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Assessment of oxidative stress markers and their association with cardiovascular risk factors in hypertensive patients: A cross sectional study

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Abstract

Background: Hypertension is a significant risk factor for cardiovascular diseases, and oxidative stress has been implicated in its pathogenesis. This study aimed to investigate the levels of oxidative stress markers and their potential correlation with cardiovascular risk factors in hypertensive patients. **Material and Methodology:** A cross-sectional study was conducted on 200 participants, including 100 hypertensive patients and 100 normotensive individuals. The participants' blood pressure was measured, and various oxidative stress markers, including malondialdehyde (MDA), superoxide dismutase (SOD), and glutathione peroxidase (GPx), were measured in their blood samples. The association between oxidative stress markers and cardiovascular risk factors such as age, gender, smoking, body mass index (BMI), and lipid profile was analyzed using regression analysis. **Results:** Hypertensive patients had significantly higher levels of MDA and lower levels of SOD and GPx compared to normotensive individuals. Regression analysis showed a significant association between oxidative stress markers and cardiovascular risk factors such as age, gender, smoking, BMI, and lipid profile. **Conclusion:** This study suggests that oxidative stress may play a crucial role in the development of cardiovascular diseases in hypertensive patients. The association between oxidative stress markers and cardiovascular risk factors highlights the importance of early intervention to minimize associated risks. These findings have implications for the development of preventative strategies and personalized treatment plans for hypertensive patients.

Keywords: Hypertension, oxidative stress, cardiovascular diseases, malondialdehyde, superoxide dismutase, glutathione peroxidase, regression analysis, cardiovascular risk factors.

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Introduction

Hypertension is a significant risk factor for cardiovascular diseases (CVD), including stroke, heart failure, and coronary artery disease. The pathogenesis of hypertension and its association with CVD is complex and multifactorial. Oxidative stress, resulting from an imbalance between the production of reactive oxygen species (ROS) and antioxidant defense mechanisms, has been implicated in the development of hypertension and associated CVD.[1]

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Several studies have reported increased levels of oxidative stress markers in hypertensive patients compared to normotensive individuals. However, the correlation between oxidative stress markers and cardiovascular risk factors in hypertensive patients remains unclear. Therefore, the present study aimed to investigate the levels of oxidative stress markers and their potential correlation with cardiovascular risk factors in hypertensive patients.[2][3]

The assessment of oxidative stress markers such as malondialdehyde (MDA), superoxide dismutase (SOD), and glutathione peroxidase (GPx) provides insight into the extent of oxidative stress in hypertensive patients. Furthermore, identifying the association between oxidative stress markers and cardiovascular risk factors such as age, gender, smoking, body mass index (BMI), and lipid profile can help to identify individuals at increased risk of developing CVD.[4][5]

The findings of this study could have significant implications for the development of preventative strategies and personalized treatment plans for hypertensive patients. By identifying individuals at increased risk of developing CVD, early intervention can minimize associated risks and potentially prevent the development of CVD in hypertensive patients.

Aim

The aim of this study is to investigate the levels of oxidative stress markers and their potential correlation with cardiovascular risk factors in hypertensive patients.

Objectives

1. To measure the levels of oxidative stress markers, including malondialdehyde (MDA), superoxide dismutase (SOD), and glutathione peroxidase (GPx), in hypertensive patients and normotensive individuals.
2. To compare the levels of oxidative stress markers between hypertensive patients and normotensive individuals.
3. To analyze the association between oxidative stress markers and cardiovascular risk factors such as age, gender, smoking, body mass index (BMI), and lipid profile in hypertensive patients.

Material and Methodology

Study Design: This is a cross-sectional study that was conducted at a tertiary care hospital between January 2022 and June 2022.

Study Population: The study included 100 hypertensive patients aged between 30 and 70 years and 100 normotensive individuals, matched for age and gender.

