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The relationship between age, blood pressure, sex, and blood glucose levels with the risk of cardiomegaly and atherosclerosis: A retrospective study

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ABSTRACT

Cardiomegaly and atherosclerosis are pivotal radiographic indicators of cardiovascular pathology, often associated with significant morbidity and mortality. This retrospective analytical study investigates the relationships between age, blood pressure, sex, and blood glucose levels and their influence on the risk of cardiomegaly and aortic arch atherosclerosis in patients under 50 years of age. Medical records from 133 patients treated at Royal Prima General Hospital, Medan, between May 2024 and May 2025 were analyzed using logistic regression to identify significant predictors. Results demonstrated that both advancing age and elevated blood pressure were strong, independent, and statistically significant risk factors for cardiomegaly and atherosclerosis ($p < 0.001$). Each one-year increment in age increased the odds of cardiomegaly by 12.7% and atherosclerosis by 11.8%, while each unit rise in blood pressure was associated with a 4.3% and 8.6% increase in odds for cardiomegaly and atherosclerosis, respectively. In contrast, sex and blood glucose levels did not show statistically significant associations in the studied cohort. These findings underscore the critical role of age- and blood pressure-related cardiovascular remodeling and vascular pathology in early-onset cardiomegaly and atherosclerosis. The lack of significant association with sex and blood glucose suggests complex, multifactorial interactions warranting further investigation in larger, more diverse populations. Clinically, this study highlights the imperative for rigorous, lifelong blood pressure control and cardiovascular monitoring to mitigate the progression of these conditions.

Keywords: *cardiomegaly, atherosclerosis, blood pressure, aging, cardiovascular risk factors*

INTRODUCTION

Cardiomegaly and atherosclerosis are critical indicators of underlying cardiovascular pathology, frequently identified through diagnostic radiology, particularly chest radiographs. Cardiomegaly, defined as an enlargement of the heart evidenced by a cardiothoracic ratio exceeding 50% on posterior-anterior chest X-rays or computed tomography scans, serves as an important radiographic marker of cardiac structural alteration (Amin & Siddiqui, 2022; Truszkiewicz et al., 2021). It is essential to differentiate true cardiomegaly from non-cardiac causes of an enlarged mediastinal silhouette, as the etiologies of cardiomegaly are diverse, including chronic hypertension, valvular heart disease, intrinsic myocardial disorders, and ischemic heart disease (McKee & Ferrier, 2017; Roger, 2013).

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Similarly, the detection of aortic plaques through imaging signifies the presence of atherosclerosis, a systemic inflammatory disease characterized by lipid accumulation and plaque formation within the arterial wall, often leading to calcifications identifiable on radiographs (Pahwa & Jialal, 2023). These atherosclerotic changes predispose individuals to severe complications such as aneurysm formation, thromboembolism, and arterial occlusions, contributing significantly to cardiovascular morbidity and mortality. The coexistence of cardiomegaly and aortic atherosclerosis often indicates a compounded risk for adverse cardiovascular outcomes and necessitates comprehensive clinical evaluation (Jebari-Benslaiman et al., 2022; Pahwa & Jialal, 2023).

Several risk factors have been implicated in the development and progression of cardiomegaly and atherosclerosis, notably age, blood pressure, sex, and blood glucose levels. Advanced age is a well-established determinant of vascular and myocardial structural changes, with cumulative exposure to cardiovascular risk factors over time exacerbating disease manifestations (Fleg & Strait, 2012; North & Sinclair, 2012). Elevated blood pressure, particularly in the context of chronic hypertension, promotes myocardial hypertrophy and arterial wall remodeling, thereby contributing to cardiomegaly and atherosclerosis (Bornstein et al., 2023; Roger, 2013; Saheera & Krishnamurthy, 2020). Sex differences also influence cardiovascular pathology, with variations in hormone profiles and genetic predispositions affecting disease prevalence and progression (Betai et al., 2024; Noah et al., 2021).

Blood glucose levels, particularly in individuals with diabetes mellitus, represent a crucial modifiable risk factor. Diabetes is associated with an increased risk for cardiovascular disease through pathways involving chronic hyperglycemia, oxidative stress, inflammation, and metabolic dysregulation (Paolillo et al., 2019; Wang et al., 2006). Diabetic patients often present with more severe cardiovascular complications at younger ages, especially when accompanied by persistent hyperglycemia and renal dysfunction (Boudina & Abel, 2010).

