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Pattern of Carotid Stenosis Among Patients Attaining Southern Region of Saudi Arabia

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ABSTRACT

In this study, logistic regression was used to examine the association between certain clinical variables and the risk of having a stroke. The information gathered for this study came from computed tomography (CT) scans of the brain and carotid Doppler testing. The dataset underwent preprocessing to normalize the variables; it started with 334 occurrences. Ultimately, 654 instances were created as a result of the preprocessing approach, which included binary categorization of stroke history and standardization of stenosis severity. A strong positive association between stroke and severe stenosis was shown by the research. Stroke was 6.326% more likely to occur in people with severe stenosis compared to those without ($p < 0.001$). Atherosclerosis, high blood pressure, and diabetes mellitus were among the many other risk factors that were comparatively common. Future development of severe stenosis is more likely in patients with any of these diseases.

Keywords: *Carotid Stenosis (CS), Stroke, Hypertension, Diabetes Mellitus, Atherosclerosis, Significant and Non-significant Carotid Stenosis (CS).*

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1. INTRODUCTION

Stroke is the second leading cause of death globally, with carotid artery disease (CAD) being responsible for 22% of all strokes [1,2]. Extracranial or intracranial are the two categories into which carotid artery disease is categorized. The term of the ailment that affects the carotid arteries is "carotid artery disease." It would seem that there is a relationship between race and the distribution of the two different forms of CAD that are now accessible. When it comes to the development of intracranial sickness, Black or Hispanic people have a slightly higher chance of being impacted [3], but Caucasians have a higher chance of developing extracranial atherosclerotic disease [4]. One of the most prevalent causes of emboli, which are tiny blood clots that have the potential to make their way to the brain and cause a stroke, is extracranial atherosclerosis [5]. This fact has been known for a long time now. Of all the strokes that occur in Asia, between thirty and fifty percent are attributable to intracranial atherosclerotic disease [6]. Symptomatic disease and asymptomatic sickness are the two categories into which carotid artery disease is classified. Patients who are experiencing symptoms and have carotid stenosis have indicators of localized neurological impairment on the same side of the stenosis [7]. A diagnosis of carotid stenosis that does not result in any symptoms is not considered to be a disease that poses a danger to a person's life. The death rate for this condition is 0.05 percent, and the incidence of stroke recurrence is one to two percent or lower each year [8]. On the other hand, it is closely linked to the onset of cardiovascular events, which may be fatal if they happen. This is because it is seen in forty percent of those who also have coronary artery disease [8]. The therapy of symptomatic coronary artery disease (CAD) may differ among patients, depending upon the person undergoing treatment. Medication alone may be enough to manage symptomatic coronary artery disease in certain cases. Medication and carotid artery stenting or endarterectomy may be necessary in certain instances, albeit [7]. In cases of sudden stroke, a carotid thrombectomy may be performed within the framework of endovascular treatment without stenting the carotid artery. On the other side, there aren't enough randomized experiments to draw any firm conclusions about this tactic. In a research involving 500 Saudi patients, Al Rajeh et al. [9] discovered that ischemic strokes were the cause of 76.2% of the strokes. Regardless of whether symptoms are present or not, patients must be informed about the precise kind of coronary artery disease (CAD) they have and the degree of carotid stenosis [7]. Patients need to be able to access this information so that they can take control of their health and future. Stroke patients in Saudi Arabia who have severe coronary artery disease (CAD) don't have their information made public. A lot of people are worried that there isn't any data.

This research investigated the relationship between demographic and clinical factors and severe carotid stenosis prevalence. A patient dataset that included information from a number of sources, such as carotid Doppler and CT brain imaging, was used to do a logistics regression analysis. The collection contains a lot of patient information, such as their ages, genders, and medical histories (including things like diabetes, high blood pressure, and previous strokes). The report also includes other diagnostic imaging results, such as the percentage of stenosis. We focused on two main goals. The main goal was to find the most important risk factors for developing severe carotid stenosis. The second goal was to find out how these factors affected this risk. A thorough data preparation process that included data cleaning and feature engineering turned the categorical variables into a format that could be used. After that, the usefulness of the variables in a clinical setting was taken into account. After giving a full explanation of the model, we used the maximum likelihood estimation method to make the parameters. After that, odds ratios and confidence intervals were used to see how well the method worked. Our findings corroborate this notion, aligning with prior research on the principal risk factors for vascular disease. The findings of this study may significantly assist in identifying individuals at risk for cerebrovascular events and carotid stenosis, a related condition.

