

# Understanding Cardiovascular Care in Asian Women: Insights into Epidemiology, Impact of Uric Acid, and AI-Driven Solutions

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## Abstract

Cardiovascular disease (CVD) remains a significant yet underrecognized health concern among Asian women, influenced by a complex interplay of genetic, cultural, and socioeconomic factors. Despite being the leading cause of mortality in this population, research on sex-specific risk factors, healthcare disparities, and treatment outcomes remains limited. This review aims to address these gaps by examining regional variations in CVD prevalence, unique risk factors such as metabolic syndrome, osteoporosis, and elevated serum uric acid levels, as well as disparities in healthcare access that contribute to poorer outcomes in Asian women. Elevated serum uric acid has been associated with an increased risk of heart failure (HF), all-cause mortality, and cardiac-related death, yet findings indicate that uric acid-lowering treatments may not improve prognosis and could even increase mortality in HF patients. Additionally, the role of artificial intelligence (AI) in enhancing early detection, risk prediction, and personalized treatment is explored, highlighting the need for innovative, culturally tailored approaches to cardiovascular care. By integrating insights from epidemiological data, clinical research, and emerging AI-driven solutions, this review underscores the urgent need for targeted interventions to improve cardiovascular outcomes for Asian women. Key findings include the disproportionate burden of CVD among different Asian subgroups, the underrepresentation of women in cardiology research and clinical trials, and the potential of AI tools-such as machine learning (ML) -based risk assessment models and wearable health devices-to bridge existing gaps in diagnosis and treatment. Additionally, the complex role of serum uric acid in cardiovascular health suggests the need for further investigation into its clinical significance and management. Addressing these disparities requires a multifaceted approach that combines public health initiatives, policy reforms, and technological advancements to ensure equitable and effective cardiovascular care for Asian women.

**Keywords:** Artificial intelligence, Asian women, Cardiovascular disease, Healthcare disparities, Personalized medicine, Predictive analytics, Risk factors, Serum uric acid

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## Introduction

CVD remains a leading cause of mortality among women globally, with a particularly alarming trend observed in Asian populations. The World Health Organization estimates that CVD accounts for approximately 30% of all deaths worldwide, with projections indicating that this figure could rise to 23.4 million deaths by 2030, comprising 35% of all deaths globally [1].

Cardiology in Asian women is an important area of study due to the impact of racial, ethnic, and gender disparities in cardiology [2]. Research has shown that CVD is the leading cause of death for Asian women in the United States [3]. Studies have also highlighted the prognostic value of lower bone mineral density (BMD) in predicting adverse CVD in Asian women [4]. Furthermore, cardiovascular and cerebrovascular disease mortality rates vary among different Asian

subgroups, with Asian Indian women typically having lower rates of coronary heart disease (CHD) compared to other Asian American women [5]. It has been noted that Asian American women have varied rates of CVD risk within different Asian subgroups, emphasizing the need for a personalized approach to prevention [6]. Studies such as the MASALA study aim to understand the factors that lead to heart disease in South Asians and guide prevention and treatment strategies [7].

Additionally, primary prevention of CVDs among women in South Asian populations has been studied to identify modifiable risk factors [8]. Research on cardiology in Asian women highlights the importance of considering racial, ethnic, and gender disparities in cardiovascular health outcomes. Understanding the unique risk factors and challenges faced by Asian women can help improve prevention and treatment strategies for CVDs in this population.



## Prevalence and Mortality Rates

The prevalence of CVD among Asian women varies significantly across different regions. In high-income countries, such as Japan, the death ratio from stroke and CHD is reported to be 3:1, indicating a higher prevalence of stroke compared to CHD [1]. Conversely, in South Asia, particularly in countries like India and Bangladesh, there has been a notable increase in coronary diseases, with CVD deaths rising by 30% over the past decade [1]. This trend is alarming, as it suggests that Asian women are increasingly at risk of developing CVD, particularly CHD. Research indicates that the burden of CVD is not uniformly distributed across Asia. For instance, in Indonesia, the mortality rates from CVD have doubled from 1990 - 2019, with stroke and ischemic heart disease being the leading causes of mortality [9]. This highlights the urgent need for targeted interventions to address the rising prevalence of CVD among women in these regions.