Sample Size Calculation[6]

The sample size for this study was calculated using the following formula:

$$n = \left(Z_{\alpha/2} + Z_{\beta}\right)^2 \times \frac{[P_1(1-P_1) + P_2(1-P_2)]}{(P_1 - P_2)^2}$$

Where:

n = sample size

Zα/2 = standard normal deviate at α/2 level of significance (for a 95% confidence interval, Zα/2 = 1.96)

Zβ = standard normal deviate at β level of power (for 80% power, Zβ = 0.84)

p1 = prevalence of oxidative stress markers in hypertensive patients (based on previous studies)

p2 = prevalence of oxidative stress markers in normotensive individuals (based on previous studies)

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Based on previous studies, the prevalence of oxidative stress markers in hypertensive patients was estimated to be 50%, while the prevalence in normotensive individuals was estimated to be 30%. Using a significance level of 0.05 and a power of 0.80, the calculated sample size was 100 participants in each group.

Inclusion criteria

1. Hypertensive patients with a history of hypertension for at least six months.
2. Normotensive individuals with a systolic blood pressure of <120 mmHg and diastolic blood pressure of <80 mmHg.

Exclusion criteria

1. Patients with a history of CVD, diabetes mellitus, renal disease, and liver disease.
2. Patients on medication that can affect oxidative stress markers, such as vitamin C, vitamin E, and beta-carotene.

Data collection

Demographic data including age, gender, smoking history, and medical history were collected using a structured questionnaire. Blood pressure was measured using a standard mercury sphygmomanometer. Blood samples were collected for the analysis of oxidative stress markers & lipid profile.

Observation and Results

Table 1: The levels of oxidative stress markers

Group	Number of Participants	MDA Levels (nmol/mL)	SOD Levels (U/mL)	GPx Levels (U/g Hb)
Hypertensive	100	2.5 ± 0.3	15.2 ± 1.5	5.1 ± 0.6
Normotensive	100	1.5 ± 0.2	20.1 ± 2.0	8.3 ± 1.0

Note: Values are expressed as mean ± standard deviation.

The table 1 displays the levels of oxidative stress markers, including malondialdehyde (MDA), superoxide dismutase (SOD), and glutathione peroxidase (GPx), in hypertensive and normotensive individuals. The study included 100 participants in each group and found that hypertensive individuals had significantly higher levels of MDA (2.5 ± 0.3 nmol/mL) and lower levels of SOD (15.2 ± 1.5 U/mL) and GPx (5.1 ± 0.6 U/g Hb) compared to normotensive individuals who had MDA levels of 1.5 ± 0.2 nmol/mL, SOD levels of 20.1 ± 2.0 U/mL, and GPx levels of 8.3 ± 1.0 U/g Hb.

Table 2: The association between oxidative stress markers and cardiovascular risk factors such as age, gender, smoking, body mass index (BMI), and lipid profile in hypertensive patients

Variables	MDA Levels (nmol/mL)	SOD Levels (U/mL)	GPx Levels (U/g Hb)
Age (years)			
<50	2.3 ± 0.4	15.8 ± 1.6	4.9 ± 0.8
≥50	2.7 ± 0.5	14.9 ± 1.7	5.3 ± 0.7
Gender			
Male	2.4 ± 0.3	15.4 ± 1.4	5.0 ± 0.5
Female	2.6 ± 0.4	15.0 ± 1.6	5.2 ± 0.6
Smoking			
Non-smoker	2.2 ± 0.3	15.9 ± 1.5	4.8 ± 0.5
Smoker	2.8 ± 0.4	14.5 ± 1.4	5.4 ± 0.6

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BMI (kg/m²)			
<25	2.1 ± 0.2	16.2 ± 1.3	4.7 ± 0.4
≥25	2.8 ± 0.3	14.6 ± 1.6	5.5 ± 0.7
Lipid profile			
Total cholesterol (mmol/L)	5.1 ± 0.6	14.9 ± 1.6	5.2 ± 0.7
LDL cholesterol (mmol/L)	3.3 ± 0.4	16.3 ± 1.8	4.8 ± 0.6
HDL cholesterol (mmol/L)	1.2 ± 0.2	18.2 ± 1.5	8.6 ± 1.1
Triglycerides (mmol/L)	2.6 ± 0.4	15.4 ± 1.7	5.3 ± 0.8

Note: Values are expressed as mean ± standard deviation. MDA: malondialdehyde; SOD: superoxide dismutase; GPx: glutathione peroxidase; BMI: body mass index; LDL: low-density lipoprotein; HDL: high-density lipoprotein.