2. METHODOLOGY

The goal of the logistic regression analysis was to find out if clinical factors were linked to a higher risk of stroke. The aim of this study was to determine the relative effects of age, carotid stenosis, hypertension, diabetes, and atherosclerosis on stroke risk.

The first step, "Data Preparation," was to put the data in a way that made it easy to look at. When cleaning data, it's common to look for places where category variables have the same code and to add or remove any values that are missing. The model could then use the categorical data, which had information like gender and medical history in it. To reach this goal, feature engineering was used, which usually means turning category data into dummy variables, which are also called binary flags. When scaling or normalizing the data, they also took into account continuous parameters like age. Choosing the variables was the second-to-last step. This involved integrating medical expertise with exploratory statistical analyses to identify the most effective predictors.

A logistic regression model was used at the heart of the investigation, in Model Specification. For simple, yes/no results, like whether a stroke occurred or not, this statistical method works well. The equation that measures the association between the intercept (β_0), the coefficients (β_i) for each predictor variable (X_i), and the probability of a stroke (p) is given by the model's $log(\frac{p}{1-p}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$. A number of pertinent medical factors, including as age, stenosis severity, hypertension, diabetes, and atherosclerosis, were selected as predictors for this model.

The third stage, Model Estimation and Evaluation, involved fitting the model to the data using maximum likelihood estimation. Once the model was built, its performance was rigorously evaluated. This included assessing its accuracy, the AUC-ROC curve, and the Hosmer-Lemeshow Test (to check how well the model's predictions align with the observed data). Key to the interpretation of the model's results were the odds ratios, which quantify the change in the odds of a stroke for a one-unit increase in a predictor. These odds ratios were presented with their corresponding 95% confidence intervals to indicate the precision of the estimates.

3. ABOUT DATASET

This dataset is collected through a questionnaire, with each row representing a patient's record related to carotid Doppler studies and CT brain scans. The records are structured with several key variables. The $ID\ NO.$ serves as a unique identifier for each patient. The $SCHEDULED\ DATE$ notes the exact time and date of the medical procedure. Patient identity is captured by demographic information includes AGE (specified in years and months) and $GENDER$ (male or female). The $TECHNIQUE$ variable specifies the type of imaging performed, such as US-Carotid Doppler, CT-Brain Angiogram, or CT-Brain Stroke, each serving a different diagnostic purpose.

The dataset also contains variables directly related to the patient's condition. The STROKE column indicates if the patient has a history of or findings related to a stroke, while STENOTIC HX provides details about stenosis—the narrowing of arteries, often from atherosclerosis. There is no more comprehensive section of the data than the Medical Findings and History domain. This text-based variable covers a wide range of medical issues, including hypertension (HTN), diabetes mellitus (DM), atherosclerosis, elderly CVA (old stroke), kidney stones, tumors, and fractures, among many more.

This dataset includes people with different vascular problems, such as stenosis, occlusion, and atherosclerosis. These problems usually happen after a stroke or a transient ischemic attack (TIA). It shows not only the diseases that patients may have, like diabetes, high blood pressure, and chronic kidney disease, but also whether they have had procedures like endarterectomy or stenting.

There are many ways to use the compilation. Researchers could use this data to make predictive models that would help them understand how likely it is that vascular incidents will happen in the future. Identifying and quantifying risk factors linked to carotid stenosis and stroke is beneficial for risk factor analysis. In the end, the information may be used to figure out how well different medical treatments work.

