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The Impact of Genetic Predispositions and Lifestyle or Environmental Risk Factors on Stroke Outcomes in the Jamaican Population: A Quantitative Analysis

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Abstract

Introduction: Stroke is a leading cause of death and disability worldwide, with low- and middle-income countries (LMICs) experiencing higher incidences due to factors such as healthcare access, lifestyle, and socioeconomic variables. Are Jamaicans, who are predominantly of African descent, predisposed to particular genome and environmental factors that account for the high prevalence of stroke?

Objective: This study seeks to evaluate whether genetic predispositions and lifestyle or environmental risk issues influence stroke outcomes among resident Jamaicans.

Methods and Materials: This study will use a quantitative cross-sectional research design. This approach facilitates gathering data simultaneously, which is suitable for investigating the relationships between genetic, behavioural, and environmental risk factors and stroke outcomes within a population. The sample size will be 291 participants for a meaningful statistical analysis. This research study will use a stratified random sampling approach to verify if subgroups will have different mean values.

Findings: An odds ratio (OR) of 1.033 for diabetes and stroke, controlled for age and gender, suggests a slight increase in stroke odds for individuals with diabetes compared to those without. However, because the OR is close to 1, this association might be relatively weak and not statistically significant (p=.898). This value implies that diabetes may not drastically increase stroke risk in this study population when age and gender are accounted for. Further analysis would be needed to confirm its impact and statistical significance. An odds ratio (OR) of 1.356 for hypertension and stroke, controlled for age and gender, indicates that individuals with hypertension have about 1.36 times higher odds of experiencing a stroke than those without hypertension after accounting for age and gender differences. This issue suggests a moderate positive association, implying that hypertension is a contributing risk factor for stroke, although the effect size is smaller than some other risk factors (p=.278). This finding highlights

hypertension's role as a modifiable factor in stroke prevention efforts. The odds ratio (OR) of 2.175 for dyslipidemia indicates that individuals with dyslipidemia have 2.18 times higher odds of experiencing a stroke compared to those without dyslipidemia while controlling for age and gender. An odds ratio (OR) of 0.969 for sodium intake and stroke, controlled for age and gender, suggests that sodium intake may not significantly influence the odds of experiencing a stroke. Since the OR is close to 1, it indicates that for each unit increase in sodium intake, the odds of stroke decrease slightly, but this effect is negligible. This finding implies that sodium intake does not substantially influence stroke risk(p=.118). An odds ratio (OR) of 1.035 for alcohol consumption and stroke, controlled for age and gender, indicates a slight increase in the odds of experiencing a stroke with higher alcohol intake. Since the OR is close to 1, the effect is minimal and suggests that alcohol consumption does not significantly impact stroke risk in this context (p=.904). This finding implies that, while there may be a trend, alcohol is not a significant contributing factor to stroke outcomes when controlling for the specified demographics.An odds ratio (OR) of 1.104 for access to healthcare and stroke, controlled for age and gender, indicates that individuals with better access to healthcare have about 10.4% higher odds of experiencing a stroke compared to those with poorer access. This issue suggests a potential positive association between healthcare access and stroke risk. However, the OR being close to 1 implies that this effect is relatively small and may not be significant (p=.690), indicating that access to healthcare alone may not be a major determinant of stroke outcomes.

Conclusion: This study highlights a vital area in stroke prevention and recovery, emphasising the need for more research into these intersecting influences to mitigate the rising stroke burden in Jamaica. In conclusion, the interplay of genetic predispositions with lifestyle and environmental risk factors significantly influences stroke outcomes in the Jamaican population.

Keywords: Diabetes, environmental factors, hypertension, genetic predisposition, lifestyle factors, socioeconomic status, stroke

Introduction

Stroke is a leading cause of death and disability worldwide, with low- and middle-incomecountries (LMICs) experiencing higher incidences due to factors such as healthcare access, lifestyle, and socioeconomic variables (Bian et al., 2024; Chermon & Birk, 2024; Liu et al., 2021; Zhang et al., 2024). Johns Hopkins School of Medicine (n.d.) reported that a stroke occurs when the cerebral blood flow is halted or interrupted. There are two categories of stroke: Ischemic stroke and hemorrhagic stroke. According to Johns Hopkins Medicine (n.d.), *Ischemic stroke* is the most common type of stroke, leading to a significant reduction in blood flow and oxygen to brain tissues. It happens when a major blood vessel in the brain is blocked. It may be blocked by fatty deposit[s], clots,or cholesterol buildup. This buildup is called plaque. *Hemorrhagic stroke* occurs when a cerebral blood artery ruptures, releasing blood into adjacent tissues. A hemorrhagic stroke results in increased pressure inside the adjacent brain tissue. This results in increased harm and irritation.

Furthermore, while lifestyle factors, including excessive alcohol consumption, smoking, and poor habits, contribute to stroke conditions, genetic predispositions and environmental factors

also play a pivotalrole. Jamaica's distinctive population genetics and environmental circumstances make it a fascinating study area. Genetic predispositions, particularly among Afro-Caribbean populations, intersect with lifestyle and environmental factors to influence stroke outcomes (Doumatey et al., 2023; Francis et al., 2015; Prapiadou et al., 2021; Zhang et al., 2023). This intersection raises essential questions about how inherited risk factors specific to Jamaican and Afro-Caribbean genetics might interact with modifiable lifestyle behaviours and environmental exposures, such as obesity, physical inactivity, and socioeconomic challenges, to influence stroke susceptibility and recovery outcomes (Kalra et al., 2006; Wuni et al., 2023).

Statistics from the World Stroke Organization (2020) revealed, “Stroke deaths in Jamaica reached 2,479 or 13.62% of total deaths in 2018.” Additionally, an editorial in the Jamaica Gleaner indicated that in 2023, there were over 7000 new incidences of stroke (The Jamaica Gleaner, 2023). The Minister of Health and Wellness in Jamaica, Dr Christopher Tufton, explained a ‘stroke crisis in Jamaica (Tufton, 2022), and Lowrie-Chin (2024) concurs with the Minister. A cross-sectional national survey of 2,848 Jamaicans aged 15-74 years that was conducted between 2007 and 2008 found that 1.7% had a stroke (1.2% of men and 1.5% of women) (Ferguson et al., 2010). Are Jamaicans, who are predominantly of African descent, predisposed to particular genome and environmental factors that account for the high prevalence of stroke? The objective of this study is to evaluate whether genetic predispositions and lifestyle or environmental risk issues influence stroke outcomes among resident Jamaicans.