Mortality rates from CVD among Asian women are concerning, with studies indicating that the crude CVD mortality rates have increased continuously over the years [10]. In particular, the mortality rates for stroke and CHD are significantly higher in South Asian populations compared to their Western counterparts. This disparity can be attributed to a complex interplay of genetic, environmental, and lifestyle factors, including smoking, hypertension, and metabolic abnormalities [1]. Furthermore, the impact of body mass index on in-hospital mortality for various acute CVDs has been studied in Japan, revealing that both underweight and obesity are associated with higher mortality rates among CVD patients [11]. This finding underscores the importance of addressing obesity and malnutrition as critical factors influencing CVD outcomes in Asian women.

Recent studies indicate that CVD is the leading cause of death for Asian women in the United States, highlighting the urgent need

for targeted interventions [12]. The mortality rates associated with cardiovascular and cerebrovascular diseases have shown alarming trends, particularly among specific Asian subgroups (Figure 1). For instance, Filipino, Asian Indian, and Japanese women have experienced significant increases in HF mortality rates [5]. This underscores the necessity for a nuanced understanding of how CVD affects Asian women differently compared to their male counterparts and other ethnic groups.

## Risk Factors

The risk factors for CVD in Asian women are multifaceted and often intertwined with cultural, socioeconomic, and biological elements. These include lifestyle factors such as diet, physical inactivity, and smoking, as well as socio-economic determinants of health (Table 1). For instance, the prevalence of diabetes, which is closely linked to CVD, is rising among Asian populations, further exacerbating the mortality rates associated with cardiovascular conditions [24]. Additionally, environmental factors, such as altitude, have been shown to influence stroke mortality and hospitalization rates, with significant disparities observed among different racial groups [25]. This highlights the need for a comprehensive understanding of how environmental and socio-economic factors intersect to affect CVD outcomes in Asian women (Figure 2).

High consumption of sugar-sweetened beverages has been associated with increased weight gain and a higher risk of type 2 diabetes and CVD in Asian populations [26]. Additionally, adverse pregnancy outcomes, such as gestational diabetes and hypertensive disorders, have been shown to elevate long-term cardiovascular risk in women, particularly among those of Asian descent [27, 28].

