk management is crucial, especially for diabetic patients with comorbidities and at-risk non-diabetic individuals.

Conclusion: This study provides vital insights into stroke incidence and predictors of different glycemic states, laying the foundation for personalized preventive strategies and healthcare interventions. These strategies aim to enhance stroke management, reduce morbidity, and benefit public health efforts.

Keywords: Stroke, Metabolic States, Stroke Riskometer, Diabetic, Prediabetic, Non-Diabetic....

INTRODUCTION

Stroke is a major global health concern and accounts for a significant burden of morbidity and mortality. It is a complex multifactorial condition with various risk factors contributing to its occurrence [1,2]. One such risk factor is diabetes, a chronic metabolic disorder characterized by high blood glucose levels. The association of diabetes with stroke has been

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extensively studied, and it is well established that individuals with diabetes have an increased risk of developing stroke compared to non-diabetic individuals [2,3]..

However, there is a significant knowledge gap regarding understanding the stroke incidence and predictors in individuals with prediabetes, a condition characterized by higher-than-normal blood glucose levels but not meeting the diagnostic criteria for diabetes. The progression from prediabetes to diabetes is associated with various metabolic and cardiovascular changes, which may influence the risk of stroke [4-7].

To bridge this gap and gain further insights into the comparative analysis of stroke incidence and predictors, we propose conducting a research study using a stroke riskometer [8]. The stroke riskometer is a validated tool that calculates an individual's risk of developing a stroke based on various demographic, lifestyle, and clinical factors. By utilizing this approach, we aim to assess the risk of stroke in three distinct groups: non-diabetic, prediabetic, and diabetic patients [9].

The primary objective of this research was to compare the incidence of stroke among these groups and to determine whether there are significant differences in the occurrence of stroke between non-diabetic, prediabetic, and diabetic patients [10]. Additionally, we aimed to identify the predictors of stroke within each group by examining factors such as age, sex, blood pressure, cholesterol levels, smoking habits, physical activity, and comorbidities [11-13].

Understanding the comparative stroke incidence and predictors in these distinct patient groups is of paramount importance for several reasons. This approach can help healthcare professionals and policymakers identify high-risk individuals who may benefit from targeted preventive interventions. Additionally, these findings can provide valuable insights into the pathophysiological mechanisms underlying stroke development in different metabolic states. This study may contribute to the development of personalized risk assessment and management strategies for stroke prevention.

METHODOLOGY:

2.1 Study area:

This study was conducted at Erode Tertiary Care Hospital, a prominent healthcare institution situated in Erode, India. The Erode serves as a crucial medical hub in the region, attracting patients from various demographic areas. The research spanned a duration of 6 months, ensuring a comprehensive analysis of the collected data.

Of the 391 patients enrolled in the study, 222 (56.78%) were men, and 169 (43.22%) were women, reflecting a diverse participant composition. The age distribution of the patients revealed that the majority were 45-65 years (63.17%), followed by 65 years or older (24.55%) and 30-44 years (12.27%).

2.2 Inclusion and exclusion criteria

The inclusion criteria included individuals aged 30 years and above, of both sexes (male and female), and diagnosed with prediabetes or diabetes, as well as non-diabetic conditions such as hypertension, high cholesterol, and cardiovascular diseases such as myocardial infarction, coronary artery disease, and atherosclerosis [14,15]. However, individuals diagnosed with stroke were excluded from the stroke riskometer analysis. The exclusion criteria further specified the exclusion of pregnant women and patients with psychiatric disorders.

2.3 Stroke riskometer application

The research methodology incorporated the use of a stroke riskometer to enhance the depth of analysis in the study. Participants diagnosed with stroke were identified and subsequently excluded from the stroke riskometer analysis. The stroke riskometer is a valuable tool for assessing the risk of stroke based on various health parameters and lifestyle factors [8,9]. By excluding individuals with a history of stroke from this specific analysis, the study aimed to focus on a cohort without the confounding effects of prior stroke incidents. This strategic use of the stroke riskometer not only contributes to the precision of the findings but also ensures a more targeted exploration of factors associated with prediabetes, diabetes, and related cardiovascular conditions within the specified population [16,17].