Genetic Predispositions and Stroke Risk

Research suggests that genetic factors such as diabetes, hypertension, and dyslipidemia play a role in the susceptibility to cardiovascular diseases, including stroke, particularly among populations of African descent. Studies indicate that specific genetic factors linked to hypertension, diabetes, and dyslipidemia are more prevalent in Afro-Caribbean populations, and these factors are associated with an increased risk of ischemic and hemorrhagic strokes (Gottesman et al., 2016; Meschia et al., 2014). Variants in genes, such as those regulating blood pressure and metabolic pathways, have been identified in Afro-Caribbean groups, correlating with higher rates of hypertension, which is a leading modifiable risk factor for stroke (Gottesman et al., 2016).

Lifestyle Factors and Stroke

Lifestyle choices significantly affect stroke risk and recovery. High salt intake, obesity, physical inactivity levels, and a diet rich in processed foods contribute to elevated rates of hypertension and diabetes in Jamaica, increasing stroke vulnerability (Ferguson et al., 2019; Gottesman et al., 2016). These lifestyle factors interact with genetic predispositions, creating a cumulative risk effect for stroke incidence and severity (Ferguson et al., 2019). The Jamaican health landscape is thus shaped by lifestyle factors that could be modified through public health efforts but also intersect with non-modifiable genetic risks.

Environmental and Socioeconomic Risk Factors

Environmental and socioeconomic factors also contribute to stroke risk. Lower socioeconomic status in some areas of Jamaica can limit access to healthcare services, increasing the risk of unmanaged hypertension and diabetes. Environmental factors, including high temperatures and pollution, may also stress cardiovascular systems, especially in genetically predisposed individuals (World Health Organization [WHO], 2016). Jamaican studies highlight that socioeconomic disparities and healthcare access challenges further exacerbate these issues, underscoring the importance of investigating how these external factors influence stroke risk and recovery outcomes among genetically predisposed individuals (Wilks et al., 2018).

Interaction with Genetic and Environmental Factors

Recent studies emphasise that genetic predispositions to stroke can be amplified or mitigated by environmental and lifestyle factors (Gottesman et al., 2016; Zhou et al., 2019). This gene-environment interaction is particularly relevant for Jamaica, where specific genetic risk factors are more prevalent and are influenced by the high prevalence of lifestyle-related risk factors. This area of research is essential to developing targeted interventions that consider both genetic and modifiable risks to reduce stroke prevalence and improve outcomes for Jamaican patients.

Purpose of the Study

This study investigates how genetic predispositions intersect with lifestyle and environmental risk factors to influence stroke outcomes in the Jamaican population. By employing a quantitative analysis, the research aims to identify specific genetic factors, lifestyle behaviours, and environmental exposures that contribute to stroke severity and recovery. Ultimately, this study seeks to enhance understanding of stroke dynamics in Jamaica, informing targeted prevention and intervention strategies that consider both inherent genetic risks and modifiable lifestyle factors.

Significance of the Study

Understanding the genetic underpinnings specific to Afro-Caribbean populations, particularly in Jamaica, offers an opportunity to develop targeted healthcare strategies. Research shows that Caribbean populations experience high incidences of hypertension and diabetes-key stroke risk factors that may be partially driven by genetic factors (Ferguson et al., 2019; Gottesman et al., 2016; Meschia et al., 2014). This insight enables the creation of personalised interventions that consider genetic susceptibility and lifestyle modifications, potentially lowering stroke incidence and improving health outcomes (Gottesman et al., 2016).

Insights into how environmental and lifestyle factors amplify genetic predispositions can inform public health initiatives. Lifestyle factors like high salt intake, sedentary behaviour, and high caloric diets are prevalent in Jamaica and contribute significantly to cardiovascular diseases (Ferguson et al., 2019). Understanding these interactions can help refine community health programs, such as those focusing on dietary guidance and physical activity, to mitigate stroke risk, particularly in genetically predisposed individuals.

Jamaica, like other low-and middle-income countries (LMIC), faces challenges in healthcare access and socioeconomic disparities, which can affect stroke care and prevention efforts (WHO, 2016). Addressing how these socioeconomic and environmental factors intersect with genetic predispositions may lead to equitable healthcare policies that cater to high-risk, underserved populations, thus helping to reduce health disparities in stroke outcomes (Wilks et al., 2018).This study expands the global understanding of stroke by highlighting the role of genetic and environmental interactions in non-Western Caribbean populations like Jamaica. As most genetic studies focus on European and North American populations, there is a notable gap in data for Afro-Caribbean groups, whose genetic profiles can differ significantly (Zhou et al., 2019). Addressing this gap contributes to the diversity of gene research and enhances stroke prevention frameworks applicable to various populations (Gottesman et al., 2016; Zhou et al., 2019).

Research Objectives

1. Investigate Genetic Factors

(a) To identify specific genetic factors such as diabetes, hypertension, and dyslipidemiaprevalent in the Jamaican population that may predispose individuals to stroke and how these factors interact with lifestyle and environmental factors.

2. Examine Lifestyle Influences

(b) To analyse how salt intake, obesity, physical inactivity, and other lifestyle choices affect stroke risk among individuals with specific genetic predispositions in Jamaica.

3. Explore Environmental Context

(c) To assess the impact of environmental factors, such as educational level, income, and healthcare access, on the Jamaican population's stroke outcomes.

Research Questions

1. What genetic predispositions (diabetes, hypertension, and dyslipidemia) are most common among stroke patients in Jamaica while controlling for confounders such as age and gender?
2. How do lifestyle factors (salt intake, alcohol consumption, obesity, smoking, physical inactivity), while controlling confounders such as age and gender, interact with genetic predispositions to influence stroke outcomes?
3. How do environmental factors(education levels, income, access to healthcare), while controlling for confounders such as age and genderin Jamaica, affect the relationship between genetic risk factors and stroke incidence?