A study focusing on South Asian populations identified modifiable

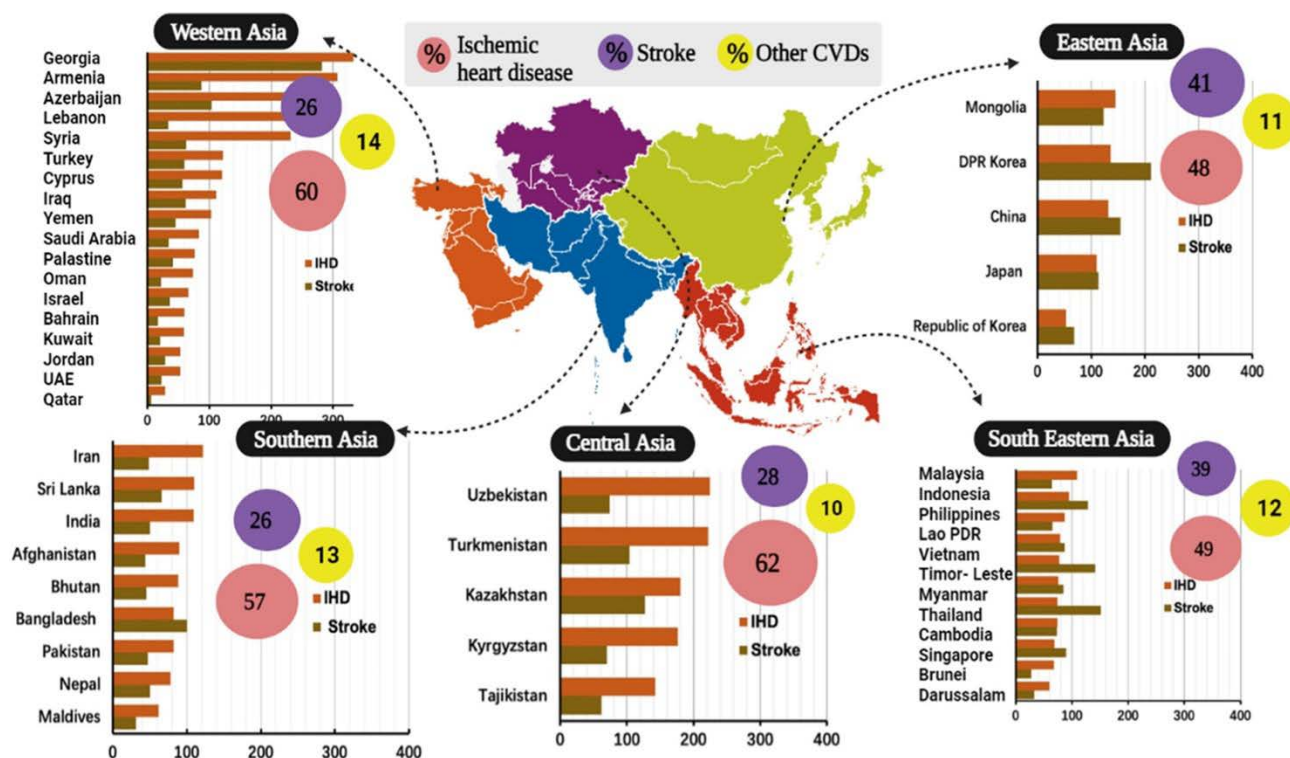
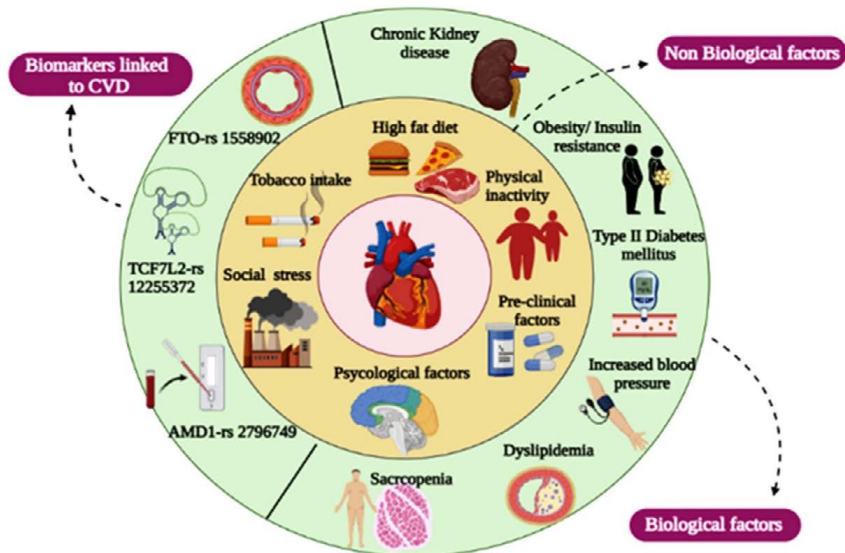


Figure 1: Percentage of CVDs across Asian populations across the globe [13].



**Table 1:** Summary of key risk factors and their impact.

| Risk factor                                                   | Category                    | Impact on CVD                                                | Key findings                                                                                                 |
|---------------------------------------------------------------|-----------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Hypertension [14]                                             | Biological                  | Increased arterial stiffness and heart strain                | Women with hypertension have a 2 to 3x higher risk of CVD compared to those with normal blood pressure       |
| Diabetes mellitus [15]                                        | Biological                  | Increases atherosclerosis and heart disease risk             | Asian women with diabetes have a higher risk of HF compared to Western populations                           |
| Metabolic syndrome [16]                                       | Biological                  | Increases likelihood of CVD by 50%                           | Women with metabolic syndrome have higher cholesterol, obesity, and blood pressure levels, all linked to CVD |
| Obesity and visceral fat [17]                                 | Lifestyle/Biological        | Increases inflammation, blood pressure, and lipid imbalances | Higher visceral adiposity index strongly correlates with CVD risk in Asian women                             |
| Physical inactivity [18]                                      | Lifestyle                   | Increases obesity and metabolic dysfunction                  | Women engaging in light physical activity have significantly lower CVD risk (p = 0.04)                       |
| Diet (High sodium, low fiber, sugar-sweetened beverages) [19] | Lifestyle                   | Raises blood pressure and cholesterol                        | High sugar intake linked to increased CVD mortality (HR: 1.28, 95% CI: 1.11 - 1.47, p < 0.001)               |
| Smoking and second-hand smoke exposure [20]                   | Lifestyle/Cultural          | Accelerates atherosclerosis and heart disease                | Smoking rates lower in Asian women, but second-hand exposure remains a significant risk                      |
| Mental health (Stress and depression) [21]                    | Psychological/Socioeconomic | Increases inflammation and risk of heart disease             | Chronic stress linked to higher cortisol levels, contributing to CVD progression                             |
| Socioeconomic status [22]                                     | Socioeconomic               | Limits healthcare access and preventive care                 | Low-income Asian women have a higher prevalence of untreated hypertension and diabetes                       |
| Oral health [23]                                              | Biological/Lifestyle        | Poor oral health linked to CVD risk                          | Periodontal disease associated with increased inflammation and cardiovascular problems                       |