2.4 Statistical analysis

Utilizing a standardized methodology, we constructed three multivariable logistic regression models to determine the predictors of stroke in patients without diabetes, prediabetes, and those with diabetes. Using a liberal p value threshold of ≤ 0.20, we first looked at univariable relationships between each possible predictor and the outcome. We performed a two-way Spearman rank correlation analysis on variables exhibiting significant relationships ($p \leq 0.20$) in univariable analyses in order to address multicollinearity. Based on statistical analysis and biological significance, we chose one variable for assessment in subsequent multivariable models for couples that were highly linked ($r > 0.7$). After that, we created final weighted multivariable models by hand using backward elimination techniques, establishing removal criteria at a significance level of ≤ 0.05. The variables that showed statistically significant relationships with the result were included in the final main-effects models. In these final models, odds ratios and 95% confidence intervals (CIs) were calculated for each predictor. The Hosmer–Lemeshow test was used to evaluate the models' goodness-of-fit. To guarantee a thorough and

methodical investigation of stroke predictors across all patient groups, all statistical analyses were carried out using SPSS.

RESULTS:

In our comprehensive study encompassing 391 patients, 56.78% were men, and 43.22% were women. The predominant age groups were 45-65 years (63.17%), 65 years or older (24.55%) and 30-44 years (12.27%). The majority of non-diabetic patients were aged 45 to 65 years (65.27%), with a predominant male representation (60.41%). A significant proportion of these patients exhibited a body mass index between 18.5 and 24.9 (56.25%). In terms of risk behaviors, a considerable number of participants were smokers (56.25%), had experienced depression (84.72%), had engaged in heavy drinking habits (55.55%), and reported consuming fruits and vegetables at least once a day (52.08%). However, a lower percentage indicated being highly physically active (26.38%). Additionally, almost half of the non-diabetic patients had hypertension (84.72%), and a significant portion reported having any kind of heart disease (59.72%). Of the 124 non-diabetic patients, nearly 20 (13.88%) had experienced a stroke.

Patients with prediabetes, constituting 58.62% of the cohort, were primarily in the 45 to 65 years age group, with a predominant male representation of 72.41%. A significant majority of these patients maintained a body mass index within the range of 18.5 to 24.9 (65.51%). In terms of risk behaviors, similar to non-diabetic patients, those with prediabetes were predominantly smokers (62.06%), had depression (93.1%), had heavy drinking habits (51.72%), and reported consuming fruits and vegetables at least once a day (20.68%). However, a higher percentage of prediabetic patients reported being highly physically active (50%). A similar percentage of prediabetic patients were diagnosed with hypertension (93.1%) or any kind of heart disease (46.55%). Of the 49 prediabetic patients, nearly 9 (8.99%) had experienced a stroke.

The patients with diabetes, comprising 62.96% of the total population, were predominantly in the 45 to 65 years age bracket, with a slight female majority (50.79%). The majority of these patients maintained a body mass index within the range of 18.5 to 24.9 (51.85%). In terms of risk behaviors, a significant proportion of diabetic patients were nonsmokers (53.96%), had depression (56.08%), had heavy drinking habits (43.38%), and reported consuming fruits and vegetables at least once a day (49.73%). However, a lower percentage indicated being highly physically active (26.45%). Comparatively, in contrast to non-diabetic patients, a lower percentage of diabetic patients had hypertension (56.08%) and any kind of heart disease (33.86%). Of the 172 diabetic patients, nearly 17 (8.99%) had experienced a stroke.

The overall prevalence of stroke in the patient population was 11.76%, with 46 patients identified as having experienced a stroke and the remaining 345 not having a history of stroke. Consequently, stroke patients were excluded from the subsequent stroke riskometer analysis; calculations of 5-year and 10-year risk were performed for 124 non-diabetic (35.94%), 49 prediabetic (13.33%), and 172 diabetic (49.85%) patients. Further categorization based on comorbidity status revealed that 62.60% of patients had comorbid conditions, 15.65% had non-diabetic patients, 14.20% had prediabetic patients, and 32.75% had diabetic patients. [Table: 1]

Table 1 shows the patients' health, lifestyle, and demographic information.

Characteristic	Category	Non-Diabetic (n=144)		Prediabetic (n=58)		Diabetic (n=189)	
		n	Weighted %	n	Weighted %	n	Weighted %
Age	65 years or over	35	24.3	12	20.68	49	25.92
	45 to 65 years	94	65.27	34	58.62	119	62.96
	30 to 44 years	15	10.41	12	20.68	21	11.11
Sex	Male	87	60.41	42	72.41	93	49.2
	Female	57	39.58	16	27.58	96	50.79