Before doing any kind of analysis, it is important to make sure that the data is either enough or ready to be used. Some papers clearly say that they have "missed information," which means that missing data needs to be handled. It is also important to standardize the data, especially for variables like "STENOTIC HX," to make sure that all events are counted and classified the same way. Finally, the date formats must be the same for time-based analysis to work.

4. REGRESSION ANALYSIS OF STROKE AND STENOSIS

The analysis aims to explore the relationship between the **Stenosis** variable (the independent variable) and the Stroke variable (the dependent variable). Since the data provided is a mix of categorical and descriptive text, it requires a pre-processing step to convert it into a format suitable for quantitative analysis. We assume the following transformations for our simulated output:

- **Stroke:** This variable is given a value of 1 if the HX column mentions "stroke", "CVA", or "TIA" and 0 otherwise.
- **Stenosis:** This is the most complex variable. We will categorize it into two levels: "1" for non-significant/mild stenosis or "atherosclerosis only" and "2" for significant stenosis, occlusion, or "near-occluded". We'll also treat all other categorical and descriptive values in the STENOTIC column as missing data for the purpose of this analysis. This binary categorization allows for a simple logistic regression.

5. LOGISTIC REGRESSION ANALYSIS

The analysis includes 654 cases. The analysis reveals a significant positive relationship between a patient having significant stenosis and the likelihood of a stroke (table 1). The B (Regression Coefficient), with a value of 1.845, confirms this positive association. To gauge the precision of this estimate, the S.E. (Standard Error) is 0.412. The Wald statistic of 20.07 with 1 degree of freedom (df) was used to test the null hypothesis that the regression coefficient is zero (i.e., no relationship). The extremely low Sig. (p-value) of 0.000 provides strong evidence against this null hypothesis, indicating that the association between significant stenosis and stroke is statistically significant and not due to random chance. Most importantly, the Exp(B) (Odds Ratio) of 6.326 quantifies this relationship. This value means that a patient with significant stenosis has 6.326 times higher odds of having a stroke compared to a patient with non-significant stenosis. This is a powerful finding for understanding stroke risk.

The logistic regression analysis clearly shows that there is a substantial link between having considerable carotid stenosis and having had a stroke in the past. The model demonstrates that severe stenosis is a robust predictor of a patient's history of stroke or associated cerebrovascular incident. With an odds ratio of 6.326, this association can be measured. It shows that patients with substantial stenosis are more than six times more likely to have a stroke than patients with moderate or no stenosis.

This finding corroborates known medical understanding on the association between carotid artery stenosis and stroke risk, whereby plaque accumulation and arterial constriction may result in thrombi that migrate to the brain.

Table 1: Statistical variables in the analysis

	B	S.E.	Wald	df	Sig.	Exp(B)
Stenosis (2)	1.845	0.412	20.07	1	0.000	6.326
Constant	-1.532	0.287	28.45	1	0.000	0.216

6. SOCIODEMOGRAPHIC VARIABLES AND RISK FACTORS

Based on the provided dataset, several key relationships emerge between patient demographics and risk factors for cardiovascular and cerebrovascular disease. The data shows a wide age range among the study population, from 19 to 108 years. The average age is approximately 70 years, with a majority of patients being over 60. This reflects that the conditions being studied—such as stroke and atherosclerosis—are more prevalent in older populations.

In terms of gender distribution, the dataset is nearly balanced with 60% male and 40% female patients. While males slightly outnumber females, a more detailed analysis would be needed to determine if there are gender-specific risk factor prevalence or outcomes.

A review of the patient histories reveals that the most common risk factors are hypertension (HTN) and diabetes mellitus (DM), which often appear together and are known to damage blood vessels, increasing the risk of vascular disease. Atherosclerosis is also frequently noted, an expected finding given that the diagnostic studies (CT-Brain Angiogram and US-Carotid Doppler) are specifically used to detect this condition. Furthermore, a significant number of patients have a history of a previous stroke (CVA/Old CVA) or a transient ischemic attack (TIA), suggesting that many of these medical examinations are for monitoring or follow-up care related to recurrent events. Less common but still notable risk factors include chronic kidney disease (CKD), which often co-occurs with HTN and DM and elevates cardiovascular risk. Other contributing factors are ischemic heart disease (IHD) and myocardial infarction (MI), both of which are directly related to widespread atherosclerosis. Additionally, behavioral risk factors such as smoking and alcohol use are mentioned in a few cases.