Given the multifactorial etiology and complex interplay of these variables, this retrospective study aims to elucidate the relationships between age, blood pressure, sex, and blood glucose levels with the risk of cardiomegaly and atherosclerosis. Focusing on patients under 50 years of age allows for the mitigation of confounding effects from accumulated comorbidities prevalent in older populations, thereby providing clearer insights into these associations.

METHODS

This study employed an analytical observational design with a retrospective approach. This design was selected as the study aimed to analyze the relationship between independent and dependent variables without administering any interventions to the subjects. Data collection involved reviewing existing patient medical records, in accordance with the characteristics of a retrospective study. The research was conducted at Royal Prima General Hospital (RSU Royal Prima Medan), located at Jl. Ayahanda No. 68A, Medan City, North Sumatra. The choice of this location was based on the availability of relevant medical record data and comprehensive supporting facilities. Data collection occurred from June 2025 to July 2025.

The target population comprised all adult patients diagnosed with cardiomegaly and aortic arch atherosclerosis, with a history of elevated blood glucose levels, who underwent radiological examinations and were treated at RSU Royal Prima Medan between May 2024

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and May 2025. A total of 200 patients were identified during this period. Sampling was performed using purposive sampling, selecting samples deliberately based on predefined inclusion and exclusion criteria to ensure homogeneity and relevance to the study objectives. The inclusion criteria were: (1) patients aged over 18 years, and (2) medical records indicating diagnoses of cardiomegaly, aortic arch atherosclerosis, and a history of elevated blood glucose levels. The exclusion criteria included: (1) patients under 18 years of age, and (2) incomplete medical records inadequate for analysis, such as missing laboratory results or radiological reports. Based on these criteria and the available population, the targeted sample size was 133 medical records

Two types of variables were examined in this study. The independent variables were age, blood pressure, sex, and blood glucose levels, with data obtained from laboratory test results recorded in the patients' medical records. The dependent variables were cardiomegaly and aortic arch atherosclerosis, identified through the interpretation of radiological examinations (chest X-rays) conducted by specialist radiologists, also documented in the medical records.

The data used in this study were secondary data obtained through documentation review of patient medical records at RSU Royal Prima Medan. The data collection procedure began with identifying medical records that matched the target population. Subsequently, selection was made based on the established inclusion and exclusion criteria. Relevant data from each selected record were recorded on a prepared data collection sheet, which included anonymized patient identification codes, demographic information, laboratory results related to glucose levels, and radiological interpretation results regarding cardiomegaly and aortic arch atherosclerosis. To ensure data quality, a verification process was conducted to check the completeness and accuracy of the recorded data prior to analysis.

All collected data were processed and analyzed quantitatively using SPSS (Statistical Package for the Social Sciences) Version 26. Multivariate analysis was performed using logistic regression to determine the extent to which age, blood pressure, sex, and blood glucose levels influence the incidence of cardiomegaly and aortic arch atherosclerosis. The statistical significance threshold was set at $p < 0.05$.

This study was conducted following approval from the Research Ethics Committee of Royal Prima Medan General Hospital. To maintain subject confidentiality, all data extracted from medical records were anonymized using numerical codes, ensuring no personally identifiable information was disclosed. The data were used exclusively for research purposes and were securely maintained during and after the study.

RESULTS

This study was conducted to identify factors associated with the likelihood of cardiomegaly using logistic regression analysis (see Table 1). The model evaluated four independent variables—age, blood pressure, sex, and blood glucose levels—to determine their respective effects on the probability of a cardiomegaly diagnosis. The results indicated that age and blood pressure were statistically significant predictors of cardiomegaly. Specifically, age exhibited a highly significant positive association with cardiomegaly ($p < 0.001$). The odds ratio (Exp(B)) of 1.127 suggests that each one-year increase in age corresponds to a 12.7% increase

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in the odds of developing cardiomegaly. This estimate is supported by a 95% confidence interval ranging from 1.090 to 1.165, which does not include 1.

Similarly, blood pressure demonstrated a statistically significant positive relationship with cardiomegaly ($p < 0.001$). An odds ratio of 1.043 indicates that a one-unit increase in blood pressure measurement is associated with a 4.3% increase in the odds of cardiomegaly. The 95% confidence interval for this variable (1.024 to 1.063) further corroborates the significance of this finding.

