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Unveiling the dominant influence: genetic status and lifestyle factors in cardiovascular health

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Abstract. Cardiovascular disease (CVD) is a leading cause of death globally, with a profound impact on public health worldwide. Nevertheless, the dominant risk factor of CVD is still not established. Developing customized therapies and preventative measures for CVD requires an understanding of the interaction between inherited genetic variables and lifestyle choices. This study aims to investigate whether genetic status or acquired lifestyle factors predominantly influence the prevalence of CVD, using a dataset of over 400,000 adults. Through chi-square tests and logistic regression, the study analyses the association between genetic health, lifestyle habits, and the occurrence of CVD. The results reveal that both genetic health and lifestyle choices significantly impact CVD, with smoking showing the most substantial influence. This research underscores the importance of addressing lifestyle behaviors, especially smoking, as a key factor in managing and preventing cardiovascular disease. This study adds to the understanding of how genetics and lifestyle together influence cardiovascular disease risk.

Keywords: Cardiovascular diseases, Genetic status, Smoking, Alcohol consumption Cardiovascular disease.

1. Introduction

According to the United States of America centres for disease control and prevention, heart disease is one of the leading causes of death and disability worldwide. About half of all Americans have at least one of the 3 major risk factors for heart disease [1]. Globally, the number of deaths from cardiovascular disease (CVD) has increased by 12.5% over the past decade [2]. Today, approximately one-third of deaths are related to CVD. These changes are driven by population growth and aging populations. To develop targeted interventions for heart disease, a deeper understanding of the relationship between lifestyle factors and heart disease progression in various age groups and genders is essential. Researchers will be able to identify populations at high risk and adjust preventative strategies by looking into lifestyle choices.

The last several decades have seen breakthroughs in the understanding of CVD risk factors. Advances in data analytics have allowed researchers to better explore the nature of CVD risk factors and their impact on cardiovascular outcomes. Numerous epidemiological studies have revealed important risk factors such as alcohol consumption and smoking for CVD, including the Framingham Heart Study [3]. Furthermore, CVD, which is a heritable disease, has also been influenced by genetic health [4].

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However, recent studies on cardiovascular health indicate several gaps that need to be addressed, especially the lack of comparative research on genetic status and lifestyle choices. While smoking, drinking, and inherited genetic health have been confirmed as risk factors for CVD, it has not yet been established whether CVD is predominantly inherited or acquired. By researching whether genetic health and lifestyle habits significantly influence CVD, a comparison can be made and a leading cause can be concluded. This comparison can provide valuable insights for medical professionals to develop targeted plans for managing heart disease. By investigating and comparing genetic and lifestyle factors, informed decisions for prevention, intervention, and treatment can be made.

This study, leveraging a dataset of over 400,000 adults including various variables carries substantial research significance. The study aims to research whether innate factors or acquired factors significantly lead to CVD and which of them serve as the determining risk factor for CVD. The chi-square test is employed to determine the impact. The study will first analyze the association fbetween CVD and genetic factors or personal habits respectively, followed by a comparison using logistic regression.

2. Methods

The dataset originally comes from the U.S. Centers for Disease Control and Prevention and is a major part of the Behavioral Risk Factor Surveillance System (BRFSS). It collects data by annual telephone surveys of U.S. residents. BRFSS is the largest continuously conducted health survey system worldwide. The dataset contains various factors such as “Body Mass Index (“BMI”)”, obesity, smoking, alcohol consumption, physical activity, diabetes, stroke, genetic health, gender, and age. Research has already shown that among these factors, women, elderly individuals, and obese or overweight individuals are at a higher risk of heart disease [5]. Furthermore, lifestyle factors like smoking and alcohol consumption are linked to conditions such as stroke and diabetes, which contribute to an increased risk of CVD [6].

To assess the impact of genetic factors and lifestyle choices on heart disease individually and comparatively, a Chi-square test is employed. The Chi-square test is specifically designed to analyze more than two independent categorical data groups. For example, genetic status and lifestyle choices. The Chi-square test is also a non-parametric test, meaning it does not assume a specific data distribution. This makes it applicable to the dataset of this research. Additionally, the observed frequencies and the expected frequencies under the null hypothesis are allowed to be compared using the chi-square test, which allows for assessing whether any differences between groups are statistically significant.

Firstly, genetic data collected from participants is categorized based on genetic status related to heart disease risk (excellent, very good, good, fair, and poor) and compared with their heart disease status (yes or no). Through the making tables of observed and expected frequencies, the p-value is further calculated.