**Figure 2:** Prevalence of CVDs in Asians: traditional and newly recognized risk factors [13].

risk factors such as hypertension, diabetes, and obesity as prevalent among women, necessitating a comprehensive approach to primary prevention [8]. Furthermore, the MASALA study has shed light on the specific cardiovascular health challenges faced by South Asian women, revealing that many perceive themselves as less at risk for heart disease, which can lead to delayed diagnosis and treatment [7].

CVD is the leading cause of death for Asian women in the United States. The classification of Asian race and ethnicity includes origins from the Far East, Southeast Asia, or the Indian subcontinent. The prevalence of CVD is high among non-Hispanic Asian women, with a rate of 45%. However, there is significant heterogeneity in CVD risk factors and outcomes among different Asian subgroups. A study of the six largest Asian subgroups in the United States (Asian Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese) from 2003 to 2011 showed significant differences in cause-specific death rates. Asian Indian women had the highest CVD death rates among these subgroups. Although Asian Indian and Filipina women have the highest age-adjusted CVD death rates compared to other Asian subgroups, these

rates are still significantly lower than those for non-Hispanic White women. These findings highlight the importance of considering racial and ethnic differences in CVD risk factors and outcomes among Asian women in the United States [12].

### Sex Differences in Cardiac Conditions

The pathophysiology of CVD can differ significantly between sexes, with Asian women exhibiting unique characteristics in disease presentation and progression. Factors such as hormonal differences, genetic predispositions, and lifestyle choices contribute to these disparities [29]. Understanding these differences is essential for developing effective treatment strategies that cater specifically to Asian women. Hypertension is a critical risk factor for CVD, and its consequences can differ between sexes. Studies have shown that Asian women experience distinct cardiovascular consequences from hypertension, which may not be as pronounced in their male counterparts [30]. This difference underscores the need for sex-specific approaches in managing hypertension and its related cardiovascular risks.



Research has shown that sex differences significantly impact the presentation and outcomes of various cardiac conditions, including hypertrophic cardiomyopathy (HCM). A study conducted in Singapore found that while men constituted the majority of HCM patients, women were older and presented with more comorbidities such as hypertension and atrial fibrillation (AF) [3]. Notably, women were more likely to develop progressive HF, indicating a need for gender-specific treatment strategies in managing HCM among Asian populations.

## Bone Health and Cardiovascular Risk

The intersection of bone health and CVD risk is a critical area of research, particularly among Asian women. As the prevalence of osteoporosis and CVD rises in this demographic, understanding the relationship between BMD and cardiovascular health becomes increasingly important. Recent studies have indicated a significant association between lower BMD and increased cardiovascular risk in Asian women. For instance, research has shown that decreased BMD can serve as a prognostic factor for adverse cardiovascular outcomes, suggesting that bone loss may be a novel risk factor for CVD in this population [31]. The underlying mechanisms may involve shared pathophysiological pathways, including inflammation and metabolic dysregulation, which are common in both osteoporosis and cardiovascular conditions.

Osteoporosis, characterized by reduced bone density and increased fracture risk, has been linked to various cardiovascular risk factors. Studies have demonstrated that women with osteoporosis are at a higher risk of developing CVD, potentially due to the interplay of hormonal changes, particularly during menopause, which affect both bone and cardiovascular health [32]. Furthermore, hypertension has been identified as a common risk factor that exacerbates both osteoporosis and CVD, particularly in older Asian women [32].