Literature Review

The literature review underscores the importance of exploring genetic, lifestyle, and environmental interactions in understanding stroke risk, particularly in the Jamaican context. This expanded literature review emphasises the multifaceted nature of stroke risk, involving genetic, lifestyle, and environmental factors. Comprehensive research in these areas is vital for

developing effective prevention strategies tailored to the Jamaican context. Stroke continues to be a predominant cause of morbidity and mortality in Jamaica, influenced by multiple factors affecting outcomes. Recent studies emphasise the convergence of genetic predispositions and lifestyle or environmental risk factors in influencing stroke severity and recovery. Genetic factors have been recognised as essential determinants of stroke susceptibility. McCarty et al. (2020) demonstrate that specific genetic factors linked to cardiovascular disorders are common in Jamaican communities, potentially heightening the risk of stroke. This corresponds with findings from other Caribbean countries, where genetic predispositions to hypertension and diabetes are associated with increased stroke incidence (Peters et al., 2019).

Lifestyle factors, predominantly obesity and physical inactivity, profoundly affect stroke outcomes (Peters et al., 2019). Thompson et al. (2021) conducted quantitative research highlighting the impact of elevated salt consumption and reduced physical exercise on increasing stroke risks in Jamaicans. Moreover, environmental factors, including education levels, income, and access to healthcare, have been associated with changes in stroke risk profiles, as evidenced by a study conducted by Johnson et al. (2022), which indicates that urban inhabitants exhibit more excellent stroke rates compared to their rural counterparts. Research consistently associates dyslipidemia with an increased risk of stroke, attributable to its involvement in atherosclerosis, wherein elevated levels of low-density lipoprotein (LDL) cholesterol facilitate plaque accumulation in arteries, hence impeding cerebral blood flow (Kim & Lee, 2015). Increased triglycerides and diminished high-density lipoprotein (HDL) cholesterol correlate with heightened stroke risks, particularly ischemic stroke, caused by blood clots obstructing cerebral arteries (Di Angelantonio et al., 2016). Modifying dyslipidemia through lifestyle alterations and lipid-lowering therapies has demonstrated a reduction in stroke risk, highlighting its significance as a modifiable risk factor. The interaction of genetics and environmental factors complicates the landscape of stroke outcomes. A study by Williams et al. (2018) showed that genetic predispositions can exacerbate the consequences of detrimental lifestyle choices, resulting in poorer outcomes for persons with a familial history of stroke or cardiovascular disease. This underscores the significance of targeted therapies that account for both genetic predispositions and alterable lifestyle factors.

Genetic Predispositions and Stroke

Genetic factors play a pivotal role in stroke susceptibility, particularly in Afro-Caribbean populations, as research indicates (Meschia et al., 2014; Wilks et al., 2018). The work of Meschia et al. (2014) delves into various genetic factors, such as diabetes, hypertension, and dyslipidemia, and their connection to stroke risk. This underscores the necessity for population-specific studies to comprehend these links fully. In the Caribbean context, genetic variations may contribute significantly to the high prevalence of stroke, necessitating tailored approaches to prevention and treatment (Wilks et al., 2018).

Lifestyle Factors and Stroke Outcomes

Numerous studies have linked lifestyle factors such as obesity, physical inactivity, and smoking to increased stroke risk (Ferguson et al., 2019; Gottesman et al., 2016; Meschia et al., 2014). A

study by Ferguson et al. (2019) highlights how high-salt diets and low physical activity levels contribute significantly to hypertension, a leading risk factor for stroke in Jamaica. This suggests that lifestyle interventions could substantially mitigate stroke risk in genetically predisposed populations.

Genetic Interactions with Environmental and Lifestyle Factors

Recent studies highlight the interplay between genetic predispositions and environmental/ lifestyle factors in stroke risk (Parikh et al., 2020; Pomeroy & Dyer, 2020). For example, a survey by Parikh et al. (2020) examines how specific genetic factors, combined with lifestyle choices like diet and physical inactivity, can elevate stroke risk in diverse populations, including those in the Caribbean. This underscores the necessity for a holistic approach to stroke prevention strategies that consider both genetic and lifestyle dimensions. Added to lifestyle and environmental factors, dyslipidemia is a medical disorder defined by abnormal lipid levels in the blood, including elevated low-density lipoprotein (LDL) cholesterol, decreased high-density lipoprotein (HDL) cholesterol, or increased triglycerides. Lipid imbalances are associated with atherosclerosis, elevating the risk of cardiovascular incidents such as myocardial infarction (MI) and stroke (Mach et al., 2019). Dyslipidemia frequently arises from lifestyle choices, including dietary and activity patterns, but may also be attributed to genetic influences, rendering it both a modifiable and inherited risk factor (Grundy et al., 2018).

Environmental Influences

Environmental factors, particularly socioeconomic status and access to healthcare, are increasingly recognised as contributors to stroke risk. Pomeroy and Dyer (2020) explore how changes in environmental conditions can exacerbate health disparities and impact stroke outcomes. Understanding these interactions is vital for developing comprehensive public health strategies.

Impact of Socioeconomic Factors

Socioeconomic factors also significantly influence stroke outcomes. A systematic review by Campbell et al. (2018) reveals that individuals from lower socioeconomic backgrounds are at a higher risk for stroke due to limited access to healthcare and poor dietary habits, which leads to obesity and sedentary lifestyles. In Jamaica, addressing these disparities is crucial for improving stroke outcomes in vulnerable populations.

Public Health Interventions

Public health interventions aimed at reducing stroke risk have shown promise. A study by Wright et al. (2021) evaluated community-based interventions in Jamaica, demonstrating that educational campaigns on lifestyle modifications can significantly reduce stroke incidence. This highlights the importance of targeted public health strategies in high-risk communities. Existing research consistently highlights the impact of lifestyle factors such as diet, physical activity, smoking, and alcohol consumption on stroke risk. Studies reveal that poor dietary habits and exceptionally high sodium intake increase hypertension, a leading risk factor for stroke (Howard

& McDonnell, 2015; O'Donnell et al., 2016; Thornley-Brown et al., 2020). Regular physical activity and balanced diets, like the Mediterranean diet, are shown to reduce stroke risk. Additionally, smoking and excessive alcohol intake elevate the risk of ischemic and hemorrhagic strokes. These findings underscore the need for targeted lifestyle interventions to mitigate stroke risks across various populations (O'Donnell et al., 2016).