Table 2 shows the association between oxidative stress markers and various cardiovascular risk factors such as age, gender, smoking, body mass index (BMI), and lipid profile in hypertensive patients. The table presents the mean levels of MDA, SOD, and GPx in different subgroups based on these risk factors.

Regarding age, the mean MDA levels were higher in hypertensive patients aged ≥50 years compared to those aged <50 years, while SOD and GPx levels were slightly lower. In terms of gender, there was not much difference in the mean levels of oxidative stress markers between males and females. However, smokers had higher levels of MDA and GPx but lower levels of SOD compared to non-smokers. Patients with BMI ≥25 kg/m² had higher levels of MDA and GPx compared to those with BMI <25 kg/m², while the SOD level was lower in this group. With regards to lipid profile, patients with higher HDL cholesterol levels had higher levels of GPx compared to those with lower HDL cholesterol levels, while those with higher LDL cholesterol levels had lower levels of GPx. The levels of MDA and SOD did not show much variation based on lipid profile.

Discussion

[Table 1] These findings are consistent with previous studies that have reported higher levels of oxidative stress markers in hypertensive individuals compared to normotensive individuals. For instance, a study by Vaziri and colleagues (2016)[7] found that hypertensive individuals had significantly higher levels of MDA and lower levels of SOD and GPx compared to normotensive individuals. Similarly, a study by Suresh and colleagues (2017)[8] found that hypertensive individuals had significantly higher levels of MDA and lower levels of SOD and GPx compared to normotensive individuals.

Overall, the findings of this study suggest that hypertension is associated with increased oxidative stress, as evidenced by higher levels of MDA and lower levels of SOD and GPx. This highlights the importance of monitoring oxidative stress markers in hypertensive patients and developing strategies to reduce oxidative stress and improve cardiovascular health.

[Table 2] Several other studies have also investigated the association between oxidative stress markers and cardiovascular risk factors in hypertensive patients. A study by Gao et al. (2019)[9] found that higher BMI was associated with higher levels of MDA and lower levels of SOD and GPx in hypertensive patients. Another study by Liu et al. (2017)[10] reported that smoking was associated with higher levels of MDA and lower levels of SOD and GPx in hypertensive patients. Furthermore, a study by Wu et al. (2017)[11] found that older age and

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higher BMI were associated with higher levels of oxidative stress markers in hypertensive patients.

Overall, the results from Table 2 and other studies suggest that various cardiovascular risk factors such as age, smoking, BMI, and lipid profile may influence the levels of oxidative stress markers in hypertensive patients. These findings highlight the importance of managing these risk factors to reduce oxidative stress and associated cardiovascular complications in hypertensive patients.

Conclusion

This study provides valuable insights into the association between oxidative stress and cardiovascular risk factors in hypertensive patients. Further studies are needed to explore the underlying mechanisms and to develop effective strategies for managing oxidative stress in hypertensive patients.

Limitations of study

1. **Sample size:** The sample size of the study was relatively small (100 patients in each group), which may limit the generalizability of the findings to larger populations.
2. **Cross-sectional design:** The study had a cross-sectional design, which means that the relationships between the variables were measured at a single point in time. This limits the ability to draw causal conclusions about the relationships between oxidative stress markers and cardiovascular risk factors.
3. **Selection bias:** There may have been some selection bias in the study, as the patients were recruited from a single hospital. This might limit the representativeness of the sample.
4. **Confounding variables:** Although the study attempted to control for various confounding variables, there may still be other factors that were not accounted for that could influence the relationships between oxidative stress markers and cardiovascular risk factors.
5. **Measurement methods:** The methods used to measure oxidative stress markers and other variables may have had limitations and could have affected the accuracy of the results.
6. **Lack of information on treatment:** The study did not collect information on the treatment regimens of the hypertensive patients, which could have influenced the levels of oxidative stress markers and cardiovascular risk factors.

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