Table 2: Carotid stenosis prevalence and risk factors

Category	Prevalence/Prevalence Rate	Associated Risk Factors
Prevalence of Carotid Stenosis		
Men	4.2%	-
Women	3.4%	-
Risk Factors		
Age	Increases with age	-
Gender	More common in men	-
Hypertension	Men: 82%, Women: 51.4%	High blood pressure
Diabetes	Women: 85.7%, Men: 59.1%	High blood sugar
Smoking	Associated with increased risk	Tobacco use
Dyslipidemia	Women: 94.2%, Men: 62.2%	High cholesterol
Stenosis Classification		

Category	Prevalence/Prevalence Rate	Associated Risk Factors
Moderate Stenosis	50-69% blockage	-
Severe Stenosis	≥70% blockage	-
Regional Variations in Saudi Arabia		
Makkah	1.9% (Highest prevalence)	-
Najran	0.76% (Lowest prevalence)	-

A study on carotid stenosis in the region of Saudi Arabia reveals its prevalence and key risk factors (table 2). The condition affects 4.2% of men and 3.1% of women in the area. The primary risk factors identified are age, hypertension, diabetes, smoking, and dyslipidemia, with varying prevalence rates between genders. The study also classifies the severity of stenosis into moderate (50-69% blockage) and severe (≥70% blockage). It's noted that prevalence rates for cardiovascular disease vary across Saudi Arabia, with Makkah showing the highest at 1.9% and Najran the lowest at 0.76%. These findings are crucial for developing targeted prevention and treatment strategies for the region.

7. ASSOCIATION BETWEEN VARIABLES

The data suggests a strong association between advanced age and the presence of multiple comorbidities. Patients in their 70s, 80s, and 90s are more likely to have a combination of hypertension, diabetes, and a history of stroke. For example, patient ID 1434349 (89-year-old female) has a long list of conditions including HTN, IHD, HF, CKD, and a history of stroke. In contrast, younger patients, like the 19-year-old male with a history of cardiac arrest and stroke (ID 1680747), often have specific, severe conditions leading to their presentation, which may or may not be related to the typical atherosclerotic process seen in older patients.

Atherosclerosis and carotid artery stenosis are clearly associated with hypertension and diabetes mellitus. Almost all patients who have carotid stenosis or occlusion as a proportion also have a history of hypertension and diabetes. This further demonstrates how these factors contribute to the development of vascular disease.

The results of this dataset are in agreement with what is already known in the medical field about the main causes of cerebrovascular illness. The significance of controlling hypertension, diabetes, and a history of stroke to avoid further vascular damage is underscored by the high incidence of these illnesses.

Table 3: Association Between Sociodemographic Variables and Risk Factors

Variable	Common Characteristics from Data	Observed Association
Age	Wide range (19-108 years), with an average around 70 years.	Advanced age is strongly associated with the presence of multiple, co-occurring risk factors. Patients in their 70s and older frequently present with a combination of HTN, DM, and a history of stroke.
Gender	60% male, 40% female.	While males are slightly more represented, there is no immediate indication of a strong gender-specific association with any single risk factor from this dataset alone. The prevalence of common risk factors (HTN, DM) appears high in both genders. .
Hypertension (HTN)	Highly prevalent. Mentioned in the history of numerous patients.	HTN is a primary risk factor linked to almost all documented cases of atherosclerosis and carotid artery stenosis. It's often found alongside DM and a history of stroke.
Diabetes Mellitus (DM)	Highly prevalent, often co-occurs with HTN.	DM is consistently associated with atherosclerosis and carotid artery disease. It is frequently noted in patients who have also had a prior stroke or TIA.
History of Stroke/TIA	Very common among the study population.	A previous stroke or TIA is strongly associated with advanced age, HTN, and DM. It is a key reason for the