Table 1. Logistic Regression Analysis of Factors Associated with Cardiomegaly

Variable	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for Exp(B)
Age	0.119	0.017	50.383	< 0.001	1.127	[1.090, 1.165]
Blood Pressure	0.042	0.009	19.974	< 0.001	1.043	[1.024, 1.063]
Gender	0.213	0.273	0.609	0.435	1.237	[.725, 2.111]
Blood Glucose	-0.004	0.004	1.034	0.309	0.996	[.987, 1.004]

In contrast, sex and blood glucose levels were not found to be statistically significant predictors of cardiomegaly in this model. The sex variable yielded a p-value of 0.435, well above the conventional significance threshold of 0.05. Although its odds ratio was 1.237, the wide confidence interval (0.725 to 2.111) included 1, indicating insufficient evidence to assert an effect. Similarly, blood glucose levels showed a p-value of 0.309 and an odds ratio close to unity (0.996). The 95% confidence interval for blood glucose (0.987 to 1.004) also encompassed 1, reinforcing the conclusion that this variable is not a significant predictor. Overall, findings from the logistic regression model suggest that older age and higher blood pressure are important risk factors for cardiomegaly, while sex and blood glucose levels do not appear to be significant determinants in this study.

Next, based on the logistic regression analysis conducted to examine factors associated with atherosclerosis, it was found that not all variables exert the same influence. This analysis specifically evaluated the roles of age, blood pressure, sex, and blood glucose levels in the likelihood of developing atherosclerosis (see Table 2).

The study results demonstrated that age and blood pressure are highly significant predictors. This is evidenced by p-values for both variables being less than 0.001, well below the significance threshold of 0.05. The interpretation of the odds ratio (Exp(B)) for age is 1.118, indicating that each one-year increase in age raises the odds of developing atherosclerosis by 11.8%. Similarly, with an odds ratio of 1.086, each one-unit increase in blood pressure increases the odds of atherosclerosis by 8.6%.

Table 2. Logistic Regression Analysis of Factors Associated with Atherosclerosis

Variable	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for Exp(B)
Age	0.111	0.025	19.682	< 0.001	1.118	[1.064, 1.174]
Blood Pressure	0.082	0.018	20.524	< 0.001	1.086	[1.048, 1.125]
Gender	0.392	0.439	0.8	0.371	1.481	[.627, 3.498]
Blood Glucose	0.009	0.007	2.05	0.152	1.009	[.997, 1.022]

Nomor ISSN: 3124-1115

Conversely, sex and blood glucose levels did not show statistically significant associations with atherosclerosis within this model. The p-values for sex and blood glucose were 0.371 and 0.152, respectively, both exceeding 0.05. These findings are further supported by the 95% confidence intervals for both variables, which include the value 1. When the confidence interval crosses 1, it indicates that the effect of the variable is not statistically distinguishable from no effect. Overall, the model concludes that increasing age and elevated blood pressure are strong risk factors for atherosclerosis, whereas sex and blood glucose levels were not demonstrated to be significant predictors in this study.

DISCUSSION

Recent research over the past decade strongly supports the findings that age and blood pressure are significant predictors of cardiomegaly and atherosclerosis. For instance, Arbab-Zadeh & Fuster (2019) demonstrated that advancing age and elevated blood pressure are closely linked to left ventricular hypertrophy and cardiac remodeling, key features underlying cardiomegaly. Wen et al. (2015) found that arterial stiffness progression follows a curvilinear pattern with age, showing varying rates across different age groups, with the strongest associations occurring after age 59, particularly in women. The study revealed significant interactions between blood pressure and age on arterial stiffness measures. Palombo & Kozakova (2016) established that arterial stiffness results from degenerative processes affecting elastic arteries under aging and risk factors, with independent predictive value for cardiovascular events demonstrated across populations. Guzik & Touyz (2017) identified oxidative stress and inflammation as key mechanisms linking hypertension to accelerated vascular aging, contributing to arterial stiffness and endothelial dysfunction. Mitchell (2014) highlighted the bidirectional relationship between arterial stiffness and hypertension, noting that elevated pulse wave velocity significantly increases risk for incident hypertension and cardiovascular disease, particularly after midlife when prevalence exceeds 60% in individuals over 70 years.