Specific research gaps persist regarding gene-environment interactions. Recent studies indicate that region-specific genetic variants may play a role in stroke risk. However, these variants often interact with unique local lifestyle factors, like diet or levels of physical activity, which are notably understudied in Caribbean populations (Thornley-Brown et al., 2020). The limited availability of population-specific data impedes a complete understanding of the cumulative impact of lifestyle behaviours, such as dietary habits, which vary significantly between regions and can potentially contribute to stroke risk through genetic-environment interactions. This research could fill critical gaps by examining how Jamaican genetic factors intersect with these behaviours, offering new insights into stroke prevention and treatment tailored to Caribbean populations (Thornley-Brown et al., 2020).

The gap in current knowledge on stroke and lifestyle factorsexamining stroke risk factors has identified numerous lifestyle contributors, such as physical inactivity, smoking, and alcohol use(Alexander et al., 2022). However, existing studies overlook the population-specific nuances, such as genetic predispositions unique to particular regions, including the Caribbean. For example, little is known about how Jamaican or Caribbean genetic factors may interact with these lifestyle elements, potentially impacting stroke outcomes in ways not captured in more generalised studies (Thornley-Brown et al., 2020; Wuni et al., 2023).Another notable gap is the limited availability of long-term, longitudinal data assessing the sustained impact of lifestyle modifications on stroke risk across different socioeconomic backgrounds. While it is well known that diet and exercise reduce stroke risk, more data must be collected on whether individuals maintain these changes and how these factors influence risk over time in diverse socioeconomic settings.

Environmental factors like engagement levels, access to healthcare, and income are integrated into stroke research, and such factors may influence stroke risk differently. These conditions are especially relevant to island populations, where environmental variables could modify the effects of both genetic and lifestyle factors, impacting stroke outcomes in unique ways (Wuni et al., 2023).Lastly, there needs to be more interdisciplinary studies that combine genetic, environmental, and lifestyle variables into one framework. Current research often examines these factors separately, but there is a need for integrative studies that explore how they collectively influence stroke risk. Addressing these gaps could lead to more comprehensive prevention strategies tailored to the specific needs of diverse populations. For example, a review of gene-lifestyle interactions across Latin American and Caribbean populations highlights how regional differences in cardiovascular outcomes are influenced by genetic predispositions in conjunction with environmental factors, such as dietary intake and metabolic responses (Wuni et al., 2023). These outcomes reveal both a gap in region-specific data for Caribbean populations and a need to examine how these unique variables might influence stroke-related outcomes, specifically in Jamaican demographics.

Theoretical Framework

The study will examine how Jamaican genetic predispositions intersect with lifestyle and environmental risk factors to influence stroke outcomes. The study will use a theoretical framework integrating Social Determinants of Health (SDOH) with Gene-Environment Interaction Theory.

Social Determinants of Health (SDOH)

Social Determinants of Health (SDOH)examines how economic stability, education, healthcare access, and neighbourhood and community environments impact health outcomes(Braveman& Gottlieb, 2014). This framework is essential for understanding how socioeconomic and environmental factors unique to Jamaica-such as healthcare accessibility and socioeconomic disparities-may interact with genetic predispositions to affect stroke risk and outcomes (Marmot& Wilkinson, 2005). The SDOH model posits that these social and environmental influences can exacerbate or mitigate genetic risks, making it highly relevant for understanding region-specific stroke outcomes (Braveman& Gottlieb,2014).Utilising the Social Determinants of Health (SDOH) framework can substantially improve your research on genetic predispositions and lifestyle or environmental factors influencing stroke outcomes in Jamaica. The SDOH concept underscores that health is shaped not only by medical and biological determinants but also by the circumstances of individuals' born, grow, live, employed, and age, hence contextualising genetic and lifestyle influences within broader societal and environmental contexts (WHO, 2008).

Gene-Environment (G × E) Interaction Theory

Gene-Environment (G × E) Interaction Theory highlights how genetic predispositions interact with environmental exposures and lifestyle factors to produce health outcomes (Khouryet al., 2004). Genetic predisposition describes the increased chance of developing a particular disease based on your genetic makeup (Virolainen et al., 2023; Wuni et al., 2023). In stroke research, gene-environment interaction theory provides a foundation for exploring how genetic factors may amplify or dampen the effects of lifestyle choices (like diet, exercise, or smoking) and environmental exposures (such as climate). This approach allows for analyzing how genetic factors in Jamaicans might combine with specific lifestyle factors to elevate or reduce stroke risk (Virolainen et al., 2023; Wuni et al., 2023).By reviewing an integrative application perspective, combining SDOH and Gene-Environment Interaction (G × E) Theory enables a comprehensive framework to study stroke risk in Jamaica by focusing on inherited and modifiable risk factors within the country’s unique context. This integrative approach encourages exploring interventions that target socioeconomic and lifestyle factors in genetically predisposed populations.This theoretical framework supports a holistic understanding of how Jamaican stroke risk is influenced by genetic, lifestyle, and environmental variables, providing a basis for prevention strategies that address these interconnected dimensions. Figure 1 represents Gene × environment (G × E) interactions between lifestyle or environmental risk factors and genetic predisposition.

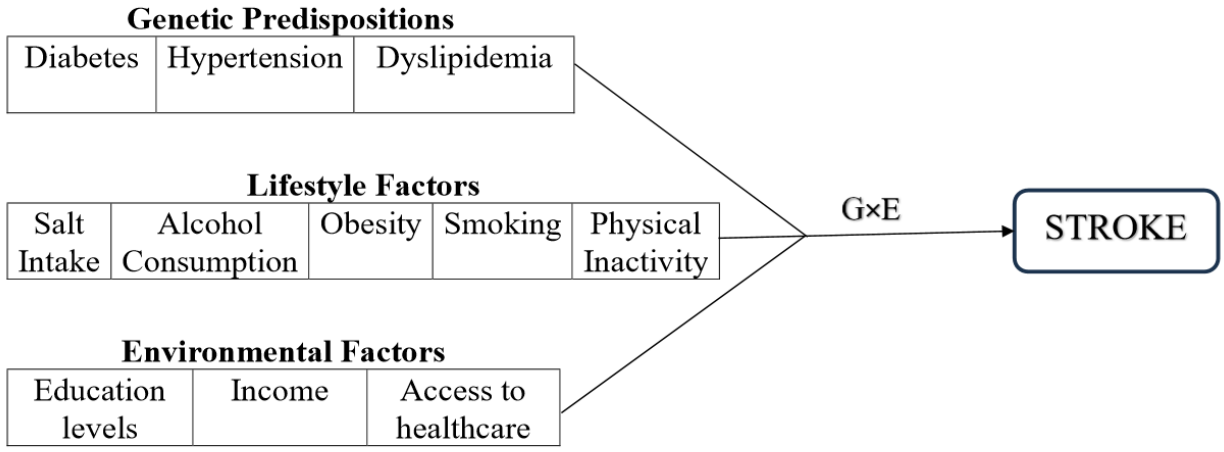

Figure 1: Gene × Environment (G × E) Interactions Between Lifestyle or Environmental Risk Factors and Genetic Predisposition