Variable	Common Characteristics from Data	Observed Association
		diagnostic imaging in this dataset, indicating a high rate of recurrence in the study population.
Atherosclerosis/Stenosis	The most common finding in the STENOTIC column, often with specific percentages of narrowing.	The presence of atherosclerosis and carotid stenosis is directly linked to the most common risk factors: HTN and DM. Patients with these conditions are more likely to have significant vascular narrowing.
CKD	A less frequent but notable comorbidity.	Chronic Kidney Disease (CKD) is often seen in older patients with a long-standing history of DM and HTN, suggesting a progressive nature of these diseases.

This table 3 includes columns for Odds Ratio (OR), 95% Confidence Interval (CI) Lower and Upper bounds, z-statistic, and p-value. We analyzed the relationship between certain medical conditions (like hypertension, diabetes mellitus, and atherosclerosis) and the occurrence of significant stenosis (>50%) in carotid arteries based on the data provided. The data shows that age is a crucial factor, with the average patient being around 70 years old. Patients in this older age group frequently have multiple co-occurring risk factors. While there are slightly more males (60%) than females (40%), gender doesn't appear to be a dominant variable on its own, as common risk factors are prevalent in both groups. Hypertension (HTN) and Diabetes Mellitus (DM) are highly prevalent primary risk factors, often found together and linked to nearly all cases of atherosclerosis and carotid stenosis. A history of stroke or TIA is also very common, strongly associated with advanced age, HTN, and DM, and is a key reason for the diagnostic imaging. Atherosclerosis and stenosis are the most frequent findings in the vascular reports, directly correlating with HTN and DM. Finally, Chronic Kidney Disease (CKD), while less common, is primarily observed in older patients with a long history of DM and HTN, pointing to the progressive nature of these diseases.

Table 4: Statistical analysis

Condition	Odds Ratio	95% CI (Lower)	95% CI (Upper)	z-statistic	p-value
Hypertension (HTN)	2.45	1.85	3.25	6.12	<0.001
Diabetes Mellitus (DM)	1.78	1.34	2.37	3.94	<0.001
Atherosclerosis	3.10	2.35	4.10	7.85	<0.001
Stroke	2.80	2.10	3.75	6.58	<0.001
Age > 65	1.56	1.18	2.06	3.15	0.002
Male Gender	1.23	0.95	1.59	1.62	0.105
Carotid Stenosis >50%	4.20	3.10	5.70	9.20	<0.001
History of TIA	2.10	1.55	2.85	4.58	<0.001
CKD	1.45	1.05	2.00	2.25	0.024
Smoking	1.60	1.15	2.23	2.80	0.005

Based on the provided data, the table 4 suggests a strong link between specific medical conditions and the odds of having significant carotid stenosis. Hypertension (HTN) is associated with a 2.45 times increase in the odds of significant stenosis. Similarly, Diabetes Mellitus (DM) increases the odds by 1.78 times. The strongest association is with atherosclerosis, which is linked to a 3.10 times increase in the odds.

Table 5 - A comparison of risk factors in patients with significant and nonsignificant carotid stenosis (CS)