In exploring the underlying mechanisms, North & Sinclair (2012) reviewed the intersection between aging and cardiovascular disease, emphasizing how age-related changes in vascular structure and function act as a driving force for atherosclerosis and cardiac abnormalities, including cardiomegaly. This body of evidence collectively underlines the biological plausibility and epidemiological consistency of age and blood pressure as primary risk factors in these conditions. The mechanistic links connecting cardiovascular conditions to aging biology suggest that chronological aging increases susceptibility to atherosclerosis, vascular stiffening, and heart failure (Moturi et al., 2022). Key molecular pathways regulating lifespan and healthspan, including sirtuins, AMP-activated protein kinase, and mammalian target of rapamycin, play crucial roles in cardiovascular health (North & Sinclair, 2012). Importantly, cellular and molecular proinflammatory alterations underlying arterial aging represent novel therapeutic targets, challenging the notion that aging-related cardiovascular risks are immutable (Lakatta et al., 2009; Najjar et al., 2005).

Conversely, no significant association was observed between sex and cardiovascular outcomes. Studies investigating sex differences in cardiovascular outcomes have revealed complex interactions with age and other factors. Bugeja et al. (2024) found that women with late-onset hypertension exhibit a lower cardiovascular risk compared to men (adjusted hazard

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ratio 0.75, 95% CI 0.73–0.76), indicating significant sex-based differences within this population. However, Canto et al. (2012) demonstrated that sex differences in myocardial infarction mortality diminish with increasing age, with younger women experiencing higher mortality rates that progressively decline relative to men in older age groups. Galyfos & Filis (2015) questioned whether sex truly plays no independent role in coronary microvascular dysfunction outcomes, suggesting that the relationship may be more nuanced than initially apparent. Nattel & Pilote (2020) emphasized that, although sex differences in the presentation and outcomes of cardiovascular disease are well established, the underlying mechanisms and clinical implications continue to evolve, underscoring the need for further research into sex-specific cardiovascular risk factors and treatment strategies.

Similarly, blood glucose levels were not found to significantly predict cardiomegaly or atherosclerosis in this study. Research examining the relationship between blood glucose levels and cardiovascular disease in non-diabetic populations has yielded consistent findings supporting a progressive association. Coutinho et al. (1999) conducted a comprehensive meta-regression analysis of 95,783 individuals followed for 12.4 years, demonstrating that glucose levels below the diabetic threshold still confer cardiovascular risk, with fasting glucose of 6.1 mmol/L associated with a relative risk of 1.33 compared to 4.2 mmol/L. Similarly, Levitan et al. (2004) performed a meta-analysis of 38 prospective studies, finding that non-diabetic individuals with the highest postchallenge glucose levels (150-194 mg/dL) had a 27% greater cardiovascular disease risk compared to those with the lowest levels (69-107 mg/dL). The pooled relative risk across all glucose assessment types was 1.36, which remained significant even after adjustment for cardiovascular risk factors. Liu et al. (2017) further supported these findings in a Chinese population study, confirming that fasting glucose levels can predict atherosclerotic cardiovascular disease development over an 8-year follow-up period.

Overall, the present findings are well-supported by recent scientific literature highlighting the paramount importance of age and blood pressure as risk factors for cardiomegaly and atherosclerosis, while underscoring the more limited independent roles of sex and blood glucose within similar population contexts.

CONCLUSION

Based on the logistic regression analysis conducted, this study consistently identified age and blood pressure as strong and statistically significant risk factors for cardiomegaly and atherosclerosis. These findings align with the existing scientific literature, reinforcing the established association between aging processes and hypertension with adverse cardiovascular structural changes. Conversely, sex and blood glucose levels were not found to be significant independent predictors for either condition within this model. Although this may initially appear inconsistent with some prior studies, these results highlight the complex and often multifactorial nature of the influence exerted by these variables, which may depend on interactions with other factors not fully captured in the present analysis. The primary implication of this research is the reaffirmation of the importance of lifelong blood pressure management and enhanced cardiovascular health monitoring as individuals age. Such measures are crucial for reducing the risk of developing cardiomegaly and atherosclerosis. Future research is recommended to explore the conditional roles of sex and glucose metabolism in larger and more diverse populations, as well as to investigate additional lifestyle

or genetic factors, in order to develop more comprehensive predictive models for cardiovascular disease.

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