Emerging evidence suggests a link between bone health and cardiovascular risk in Asian women. Lower BMD has been associated with adverse cardiovascular outcomes, indicating that osteoporosis may serve as a potential risk factor for CVD in this demographic [4]. This relationship highlights the importance of considering bone health in the overall cardiovascular risk assessment for Asian women. The study retrospectively analyzed 12,681 women aged 50 to 80 years who underwent dual-energy X-ray absorptiometry to assess BMD. The analysis adjusted for various clinical risk factors, including age, body mass index, hypertension, type 2 diabetes, hyperlipidemia, current smoking, and previous fractures. The study found that lower BMD at the lumbar spine, femur neck, and total hip was independently associated with a higher risk of atherosclerotic CVD (ASCVD) events. Specifically, the adjusted hazard ratios (HR) per 1-standard deviation decrease in BMD were 1.16 for the lumbar spine, 1.29 for the femur neck, and 1.38 for the total hip, all with p-values less than 0.001, indicating strong statistical significance. A clinical diagnosis of osteoporosis was also independently linked to a higher risk of ASCVD events, with an adjusted HR of 1.79 and a p-value less than 0.001, further supporting the association between bone health and cardiovascular risk. The addition of BMD measurements or a clinical diagnosis of osteopenia or osteoporosis to existing clinical risk factors significantly improved the prediction of ASCVD events. This was particularly evident with the inclusion of total hip BMD, which showed a significant incremental value in discriminating ASCVD events ( $p < 0.001$ ). During the median follow-up period of 9.2 years, 468 women (3.7% of the study population) experienced ASCVD events, which included ASCVD death, non-fatal

myocardial infarction, and ischemic stroke. The study concluded that evaluating BMD provides independent and incremental prognostic value for ASCVD in women, suggesting that BMD assessment could enhance risk stratification for cardiovascular events in this population [4].

Given the strong association between bone health and cardiovascular risk, public health strategies should focus on integrated approaches that address both osteoporosis and CVD prevention. This includes promoting awareness of the importance of maintaining healthy bone density through adequate nutrition, physical activity, and regular health screenings. Additionally, healthcare providers should be trained to recognize the signs of osteoporosis and its potential cardiovascular implications, ensuring timely intervention and management [33].

## Uric Acid and its Association with Cardiovascular Health

Uric acid has been extensively studied as a potential predictor for adverse cardiac events, with varying results across different patient populations and conditions. Elevated serum uric acid levels have been associated with increased cardiovascular morbidity and mortality, suggesting its role as a biomarker for cardiovascular risk. However, the predictive value of uric acid can vary depending on the specific cardiovascular condition and patient demographics. This section explores the evidence from various studies on the role of uric acid as a predictor for adverse cardiac events.

A study focusing on patients with coronary artery disease (CAD) undergoing percutaneous coronary intervention found that elevated uric acid levels were associated with higher 10-year mortality rates, indicating that uric acid is a significant predictor of long-term adverse outcomes in these patients [34]. Patients were divided into three tertiles based on their uric acid levels: Tertile 1:  $< 5.80$  mg/dl ( $n = 1347$ ); Tertile 2:  $5.80 - 7.04$  mg/dl ( $n = 1340$ ); and Tertile 3:  $> 7.94$  mg/dl ( $n = 1311$ ). Primary outcome-all-cause mortality: Over a 10-year period, 1200 patients died. Deaths by tertile: Tertile 1: 320 deaths (26.5%); Tertile 2: 325 deaths (26.9%); and Tertile 3: 555 deaths (46.0%). The adjusted HR for all-cause mortality was 1.22 per 1 mg/dl increase in uric acid level, with a 95% confidence interval (CI) of 1.17 - 1.27, and a significant  $p < 0.001$ . Total cardiac deaths: 748 patients. Deaths by tertile: Tertile 1: 194 deaths (16.5%); Tertile 2: 202 deaths (17.0%); and Tertile 3: 352 deaths (29.7%). The adjusted HR for cardiac deaths was 1.24 per 1 mg/dl increase in uric acid level, with a 95% CI of 1.17 - 1.32, and a significant  $p < 0.001$ . The study found no significant differences in the 10-year rates of target lesion revascularization, target vessel revascularization, or nontarget vessel revascularization based on uric acid levels. Elevated uric acid levels were associated with higher 10-year mortality in patients with CAD treated with percutaneous coronary intervention [34]. However, elevated UA levels were not linked to the progression of atherosclerosis in untreated coronary vessels or the progression of intimal hyperplasia in stented lesions requiring intervention.