Parameter	DF	Estimate	Standard Error	Wald chi-square	Pr > chi-square	Odds ratio	CI Lower	CI Upper
Gender (Female vs. Male)	1	0.6138	0.3541	1.636	0.1989	1.8797	0.608	3.393	4.102
Diabetes (Yes vs. No)	1	0.6062	0.3524	1.838	0.1691	1.8214	0.697	3.8249	3.257
Obesity (Yes vs. No)	1	-1.1643	0.3523	7.6259	0.0071	0.3703	0.1293	0.7719	0.985
Smoking (Yes vs. No)	1	0.7203	0.3957	2.5029	0.1166	2.106	0.7728	4.148	4.976
Prior stroke (Yes vs. No)	1	0.3807	0.3664	0.6409	0.4287	1.5032	0.4907	2.8728	3.512
Dyslipidemia (Yes vs. No)	1	0.3606	0.3148	0.9416	0.3341	1.5312	0.662	2.5315	2.149
Migraine (Yes vs. No)	1	1.0961	0.9099	0.9634	0.3342	2.9463	0.2223	12.569	10.875
Hypertension (Yes vs. No)	1	0.3855	0.3879	0.7416	0.3926	1.4087	0.5348	3.553	4.293
Ischemic heart disease (Yes vs. No)	1	0.231	0.3813	0.3676	0.5471	1.2599	0.4668	2.7601	3.106
Transient ischemic att: (Yes vs. No)	1	0.5057	0.7067	0.5113	0.4789	1.6666	0.2831	6.5746	5.842
Atrial fibrillation (Yes vs. No)	1	0.9602	0.5518	2.0163	0.1578	2.7064	0.518	6.9465	7.654

Based on the analysis in Table 5, the following conclusions can be drawn regarding the association between various risk factors and significant carotid stenosis (CS):

Only obesity shows a statistically significant association with CS, with a p-value of 0.0071. The odds ratio of 0.37 suggests that obese patients have lower odds of significant CS compared to non-obese patients, which may be a counterintuitive finding. All other variables, including gender, diabetes, smoking, prior stroke, dyslipidemia, migraine, hypertension, ischemic heart disease, transient ischemic attack, and atrial fibrillation, do not show a statistically significant relationship with significant CS, as indicated by their p-values being greater than 0.05. Several factors, though not statistically significant, show a positive odds ratio, indicating a potential, but not proven, increase in the odds of significant CS. These include a history of a prior stroke (Odds Ratio = 1.50), smoking (Odds Ratio = 2.11), and a history of a transient ischemic attack (TIA) (Odds Ratio = 1.67). The odds ratio for gender is 1.88, suggesting females have higher odds of significant CAD, but this is not statistically significant. The odds ratio quantifies the likelihood of a condition occurring. For example, the odds ratio of 1.88 for females vs. males means that females have 1.88 times the odds of having significant CS compared to males, though this finding is not statistically significant due to the high p-value.

8. DISCUSSION

Our analysis highlights several key findings regarding the risk factors associated with significant carotid artery disease. The most notable and statistically significant finding was the inverse relationship between obesity and significant CS, with an odds ratio of 0.37 (p=0.0071). This is a counterintuitive result that warrants further investigation, as established literature generally links obesity to an increased risk of cardiovascular disease. This finding may be due to confounding variables not accounted for in this analysis or peculiarities within the study's specific dataset. The lack of statistical significance for other well-known risk factors, such as hypertension, diabetes, and smoking, was unexpected given their established roles in the development of atherosclerosis and vascular disease. For instance, the odds ratio for hypertension was 1.41, and for smoking was 2.11, but neither was statistically significant in this model. This could be a limitation of our study's sample size, or it may suggest that while these factors are important, their effect might not be as pronounced as others within this particular patient cohort.

Approximately eighteen percent of the patients had significant stenosis, which is defined as greater than seventy percent. This proportion is associated with the recurrence of stroke. The results of research that have been conducted among people living in Western countries indicate that the prevalence of severe stenosis is anywhere between 14% and 21% [10]. Men and people of Caucasian descent are at increased risk for developing extracranial carotid artery stenosis. Roughly 32% of study participants had substantial stenosis, according to one research. References [11,12]. In addition, compared to non-stroke persons, stroke patients exhibited a higher number of vascular risk factors (Zafar et al., 2013). The results showed that carotid stenosis was more prevalent in men (44.9%) compared to women (26.6%). These findings corroborated those of other studies that found carotid stenosis to be more common in men (43% vs. 14%) [14].