Similarly, to assess if bad lifestyles influence the occurrence of CVD significantly, people are divided into two groups. Two groups of individuals, one with the habits of smoking and drinking as acquired risk factors for CVD, and the other with healthy lifestyle habits (no smoking or drinking), are categorized. The numbers of CVD cases in these two groups are then recorded. Subsequently, a Chi-square test is conducted to analyze whether a bad lifestyle significantly impacts the occurrence of CVD.

Finally, to examine whether inheritable or acquired factors have a more significant influence on CVD, logistic regression is conducted. Logistic regression is utilized in this case due to the binary nature of the variable, CVD. It examines the correlation between the independent variables, such as genetic health and unhealthy way of living. Through logistic regression analysis, it becomes possible to ascertain and compare the effects of smoking, alcohol consumption, and genetic health on the probability of developing CVD. Furthermore, the coefficients in logistic regression interpreted specifically how far the variables affect the risk of CVD.

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3. Results

3.1. The influence of genetic status on CVD

To examine whether genetic status significantly influences CVD, a chi-square test is designed with a significance level of 0,05.

The Null Hypothesis (H0): "There is no significant relationship between genetic health and the occurrence of heart disease in the U.S. population."

The Alternative Hypothesis (Ha): “There is a significant relationship between genetic health and the occurrence of heart disease in the U.S. population."

Table 1. Counts the observed frequencies, compares the observed frequencies with the expected frequencies, and shows the calculated X^2, degree of freedom, and p-value.

		Observed			
	Excellent	Very good	Good	Fair	Poor
Have CVD	1500	5381	9558	7084	3850
No CVD	65342	108477	83571	27593	7439
	66842	113858	93129	34677	11289
		Expected			
	Excellent	Very good	Good	Fair	Poor
Have CVD	5721,37171	9745,728	7971,42	2968,194	966,2871
No CVD	61120,62829	104112,3	85157,58	31708,81	966,2871
		(O-E)^2/E			
	Excellent	Very good	Good	Fair	Poor
Have CVD	3114,634045	1954,79	315,7828	5707,128	8605,93
No CVD	291,5542528	182,9837	29,55976	534,2321	43357,72
X^2	64094,31905				
df	4				
p-value	0,000000000				

The calculated p-value approaching zero from Table 1 indicates that the null hypothesis is rejected, indicating that genetic health significantly influences the prevalence of CVD.

3.2. The influence of lifestyle habits on CVD

A chi-square test was conducted to explore the impact of unhealthy lifestyles on CVD. This study examined the association between bad habits (smoking and alcohol consumption) and the presence of CVD within the population. By categorizing individuals into two groups based on their lifestyle choices—those who smoked and consumed alcohol, those with one bad habit (alcohol consumption or smoking), and those who did not. This test is conducted with a significance level of 0,05.

The Null Hypothesis (H0): "There is no significant relationship between bad lifestyle (smoking plus alcohol drinking) and the occurrence of heart disease in the population."

The Alternative Hypothesis (Ha): “There is a significant relationship between bad lifestyle (smoking plus alcohol drinking) and the occurrence of heart disease in the population."

Table 2. Counts the observed frequencies and compares the observed frequencies with the expected frequencies.

		Observed	
	two bad lifestyle	one bad lifestyle	no bad lifestyle
Have CVD	890	15398	11085
No. CVD	12525	111457	168440

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Table 2. (continued).

	13415	126855	179525
		EXPECTED	
	two bad lifestyle	one bad lifestyle	no bad lifestyle
Have CVD	1148,263	10858,212	15366,52488
No. CVD	12266,74	115996,788	164158,4751
		(O-E)^2/E	
	two bad lifestyle	one bad lifestyle	no bad lifestyle
Have CVD	58,08758	1898,07261	1192,947362
No. CVD	5,437455	177,674531	111,6692593

Based on the frequencies in Table 2, the Chi-square test results are calculated by EXCEL and revealed a statistic of X^2 = 3443,888797 with 2 degrees of freedom and a p-value extremely reaching zero, leading to reject the null hypothesis and accept the alternative hypothesis. This finding is consistent with the aforementioned research papers, reinforcing the significance of addressing unhealthy lifestyle behaviours to reduce the risk of cardiovascular disease in the population, given the significant impact of bad lifestyles on CVD.

3.3. The most significant factor

The two chi-square tests conducted earlier indicated that both inherited and acquired influences significantly impact CVD, with p-values extremely approaching 0. However, to understand which variable holds a greater significance, logistic regression is employed in EXCEL. By analyzing the regression coefficients, the relative impact of each variable on heart disease can be determined:

Smoking: 0.124018215; Alcohol Drinking: -0.024002588; Genetic Health: 0.016897363.