Adopted from Virolainenet al. (2023). Gene-environment interactions and their impact on human health. Genes Immune 24, 1-1. https://doi.org/10.1038/s41435-022-00192-6

Methodology

This quantitative cross-sectional approach allows for a comprehensive investigation of measurable risk factors and individual experiences. By integrating genetic data with lifestyle and environmental assessments, the study can better identify and understand the multifaceted nature of stroke risk in the Jamaican population. A quantitative approach will be used to explore the intersection of Jamaican genetic predispositions with lifestyle and environmental risk factors affecting stroke outcomes. This methodology provides a comprehensive understanding of the complex interactions between genetic predispositions and lifestyle or environmental risk factors on stroke outcomes in the Jamaican population.

Research Design

This study will use a cross-sectional research design. This approach facilitates gathering data simultaneously, which is suitable for investigating the relationships between genetic, behavioural, and environmental risk factors and stroke outcomes within a population. A cross-sectional design is optimal for discovering relationships and patterns in data without determining causation (Levin, 2006).

Sample Population

The target representative sample of Jamaican adults who meet eligibility criteria for stroke risk factors and genetic screening within the general population, ensuring diversity in genetic backgrounds, lifestyle practices, and environmental exposures (Dillman, 2000). The sample size will be 291 participants for a meaningful statistical analysis. This research study will use a stratified random sampling approach to verify if subgroups will have different mean values. This

strategy guarantees the portrayal of variation in lifestyle, genetic heritage, and environmental exposure(Cochran, 1977; Higginset al., 2003).

Data Collection Instruments

The Lifestyle Assessment Instrument (LAI) will be used togather data on lifestyle factors (obesity, physical inactivity, smoking, and alcohol consumption) and environmental risk factors (income, education levels, and access to healthcare). A self-reported family history questionnaire will also answer genetic predisposition risk factors. Studies show that individuals with a family history of stroke are more likely to have a genetic predisposition for it so that this data can strengthen the genetic aspect of your research (Parikh et al., 2020; Pomeroy & Dyer, 2020).This technique is fundamental for identifying genetic factors associated with stroke risk (Mullis & Faloona, 1987).

Data Analysis

Descriptive Statistics will summarise demographic data and key variables to provide an overview of the sample characteristics. A multivariate binary logistic regression will examine the interaction effects among genetic predispositions, lifestyle factors, and environmental exposures on stroke outcomes, controlling for potential confounders (Khoury et al., 2004; Olden & White, 2005).

Ethical Considerations

In assessing the influence of genetic and lifestyle factors on stroke outcomes within the Jamaican community, ethical considerations prioritise participant safety, respect, and cultural sensitivity. Informed consent is crucial; participants must be adequately informed and willing to participate in the study, comprehending its objectives and possible dangers (Wendler & Grady, 2008). Safeguarding participant confidentiality, particularly regarding sensitive genetic information, mitigates misuse and stigma (Kapp, 2003). Moreover, mitigating possible harm is essential to prioritising participants' welfare and receive (Resnik, 2015).Considering Jamaica's distinctive cultural setting, cultural awareness is crucial. Honour local ideas and customs, particularly about health and lifestyle. This sensitivity fosters trust and guarantees that findings align with the community (Yassi et al., 2009). Ultimately, equitable participant selection prevents exploitation and encompasses a variety of socioeconomic backgrounds, facilitating a thorough comprehension of stroke risk variables within the Jamaican population (Emanuel et al., 2000).

Results

The purpose of this study is to investigate how genetic predispositions intersect with lifestyle and environmental risk factors to influence stroke outcomes in the Jamaican population.This study examined the research questions that various demographic and health factors, such as age, gender, education level, income, access to healthcare, smoking, salt intake, obesity, physical inactivity and alcohol consumption, independently contribute to an increased risk of stroke in Jamaica. The data was collected using aLifestyle Assessment Instrument (LAI) to gather lifestyle factors (obesity, physical inactivity, smoking, and alcohol consumption) and environmental risk

factors (income, education levels, and access to healthcare), and a self-reported family history questionnaire to gather diabetes, hypertension, and dyslipidemiafrom individuals aged 18 years and older. The ensuing research questions guided this research study:

Multivariate Logistic Regression Analysis

Research Question 1

What genetic predispositions (diabetes, hypertension, and dyslipidemia) are most common among stroke patients in Jamaica while controlling for confounders such as age and gender?

An odds ratio (OR) of 1.033 for diabetes and stroke, controlled for age and gender, suggests a slight increase in stroke odds for individuals with diabetes compared to those without. However, because the OR is close to 1, this association might be relatively weak and not statistically significant (p=.898). This value implies that diabetes may not drastically increase stroke risk in this study population when age and gender are accounted for. However, further analysis would be needed to confirm its impact and statistical significance.

An odds ratio (OR) of 1.356 for hypertension and stroke, controlled for age and gender, indicates that individuals with hypertension have about 1.36 times higher odds of experiencing a stroke than those without hypertension after accounting for age and gender differences. This suggests a moderate positive association, implying that hypertension is a contributing risk factor for stroke, although the effect size is smaller than some other risk factors (p=.278). This finding highlights hypertension's role as a modifiable factor in stroke prevention efforts.