Body Mass Index	under 18.5	1	0.69	1	1.72	5	2.64
	between 18.5 and 24.9	81	56.25	38	65.51	98	51.85
	between 25 and 29.9	53	36.8	17	29.31	73	38.62
	30 or over	9	6.25	2	3.44	13	6.87
Smoking History	Yes	81	56.25	36	62.06	87	46.03
	No	63	43.75	22	37.93	102	53.96
Alcoholic History	Yes	80	55.55	30	51.72	82	43.38
	No	64	44.44	28	48.27	107	56.61
Consume fruit(s) & Vegetable(s)	≥1 per day	75	52.08	12	20.68	94	49.73
	< 1 per day	69	47.91	46	79.31	95	50.26
Physical activity per hour	1 or less	61	42.36	13	22.41	59	31.21
	1 to 2 hours	45	31.25	16	27.58	80	42.32
	2.5 hours and more	38	26.38	29	50	50	26.45
Stress or Depression in the past year	Yes	122	84.72	54	93.1	106	56.08
	No	22	15.27	4	6.89	83	43.91
Family History of stroke or heart attack	Yes	40	27.77	17	29.31	53	28.04
	No	51	35.41	22	37.93	73	38.62
	Do not know	53	36.80	19	32.75	63	33.33
Systolic Blood Pressure	<120	15	10.41	1	1.72	41	21.69
	120-129	5	3.47	2	3.44	25	13.22

	130-139	12	8.33	1	1.72	29	15.34
	140-159	27	18.75	33	56.89	35	18.51
	>160	85	59.02	21	36.2	59	31.21
Consume blood pressure-lowering medication	Yes	122	84.72	54	93.1	106	56.08
	No	22	15.27	4	6.89	83	43.91
Any Kind of heart disease	Yes	86	59.72	27	46.55	64	33.86
	No	78	54.16	31	53.44	124	65.6
Enlarged Heart	Yes	25	17.36	5	8.62	7	3.7
	No	119	82.63	53	91.37	182	96.29
Atrial Fibrillation	Yes	14	9.72	4	6.89	5	2.64
	No	130	90.27	54	93.1	184	97.35
Cognitive Problem	Yes	2	1.38	0	0	5	2.64
	No	142	98.61	58	100	184	97.35
Poor Memory	Yes	36	25	5	8.62	33	17.46
	No	108	75	53	91.37	156	82.53
Traumatic brain injury	Yes	3	2.08	0	0	2	1.05
	No	141	97.91	58	100	187	98.94
Stroke	Yes	20	13.88	9	15.51	17	8.99
	No	124	86.11	49	84.48	172	91

3.1 Predictors of stroke:

The analysis of predictors of stroke in our study revealed noteworthy associations across different glycemic states. In individuals with prediabetes, high systolic blood pressure (OR = 7.66; CI = 0.67, 5.65) and a history of alcohol consumption (OR = 5.00; CI = 0.07, 3.78) were significantly ($p \leq 0.05$) associated with increased odds of stroke. For those with diabetes, high systolic blood pressure (OR = 1.64; CI = 1.23, 8.06) remained a significant predictor, while a history of alcohol consumption (OR = 0.80; CI = -0.21, 10.31) showed a less pronounced association. Among non-diabetic individuals, high systolic blood pressure (OR = 1.46; CI = 0.80, 2.47) and a history of smoking (OR = 1.19; CI = 0.10, 1.58) were identified as significant predictors of stroke risk. [Table: 2]

Table 2 shows that the multivariable logistic regression models illustrating stroke factors among patients with non-diabetes,

prediabetes and diabetes.

Variables	Non-Diabetic		Prediabetic		Diabetic	
	OddsRatio	**P-value**	**OddsRatio**	**P-value**	**OddsRatio**	**P-value**
Age	0.029403	**0.868**	-2.06711	**0.124**	-0.434	**0.084**
Gender	0.099155	**0.644**	4.518563	**0.02**	-0.272	**0.6**
Smoking History	1.196449	**0.176**	-1.170721	**0.812**	-0.25	**0.512**
Alcoholic History	0.931539	**0.00**	5.003372	**0.024**	0.802	**0.112**
Consume Fruits	-1.148732	**0.00**	-1.794559	**0.028**	-0.153	**0.712**
Physical Activity	-1.385904	**0.00**	-6.759772	**0.00**	-3.128	**0.00**
Stress	-0.955883	**0.00**	-1.107103	**0.032**	-1.372	**0.004**
Family History	-0.540598	**0.028**	2.691783	**0.396**	0.156	**0.808**
Systolic BP	1.460371	**0.00**	7.662916	**0.004**	1.641	**0.00**
Diabetes	1.021512	**0.00**	1.744386	**0.016**	0.032	**0.912**
Heart Disease	-1.024862	**0.00**	-1.438306	**0.116**	-0.032	**0.788**
Enlarged Heart	-2.081621	**0.00**	-5.442841	**0.032**	-1.438	**0.052**
Atrial Fibrillation	-1.321968	**0.00**	-5.27689	**0.028**	0.011	**0.912**
Cognitive Problem	1.000324	**0.00**	1.744386	**0.016**	0.794	**0.052**