In patients with coronary intermediate stenosis, higher uric acid levels were linked to an increased incidence of major adverse cardiovascular and cerebrovascular events, suggesting that uric acid is a reliable predictor of long-term cardiovascular events in this group [35]. Another study demonstrated that uric acid levels were associated with worsening diastolic function and major adverse cardiovascular events in patients with coronary slow flow, further supporting its role as a risk factor for adverse outcomes [36]. The study involved 537 patients diagnosed with coronary slow flow, out of which 425



underwent a comprehensive cardiac function assessment using stress echocardiography before and after maximal treadmill exertion. Among the 425 patients, 176 (41.4%) experienced worsening of diastolic function after exercise stress. This group had higher serum uric acid levels compared to those who did not experience worsening (5.7 (4.1, 6.7) mg/dl vs 4.3 (3.6, 5.3) mg/dl, respectively;  $p < 0.001$ ). Elevated serum uric acid levels were significantly associated with increased neutrophil counts and high-sensitive C-reactive protein in patients with worsening diastolic function, indicating a potential link between uric acid and inflammation in these patients. Multivariate regression analysis identified serum uric acid as an independent predictor of worsening diastolic function, with an odds ratio (OR) of 1.87 (95% CI: 1.17 - 3.82,  $p = 0.023$ ). Serum uric acid was also associated with MACE, even after adjusting for echocardiographic and clinical variables. The HR for MACE was 1.56 (95% CI: 1.03 - 2.89,  $p = 0.016$ ). The study concludes that serum uric acid is linked to worsening diastolic function and may contribute to inflammation. It is also a risk factor for major adverse cardiovascular events in patients with coronary slow flow [36].

The uric acid to high-density lipoprotein cholesterol ratio (UHR) has been proposed as a novel index for predicting adverse cardiovascular events. In patients with coronary chronic total occlusion (CTO), elevated UHR was associated with an increased risk of major adverse cardiovascular events, highlighting its potential as a simple and reliable indicator for risk stratification [37]. The study was a retrospective cohort analysis involving 566 patients with coronary CTO lesions, treated at a hospital from January 2016 - December 2019. The patients were categorized into three groups based on their UHR levels. The main outcome measured was the occurrence of major adverse cardiovascular events (MACE), which included death, non-fatal myocardial infarction, target vessel revascularization, and non-fatal stroke. Over a median follow-up period of 43 months, 107 patients (18.9%) experienced MACEs. The study found that the cumulative incidence of being free from MACE decreased significantly across the tertiles of UHR, as shown by Kaplan-Meier survival plots (log-rank test,  $p < 0.001$ ). In a fully adjusted model, the HR for MACE was 2.16 (95% CI: 1.17 - 3.99) for patients in the highest tertile of UHR compared to those in the lowest. Additionally, for each standard deviation increase in UHR, the HR was 2.01 (95% CI: 1.62 - 2.49). The study concluded that an elevated UHR is a predictor of increased risk for MACE in patients with CTO. UHR serves as a simple and reliable indicator for risk stratification and can aid in early intervention strategies for these patients. These results highlight the potential of UHR as a prognostic tool in managing patients with coronary chronic total occlusion, emphasizing its role in predicting adverse cardiovascular outcomes [37].

However, in patients with very high cardiovascular risk treated with high-intensity statin therapy, the UHR did not significantly predict major cardiovascular events, suggesting that the predictive value of UHR may be context-dependent [38]. The study aimed to evaluate the UHR as a predictor of MACE in patients with very high cardiovascular risk who were treated with high-intensity statin therapy. A total of 82 patients with ischemic heart disease and very high cardiovascular risk were included in the study. Out of these, 49 patients (59.8%) experienced major cardiovascular events, while 33 patients (40.2%) did not. The study found that the baseline UHR did not significantly differ between patients who experienced MACE and those who did not. The mean baseline UHR was 0.188 for the group with MACE and 0.207 for the group without MACE, with a  $p$ -value of 0.806, indicating no significant difference. After 3 months of high-intensity statin treatment, the mean value of total cholesterol was 170.91 mg/dl, high-density lipoprotein was 40 mg/dl, and low-density lipoprotein was 108.43 mg/dl. The mean

uric acid level was 7.04 mg/dl. The study concluded that the UHR had no significant predictive ability for MACE in patients with very high cardiovascular risk who were treated with high-intensity statin therapy. This suggests that UHR is not sensitive or specific enough as an indicator for major cardiovascular events in this context. The findings also indicated that statin therapy might not significantly affect the UHR in the context of major cardiovascular events. Other factors such as overall health condition, lifestyle, and history of disease may be more influential in predicting MACE. The study emphasized the importance of considering various other risk factors, such as blood pressure, smoking habits, and diabetes, in assessing cardiovascular risk. It also highlighted the need for further studies with larger samples and longer observation periods to gain a more comprehensive understanding of the relationship between UHR and major cardiovascular events [38].