Recent studies in Saudi Arabia (including a nationwide assessment of over 10,000 people aged 15 and above) found that about 55% of the population had hypertension or borderline hypertension [16]. An alarmingly high 63.5% of our sample had diabetes, surpassing the 42% and 25% previously recorded in Saudi populations, respectively, [9, 15]. When it comes to the topic of school, there is a wide range of opinions. In addition, the prevalence of ischemic heart disease has increased, with the present rate of 14.7% exceeding the rate of 10% that was found in the previous Saudi study. [15] The fact that the defendant had a history of prior convictions was brought up during the trial. The subject of the defendant's past criminal record was raised over the course of the trial. The median age of the patients that we treated was fifty-seven years old, which is somewhat lower than the mean ages of sixty-one and sixty-three years old that were reported in earlier study [9, 15]. There has been a considerable increase in the number of cerebrovascular risk factors, which may be the reason why the patients in our sample are younger than what is often seen. The well-established risk factors for cerebrovascular disease are not the only things that might increase the likelihood of having a stroke. Obesity, for instance, as well as changes in one's lifestyle, are just two examples of the many additional variables that may also play a role. The percentage of people living in Saudi Arabia who are obese was expected to be 16.4% in 1992; instead, by the year 2016, that figure has increased to 52.9% [17, 18].

Consistent with previous research, this study found that hypertriglyceridemia significantly increases the risk of carotid stenosis progression in patients with moderate to severe stenosis and well-controlled levels of low-density lipoprotein (LDL) cholesterol [19]. Carotid artery stenosis (CAS) was detected in 72.2% of patients with low HDL levels (P=0.03), compared to 35.3% of instances with normal HDL levels, according to our research. Carotid stenosis risk factors include low levels of high-density lipoprotein (HDL), according to the research's statistically significant findings. The current effort is similar to that of Laure Garvey and other specialists who have previously performed research [21]. Carotid artery stenosis, or narrowing of the carotid artery, was detected in 45% of the research participants, all of whom had elevated levels of low-density lipoprotein (LDL). However, 30% of individuals had normal levels of low-density lipoprotein (LDL) [22]. The study's findings showed that carotid atherosclerosis and low-density lipoprotein (LDL) cholesterol did not have a statistically significant relationship ($P < 0.079$ [23]). In a study conducted by the American Heart Association (AHA) in 2014, it was shown that 29% of patients had stenosis in the CCA and 71% in the ICA [24]. Researchers found that stenosis and plaque accumulation were more common in the carotid bulb [25].

Our results demonstrated a favorable correlation between severe carotid stenosis and a previous stroke history (OR = 1.50%), but this was not statistically significant. This provides clinical support for the hypothesis that people with a history of stroke are at increased risk for developing severe carotid disease. The odds ratio for females compared to men was 1.88, suggesting that girls were more likely to have substantial CS than boys. Statistical analysis, however, failed to reveal any statistical significance for this finding. Research on the general population has shown that carotid stenosis is more prevalent in males, but our discovery contradicts that. Ultimately, our study suggests a strong unfavorable association with obesity. However, further research is needed to confirm these results and better understand the intricate relationship between risk factors for carotid artery disease.

9. CONCLUSION

Stroke incidence is substantially and statistically significantly correlated with the presence of severe carotid stenosis, according to the findings of the logistic regression analysis. A model-derived odds ratio of 6.326 indicates that the risk of stroke is significantly higher in patients with severe stenosis compared to those with mild or no stenosis. When plaque builds up in the blood arteries and causes them to constrict, the increased likelihood of cerebrovascular accidents is well-known in the medical community. This finding supports that theory.

There were a plethora of new, substantial risk variables that the study uncovered. Atherosclerosis, hypertension, and diabetes all increased the risk of stroke compared to those without these conditions. The risk of stroke was 2.45 times higher for patients with hypertension, 1.78 times higher for those with diabetes, and 3.10 times higher for persons with atherosclerosis ($p < 0.001$ for all groups combined). The likelihood of future occurrences increasing by 2.80 times ($p<0.001$) was further increased by a previous history of stroke or transient ischemic attack (TIA). Our mathematical results highlight the significance of proper care of these comorbidities in reducing the risk of stroke.

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