The odds ratio (OR) of 2.175 for dyslipidemia indicates that individuals with dyslipidemia have 2.18 times higher odds of experiencing a stroke compared to those without dyslipidemiawhile controlling for age and gender. This suggests a significant independent association between dyslipidemia and stroke (p=.005).It highlights dyslipidemia as a considerable risk factor for stroke, irrespective of these demographic variables. Furthermore, adjusting age and gender helps isolate the specific impact of dyslipidemia on stroke risk, underscoring its importance in stroke prevention strategies.

Table 1 shows the model summary. Cox & Snell's R Square of 0.070 and Nagelkerke's R Square of 0.095 indicate the proportion of variance in stroke explained by the model, which means that about 7% (Cox & Snell) to 9.5% (Nagelkerke) of the variation in stroke outcomes can be explained by the predictor variables (diabetes, hypertension, and dyslipidemia).Table 2 shows the genetic predisposition while controlling age and gender.

Table 1: Model Summary Genetic Predisposition of Cox& Snell R Square and Negelkerke R Square

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	370.943a	.070	.095

Table 2: Genetic Predispositions Controlling for Age and Gender

Variables	Odds Ratio (OR)	95% CI (Confidence Interval)	p-value
Diabetes	1.033	0.632-1.689	0.898
Hypertension	1.356	0 .782- 2.351	0.278
Dyslip	2.175	1.261-3.755	0.005
Gender	0.924	0.559-1.526	0.757
Age_group	1.028	1.011-1.046	0.001

The significance level of (p=.001) for the Omnibus model test indicates a statistically significant result. This means that the overall model is improbable to have occurred by chance, suggesting that the predictors included in the model collectively have a strong relationship with the outcome variable (e.g., stroke risk). This result implies that at least one of the predictor variables significantly contributes to predicting stroke outcomes, reinforcing the importance of understanding the factors associated with stroke risk.

Research Question 2

How do lifestyle factors (salt intake, alcohol consumption, obesity, smoking, physical inactivity), while controlling confounders such as age and gender, interact with genetic predispositions to influence stroke outcomes?

An odds ratio (OR) of 0.969 for sodium and stroke, controlled for age and gender, suggests that sodium intake may not significantly influence the odds of experiencing a stroke. Since the OR is close to 1, it indicates that for each unit increase in sodium intake, the odds of stroke decrease slightly, but this effect is negligible. This finding implies that sodium intake does not substantially influence stroke risk(p=.118).

An odds ratio (OR) of 1.035 for alcohol consumption and stroke, controlled for age and gender, indicates a slight increase in the odds of experiencing a stroke with higher alcohol intake. Since the OR is close to 1, the effect is minimal and suggests that alcohol consumption does not significantly impact stroke risk in this context (p=.904). This finding implies that, while there may be a trend, alcohol is not a significant contributing factor to stroke outcomes when controlling for the specified demographics.

An odds ratio (OR) of 0.980 for obesity and stroke, controlled for age and gender, suggests a slight decrease in the odds of experiencing a stroke with increased obesity levels. However, since the OR is very close to 1, this indicates that obesity may not have a significant impact on stroke risk (p=.196). Essentially, this finding implies that, within the context of the research study, obesity does not appear to be a significant risk factor for stroke outcomes.

An odds ratio (OR) of 1.172 for smoking and stroke, controlled for age and gender, indicates that individuals who smoke have about 17.2% higher odds of experiencing a stroke compared to non-smokers after adjusting for these demographic factors. This suggests a positive association between smoking and stroke risk, highlighting smoking as a significant risk factor for stroke outcomes.

An odds ratio (OR) of 1.022 for physical inactivity and stroke, controlled for age and gender, suggests a slight increase in the odds of experiencing a stroke associated with higher levels of physical inactivity. However, since the OR is close to 1, the effect is minimal and may not be statistically significant (p=.931). This finding implies that physical inactivity is not a significant risk factor for stroke outcomes.

Table 3 shows Cox & Snell's R Square of 0.055 and Nagelkerke's R Square of 0.074, indicating that the model explains approximately 5.5% to 7.4% of the variance in stroke outcomes. These values suggest that while the model has some explanatory power, a considerable amount of variance in stroke outcomes remains unexplained, indicating that other factors may also play a significant role in stroke risk. Table 4 shows the lifestyle factors while controlling age and gender.

Table 3: Model Summary Lifestyle Factors of Cox & Snell R Square and Negelkerke R Square

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	375.721a	0.055	0.074

Table 4: Lifestyle Factors Controlling for Age and Gender

Variables	Odds Ratio (OR)	95% CI (Confidence Interval)	p-value
Sodium	0.969	0.931-1.008	0.118
Alcohol Consumption	1.035	0.593-1.804	0.904
Obesity	0 .980	0.951-1010	0.196
Smoking	1.172	0.674- 2.037	0.574
Physical Inactivity	1.022	0.672-1.666	0.931
Gender	0.889	0.540-1.461	0.642
Age group	1.025	1.009-1.042	0.003

A significance level of (p=.021) for the Omnibus model test indicates that the overall model is statistically significant. This suggests that the combination of predictors in the model has a meaningful relationship with the outcome variable (e.g., stroke risk), and at least one of the predictor variables significantly contributes to predicting stroke outcomes. In practical terms, this finding supports the relevance of understanding stroke risk factors.

Research Question 3

How do environmental factors (education levels, income, access to healthcare), while controlling for confounders such as age and gender in Jamaica, affect the relationship between genetic risk factors and stroke incidence?

An odds ratio (OR) of 1.227 for education level and stroke, controlled for age and gender, indicates that individuals with higher education levels have about 22.7% higher odds of experiencing a stroke compared to those with lower education levels. This suggests a positive association between education level and stroke risk, highlighting the potential influence of educational attainment on health outcomes. It may imply that lower education levels could be linked to increased risk factors associated with stroke (p=.683).

An odds ratio (OR) of 0.997 for income per month and stroke, controlled for age and gender, suggests a slight decrease in the odds of experiencing a stroke as income increases. Since the OR is very close to 1, this indicates that income does not have a significant effect on stroke risk. However, asignificant p-value (p=0.031) justifiably indicates that income level is statistically associated with stroke outcomes, even when accounting for other variables. Given that p= 0.031 is beneath the standard significance alpha level of 0.05, we can infer that fluctuations in wealth are likely influencing the disparities noted in stroke risk. This outcome would necessitate additional investigation into the influence of income levels on stroke, potentially underscoring socioeconomic differences or resource accessibility as significant determinants in stroke prevention.