Poor Memory	-1.250416	**0.00**	-4.720252	**0.012**	-2.369	**0.00**
HbA1c	-0.655225	**0.028**	1.162924	**0.016**	1.648	**0.00**
Hypertension	0.043871	**0.72**	-0.031952	**0.876**	-0.5	**0.172**

3.2 Stroke riskometer analysis

The study revealed that diabetic patients with comorbidities had the highest average stroke risk at 7.71% over 5 years and 17.09% over 10 years. Additionally, non-diabetic patients with comorbidities exhibited substantial average stroke risk percentages, with 7.59% over 5 years and 16.6% over 10 years. [Figure 1 and Figure 2]

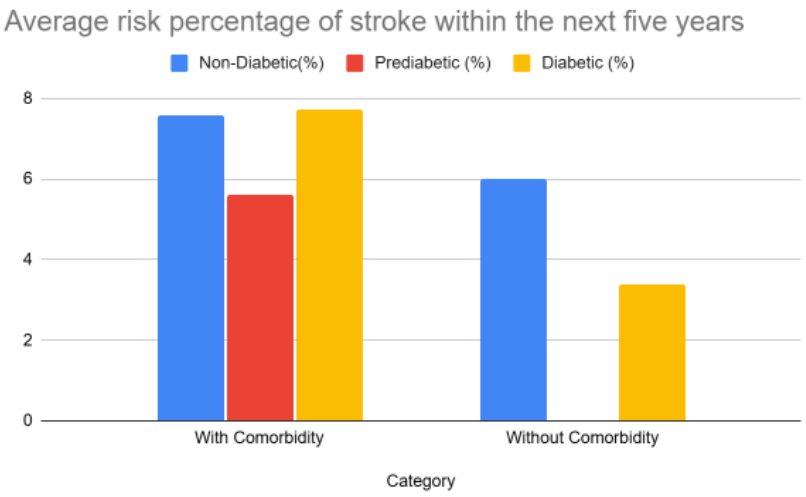

Figure 1 shows Average risk percentage of stroke for 5-years

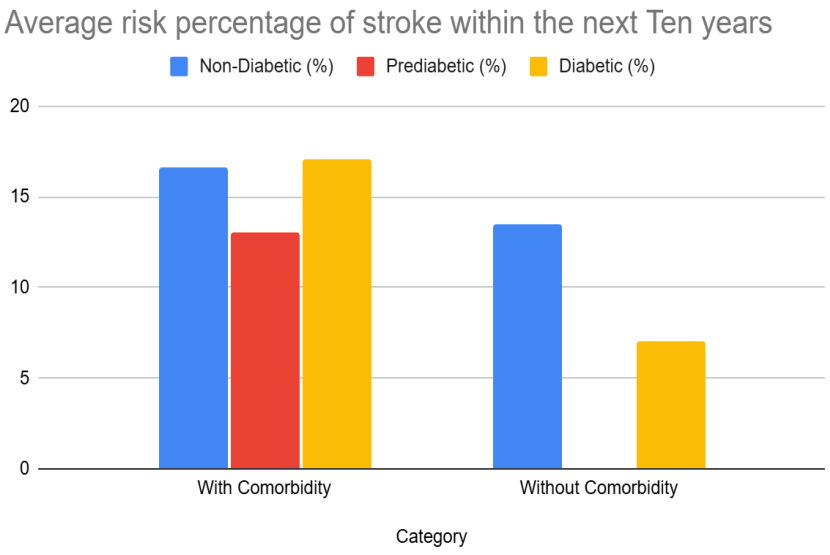

Figure 2 shows Average risk percentage of stroke for 10 years

DISCUSSION:

This study examined the prevalence and risk factors for stroke in patients at Erode Tertiary Care Hospital who did not have diabetes, prediabetes, or diabetes. Prior research has not examined stroke predictors in individuals without diabetes, prediabetes, or diabetes; however, this knowledge is vital for informing health initiatives aimed at lowering the incidence of stroke in Europe.