From the coefficients provided, smoking exhibits the most substantial influence on heart disease (0.124), followed by genetic health (0.017), while alcohol consumption demonstrates a negative impact (-0.024). Moreover, the combined effect of unhealthy habits (smoking and alcohol drinking) can be calculated using the formula: Exp(Smoking) * Exp(Alcohol Drinking).

$$\text{Combined effect} \approx 1.1326 * 0.9763 \approx 1.1050 \quad (1)$$

Hence, according to the given coefficients, it is probable that acquired factors have the greatest impact on CVD than inherited factors. CVD appears to be more influenced by lifestyle choices, especially smoking.

4. Discussion

By leveraging a large national dataset and applying statistical analyses, this study offers a systematic approach to understanding the contributions of genetic predispositions and lifestyle choices to the prevalence of CVD. However, this research faced several limitations.

One of the limitations of the research is that genetic health, as a general concept, may not directly correlate with the development of CVD in all individuals. The research of genetic status in this study provides a practical framework for assessing the overall impact of genetic factors on CVD risk in large datasets. However, its impact on CVD may vary for each individual. Investigating specific genetic markers for CVD and comparing them to CVD prevalence may be a more deliberate choice [7].

Although the study's emphasis on smoking and alcohol consumption as key components of a "bad lifestyle" is supported by well-documented evidence [8]. Another limitation to consider is the definition of a "bad lifestyle" solely based on smoking and alcohol consumption. While these habits are known as high-risk factors for CVD, defining lifestyle choices solely based on these two factors may not fully capture lifestyle behaviors. Other factors such as diet, physical activity, and stress management can also play significant roles in determining an individual's overall lifestyle style and affecting CVD. Therefore,

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a more comprehensive assessment of lifestyle factors may provide a more nuanced understanding of the impact on CVD.

There are also limitations and potential biases associated with the statistical methods used in the study.

Firstly, the reliance on self-reported data from telephone surveys may introduce bias into the study. Self-reporting can be subject to recall bias, social desirability bias, and other inaccuracies that could impact the validity of the results.

Additionally, the answers of "yes" or "no" to assess smoking and alcohol consumption in the study introduce inaccuracies and limitations. The impact of smoking intensity and duration as well as varying levels of alcohol consumption, can have different effects on CVD [9]. By dividing smoking and alcohol consumption habits into multiple categories based on frequency or intensity, researchers can capture a more nuanced understanding of how these lifestyle factors may impact the occurrence of cardiovascular disease. By grouping individuals into simplistic categories, the Chi-square test may not adequately capture the dose-response relationships between these lifestyle factors and cardiovascular disease risk. The oversimplification of using "yes" or "no" instead of multiple categories may have influenced the accuracy of the results, potentially contributing to the observed slightly negative correlation between CVD and alcohol consumption.

In light of the limitations, future research could strive to incorporate a more comprehensive evaluation of lifestyle behaviors and delve into specific genetic markers linked to CVD to provide a more nuanced understanding of CVD occurrence [10]. Furthermore, to gain a more comprehensive and accurate understanding of the relationships between CVD and genetic health or lifestyle choices, researchers may need to consider more refined categorizations or continuous variables that better represent the complexity of genetic and lifestyle factors.

5. Conclusion

Based on the findings presented in the article, it is evident that both genetic status and lifestyle factors significantly influence CVD. The research also showed that acquired factors, such as smoking and alcohol consumption, have a greater impact on CVD than inherited factors. Smoking has the most substantial influence on the prevalence of CVD, followed by genetic health and alcohol consumption. The findings highlight the importance of addressing unhealthy lifestyle behaviors, particularly smoking, in managing and preventing CVD.

The implications of this study are significant as it fills the gap in comparative research on inherited and acquired risk factors on cardiovascular health. By understanding the interactions between genetic and lifestyle factors, informed decisions for the prevention, intervention, and treatment of CVD can be made. However, the study does have limitations, including the reliance on self-reported data and the oversimplification of lifestyle factors.

Moving forward, it is recommended that future research incorporates a more comprehensive evaluation of lifestyle behaviors beyond just smoking and alcohol consumption by utilizing more refined categorizations and continuous variables. Factors such as diet, physical activity, and stress management should be further explored to gain a more nuanced understanding of CVD. Additionally, investigating specific genetic markers linked to CVD could provide deeper insights into genetic risk assessments.

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