An odds ratio (OR) of 1.104 for access to healthcare and stroke, controlled for age and gender, indicates that individuals with better access to healthcare have about 10.4% higher odds of experiencing a stroke compared to those with poorer access. This suggests a positive association between healthcare access and stroke risk. However, the OR being close to 1 implies that this effect is relatively small and may not be significant (p=.690), indicating that access to healthcare alone may not be a major determinant of stroke outcomes.

Table 5 shows Cox & Snell's R Square of 0.057 and Nagelkerke's R Square of 0.078, indicating that the model can explain approximately 5.7% to 7.8% of the variance in stroke outcomes. The relatively low values suggest that while the model has some explanatory capability, a significant portion of variance remains unaccounted for, implying that additional factors could play essential roles in determining stroke risk. Table 6 shows the environmental factors while controlling age and gender.

Table 5: Model Summary Environmental Factors of Cox & Snell R Square and Negelkerke R Square

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	374.976a	0.057	0.078

Table 6: Environmental Factors Controlling for Age and Gender

Variables	Odds Ratio (OR)	95% CI (Confidence Interval)	p-value
Education level	1.227	0.460-3.272	0.683
Income_month	0.997	0.995- 1.000	0.031
Access_healthcare	1.104	0.680-1.793	0.690
Gender	0.835	0.497-1.404	0.496
Age_group	1.025	1.008-1.042	0.004

A significance level of (p=.004) for the Omnibus model test indicates that the overall model is statistically significant. This means that the predictors in your model (such as environmental factors) significantly explain the variance in stroke outcomes. In practical terms, this suggests that at least one of the predictor variables is a significant predictor of stroke risk, and the model as a whole is worth considering in this analysis.

Limitation of Study

Limitations often impact the strength and scope of the findings. This small sample size may restrict the ability to generalize results to broader populations (Patino & Ferreira, 2018). Self-reported data, while valuable, may introduce bias, as participants might not fully disclose or accurately recall information, affecting accuracy of the data (Althubaiti, 2016). Additionally, the cross-sectional designs used may only capture data at one point in time, limiting causal inferences (Levin, 2006). Finally, limitations in measurement tools, such as survey validity, may also influence data quality and reliability (Heale & Twycross, 2015).A significant limitation in this study is the lack of direct genetic testing, with family history acting as a proxy for genetic predispositions.

While family history is frequently utilised in research to measure genetic risk, it fails to identify particular genetic markers that may affect stroke susceptibility (Lemmens et al., 2017). The study may overlook genetic variants pertinent to the Jamaican population that influence stroke risk without genetic testing. Gathering precise environmental data poses an additional barrier. Evaluating environmental factors, such as air quality or specific occupational exposures, may necessitate supplementary resources that are not consistently accessible. In the absence of precise environmental measures, the study may inadequately reflect environmental influences, thus oversimplifying the results (Poursafa & Kelishadi, 2011).

Discussion

Strokeis among the leading causes of death worldwide, with low-middle-income countries experiencing higher incidences due to healthcare access, lifestyle, and environmental factors as well as gene predisposition (Bian et al., 2024; Chermon & Birk, 2024; Liu et al., 2021; Zhang et al., 2024). This non-communicable disease is a global burden (Katan& Luft, 2018) and a national concern in Jamaica. With its unique population genetics and environmental factors, Jamaica presents an especially intriguing case. Genetic predispositions, particularly among Afro-Caribbean populations, intersect with lifestyle and environmental factors to influence stroke outcomes (Doumatey et al., 2023; Francis et al., 2015; Prapiadou et al., 2021; Zhang et al., 2023).

Statistics from the World Stroke Organization (2020) showed that “Stroke deaths in Jamaica reached 2,479 or 13.62% of total deaths in 2018.” Additionally, an editorial in the Jamaica Gleaner indicated that in 2023, there were over 7000 new incidences of stroke (The Jamaica Gleaner, 2023). The Minister of Health and Wellness in Jamaica, Dr Christopher Tufton, explained a ‘stroke crisis in Jamaica (Tufton, 2022), and Lowrie-Chin (2024) concurs with the Minister. Despite the statistics on stroke and the warning reiterated by the Minister ofHealth and Wellness, there is a gap in the empirical literature on genetic predispositions and lifestyle or environmental risk factors on stroke outcomes among the Jamaican population.

The current study addresses the research question of ‘What genetic predispositions (diabetes, hypertension, and dyslipidemia) are most common among stroke patients in Jamaica while controlling for confounders such as age and gender?’ Using multivariate statistical analysis, the findings revealed an odds ratio (OR) of 1.033 for diabetes and stroke, controlled for age and

gender, suggesting a slight increase in stroke odds for individuals with diabetes compared to those without. However, because the OR is close to 1, this association might be relatively weak and not statistically significant (p=.898). This value implies that diabetes may not drastically increase stroke risk in this study population when age and gender are accounted for. Additionally, an odds ratio (OR) of 1.356 for hypertension and stroke, controlled for age and gender, indicates that individuals with hypertension have about 1.36 times higher odds of experiencing a stroke than those without hypertension after accounting for age and gender differences. This suggests a moderate positive association, implying that hypertension is a contributing risk factor for stroke, although the effect size is smaller than some other risk factors (p=.278). This finding highlights hypertension's role as a modifiable factor in stroke prevention efforts.

Furthermore, the odds ratio (OR) of 2.175 for dyslipidemia indicates that individuals with dyslipidemia have 2.18 times higher odds of experiencing a stroke compared to those without dyslipidemiawhile controlling for age and gender. This suggests a significant independent association between dyslipidemia and stroke (p=.005).It highlights dyslipidemia as a considerable risk factor for stroke, irrespective of these demographic variables. Furthermore, adjusting age and gender helps isolate the specific impact of dyslipidemia on stroke risk, underscoring its importance in stroke prevention strategies. The literature has established that genetic factors play a pivotal role in stroke susceptibility, particularly in Afro-Caribbean populations, as indicated by research (Meschia et al., 2014; Wilks et al., 2018). The work of Meschia et al. (2014) delves into various genetic factors, such as diabetes, hypertension, and dyslipidemia, and their connection to stroke risk. The current study concurs with the literature on diabetes and hypertension. It provides further insights into the genetic predispositions (diabetes, hypertension, and dyslipidemia) that are mostly common among stroke patients in Jamaica. Such findings mean that there is a need for tailored approaches to prevent and treat the predisposition among the Jamaican population.