This study's discovery of hypertension as a common predictor of stroke in people without diabetes, prediabetes, or diabetes is in line with the conclusions of earlier research [18-20]. AHA research has shown that high blood pressure raises the risk of stroke by weakening the arteries, which increases the likelihood that the arteries burst or clog, causing ischemic or hemorrhagic stroke, respectively [20]. There is evidence that people with prediabetes and diabetes have blood vessel damage and impaired heart and kidney function as a result of having blood glucose levels that are higher than normal [21,22]. Reduced kidney function results in an increase in blood volume and a subsequent decrease in blood vessel stretching capacity. Therefore, if an adult has hypertension in addition to prediabetes and diabetes, their risk of stroke increases.

Age was identified in earlier research as a non modifiable risk factor for stroke in both men and women [23-25]. This study revealed that people with diabetes and prediabetes who were 45 years of age or older had increased odds of stroke. After age 55, the risk of stroke doubles every ten years, according to a study by Bushnell et al. [26]. One potential mechanism for the effect of aging could be that endothelial dysfunction and decreased cerebral autoregulation cause arteries to naturally grow more difficult and narrower as people age. Furthermore, as people age, their risk of stroke increases due to conditions such as diabetes, hypertension, atrial fibrillation, coronary artery disease, and peripheral artery disease [24]. However, research also points to a higher risk of stroke among teenagers and younger adults (15–49 years old) as a result of obesity and high blood pressure. Unlike earlier results, the findings of that study did not reveal a significant correlation between age and the risk of stroke in patients with diabetes [26]. The cause of this difference is still unknown. Nonetheless, older people with diabetes frequently have two or more comorbidities, which may be associated with age, one of the main cardiovascular risk factors, to increase the risk of stroke [24].

Furthermore, our analysis highlighted universally impactful predictors across all three glycemic groups, with physical activity ($p < 0.05$) and systolic blood pressure emerging as consistent factors influencing stroke risk. In the non-diabetic group, an alcohol history was a significant predictor of alcohol consumption, emphasizing the elevated risk associated with alcohol consumption in individuals without glycemic abnormalities. In the prediabetic group, sex and stress were identified as specific predictors of stroke risk, revealing sex-based disparities and the impact of psychological stress on stroke risk in individuals with impaired glucose tolerance. Within the diabetic group, the presence of heart disease and poor memory were significant predictors, underscoring the compounded risk associated with cardiovascular conditions and cognitive decline in individuals with diabetes mellitus. These findings contribute valuable insights into the multifaceted nature of stroke predictors across different glycemic states, guiding targeted interventions and risk management strategies tailored to specific patient groups.

LIMITATIONS:

A limitation of our study is that it was conducted at a single tertiary care hospital in Erode, which may not fully represent the broader population. The sample size was relatively modest, and the study's cross-sectional design limits our ability to establish causal relationships between the identified predictors and stroke occurrence. Additionally, our reliance on self-reported data for lifestyle factors such as smoking, alcohol consumption, and stress or depression may introduce reporting bias. Furthermore, while stroke riskometry is a valuable tool, it relies on certain assumptions and may not capture all potential risk factors for stroke. Future research should include larger and more diverse samples, longitudinal designs, and additional objective measures to address these limitations and provide a more comprehensive understanding of stroke risk in different patient groups.

CONCLUSION:

In conclusion, our study provides crucial insights into the prevalence and predictors of stroke among individuals with varying glycemic statuses, namely, non-diabetic, prediabetic, and diabetic patients. Through the utilization of a stroke riskometer and rigorous statistical analysis, we identified significant associations between specific risk factors and stroke occurrence within each group. Our findings underscore the importance of tailored preventive strategies and healthcare interventions for different subgroups, emphasizing the need for targeted risk management, especially among diabetic patients with comorbidities and at-risk non-diabetic individuals. Moreover, the identification of universally impactful predictors such as physical activity and systolic blood pressure across all glycemic groups highlights the multifaceted nature of stroke risk factors. While our study has certain limitations, including its single-center design and reliance on self-reported data, it lays a solid foundation for further research in this critical area. These insights contribute to the development of personalized risk assessment and management strategies, ultimately aiding in stroke prevention, reducing morbidity, and benefiting public health efforts in India and beyond.

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Availability of Data and Materials:

The data supporting the findings of this study are available within the attached manuscript. The manuscript provides detailed information on the study methodology, including the study area, inclusion and exclusion criteria, and the application of the stroke riskometer. The data collected during the research is presented in the form of tables and statistical analyses, allowing for transparency and reproducibility of the study's findings. No external funding was received for this research, and the authors have made the data readily accessible within the published work.

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