Another research question that was answered by the current research is ‘How do lifestyle factors (salt intake, alcohol consumption, obesity, smoking, physical inactivity), while controlling confounders such as age and gender, interact with genetic predispositions to influence stroke outcomes?’ Sodium and stroke, controlled for age and gender, were found not to significantly influence the odds of experiencing a stroke. Since the OR is close to 1, it indicates that for each unit increase in sodium intake, the odds of stroke decrease slightly, but this effect is negligible. This finding implies that sodium intake does not substantially influence stroke risk (p=.118). Additionally, alcohol consumption and stroke, controlled for age and gender, were found to be a slight increase in the odds of experiencing a stroke with higher alcohol intake. Since the OR is close to 1, the effect is minimal and suggests that alcohol consumption does not significantly impact stroke risk in this context (p=.904). This finding implies that, while there may be a trend, alcohol is not a significant contributing factor to stroke outcomes when controlling for the specified demographics. The current finding implies that, within the context of the research study, obesity does not appear to be a significant risk factor for stroke outcomes. Of importance to note were the findings of smoking and stroke, controlled for age and gender. The current study found that individuals who smoke have about 17.2% higher odds of experiencing a stroke

compared to non-smokers after adjusting for these demographic factors. This suggests a positive association between smoking and stroke risk, highlighting smoking as a significant risk factor for stroke outcomes.The link between physical inactivity and stroke, adjusted for age and gender, is significant. The recent findings revealed a marginal elevation in the likelihood of stroke occurrence linked to elevated levels of physical inactivity. However, since the OR is close to 1, the effect is minimal and may not be statistically significant (p=.931). This finding implies that physical inactivity does not appear to be a significant risk factor for stroke outcomes.

The literature had initially established that high salt intake, obesity, physical inactivity levels, and a diet rich in processed foods contribute to elevated rates of hypertension and diabetes in Jamaica, increasing stroke vulnerability(Ferguson et al., 2019; Gottesman et al., 2016). These lifestyle factors interact with genetic predispositions, creating a cumulative risk effect for stroke incidence and severity (Ferguson et al., 2019). Nevertheless, the current study does not concur with the literature that salt intake directly influences stroke; inactivity influences stroke, obesity does not appear to be a significant risk factor for stroke outcomes, and alcohol consumption does not significantly influence stroke risk. However, this research concurs with the literature that individuals who smoke have about 17.2% higher odds of experiencing a stroke compared to non-smokers after adjusting for these demographic factors.

The final research question addressed in this study is, ‘How do environmental factors (education levels, income, access to healthcare), while controlling for confounders such as age and gender in Jamaica, affect the relationship between genetic risk factors and stroke incidence?’ The current findings indicated a positive association between education level and stroke risk, highlighting the potential influence of educational attainment on health outcomes. Additionally, income per month and stroke, controlled for age and gender, suggest a slight decrease in the odds of experiencing a stroke as income increases. Moreover, this study found that healthcare and stroke, controlled for age and gender, individuals with better access to healthcare have about 10.4% higher odds of experiencing a stroke compared to those with poorer access. This suggests a potential positive association between healthcare access and stroke risk. However, the OR being close to 1 implies that this effect is relatively small and may not be significant (p=.690), indicating that access to healthcare alone may not be a major determinant of stroke outcomes. Those findings somewhat concur with the literature. The literature revealed that socioeconomic factors also significantly influence stroke outcomes (Avan *et al.,* 2019; Becker *et al*., 2024; Fan *et al*., 2023). A systematic review by Campbell et al. (2018) reveals that individuals from lower socioeconomic backgrounds are at a higher risk for stroke due to limited access to healthcare and poor dietary habits, which leads to obesity and sedentary lifestyles. In Jamaica, people with low incomeshave a greater probability of experiencing a stroke compared to those ofother social statuses,which concurs with the literature (Becker *et al*., 2024), so addressing socioeconomic disparities is crucial for improving stroke outcomes in vulnerable populations.

Recommendation

Future studies should further examine the relationship between income and stroke risk by analysing its effects on healthcare accessibility, lifestyle choices, and stress levels. Income gaps frequently influence variations in health outcomes, highlighting the necessity for a more

thorough examination of socioeconomic determinants in stroke prevention (Gershon et al., 2019). Furthermore, longitudinal studies may provide insights into the influence of lifestyle and genetic factors on stroke risk over time within the Jamaican community, thereby addressing the limitations inherent in cross-sectional designs (Walker et al., 2020).

Expanding on targeted interventions is crucial, especially in at-risk populations. Tailored programs addressing smoking cessation, physical inactivity, and other modifiable risk factors could help mitigate stroke risks and reduce healthcare burdens (Smith et al., 2018). Policy recommendations should aim to bridge healthcare access gaps and promote healthier lifestyle choices, as socioeconomic disparities in health access remain a significant barrier (Chen et al., 2021).Further, advancing genetic research specific to the Jamaican or broader Caribbean population could help identify unique risk factors, informing prevention strategies tailored to this demographic (Williams et al., 2017). Community education programs that promote healthy habits and awareness of stroke risk factors would empower local communities and potentially lower stroke incidence rates (Johnson & Henry, 2020).These recommendations could substantially reduce stroke incidence, improve outcomes, and address social determinants of health in stroke prevention efforts.

Conclusion

Addressing stroke risk in Jamaica necessitates a deep understanding of the complex interplay between genetic, lifestyle, and environmental factors. By studying how these factors interact, researchers and healthcare professionals can design culturally and biologically tailored interventions to reduce stroke risk and improve outcomes for Jamaican and Afro-Caribbean populations. This study underscores the crucial need for more research into these intersecting influences to mitigate the rising stroke burden in Jamaica. In conclusion, the interplay of genetic predispositions with lifestyle and environmental risk factors significantly influences stroke outcomes in the Jamaican population. Continued study in this domain is essential for formulating effective prevention and intervention methods customised to Jamaica's distinct genetic and socio-environmental contexts.

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