A study on hypertensive patients revealed that uric acid is a strong predictor of cardiovascular events and all-cause mortality, with a higher HR observed in females compared to males. This indicates a possible sex-related difference in the pathophysiology of CVD related to uric acid levels [39]. The study involved 1,650 never-treated Caucasian hypertensive outpatients, with 830 males and 820 females, aged  $52.2 \pm 11.3$  years. The follow-up period was  $9.5 \pm 3.1$  years. During which 424 new clinical events were recorded, including coronary events, cerebrovascular events, and deaths. The incidence rate of MACE was significantly higher in females compared to males (3.08% vs 2.33%,  $p = 0.001$ ). Similarly, females had higher incidence rates for coronary events (1.82% vs 1.36%,  $p = 0.014$ ) and cerebrovascular events (0.93% vs 0.57%,  $p = 0.006$ ). Uric acid was found to be a strong and significant predictor of various cardiovascular outcomes. The HR for uric acid were: Coronary events: HR = 1.493 (95% CI: 1.375 - 1.621); Cerebrovascular events: HR = 1.256 (95% CI: 1.109 - 1.423); MACE: HR = 1.415 (95% CI: 1.328 - 1.508); and All-cause mortality: HR = 1.469 (95% CI: 1.237 - 1.745). The study highlighted a sex-related difference in the predictive value of uric acid, with a higher HR observed in females. This suggests that uric acid has a more pronounced impact on cardiovascular outcomes in women compared to men. The best estimated cut-off values of uric acid for predicting cardiovascular outcomes were lower in females than in males, indicating a potential sex difference in disease pathophysiology and the role of uric acid in cardiovascular risk. The study concludes that uric acid is a significant predictor of cardiovascular events and all-cause mortality, with a notable sex-related impact. This finding suggests that uric acid levels should be considered differently in men and women when assessing cardiovascular risk [39].

In patients with acute coronary syndrome, elevated serum uric acid levels were significantly associated with worse in-hospital outcomes, including recurrent infarction, serious arrhythmias, and death. This suggests that uric acid could serve as a prognostic indicator for the severity and outcomes of acute coronary syndrome [40]. Elevated serum uric acid levels, or hyperuricemia, have been linked to worse in-hospital outcomes in acute coronary syndrome patients. A study found that patients with hyperuricemia had significantly higher rates of recurrent infarction, pulmonary edema, serious arrhythmias, shock, and death compared to those with normal uric acid levels. The composite outcome was notably worse in the hyperuricemia group (66.66% vs 6.48%) [40].

While uric acid is a recognized biomarker for cardiovascular risk, its role as a therapeutic target remains controversial. A meta-analysis concluded that uric acid-lowering treatments do not improve the prognosis of HF patients and may even increase mortality, indicating that while uric acid is a predictor of adverse outcomes, lowering it may



not necessarily translate to clinical benefits [41]. A total of 11 studies on HF incidence and 24 studies on adverse outcomes in HF patients were analyzed. Elevated serum uric acid levels were linked to a higher risk of developing HF (RR: 1.81, 95% CI: 1.53 - 2.16), as well as increased rates of all-cause mortality (RR: 1.44, 95% CI: 1.25 - 1.66), cardiac-related death (RR: 1.56, 95% CI: 1.32 - 1.84), and HF-related rehospitalization (RR: 2.07, 95% CI: 1.37 - 3.13) among HF patients. Additionally, treatment aimed at lowering uric acid levels was associated with a rise in all-cause mortality in HF patients (RR: 1.15, 95% CI: 1.05 - 1.25) [41]. This highlights the complexity of uric acid's role in cardiovascular health and the need for further research to clarify its utility in clinical practice.

Variations in perioperative serum uric acid levels were linked to in-hospital adverse outcomes in coronary artery bypass grafting (CABG) patients. An increase in serum uric acid was associated with higher incidences of all-cause death and fatal arrhythmia, independent of baseline serum uric acid levels [42]. The study included 2,453 patients undergoing CABG, with a mean age of 60.9 years. The majority of the participants were male (76.7%). Patients were divided into four groups based on perioperative serum uric acid variation ( $\Delta$ SUA): G1:  $\Delta$ SUA  $\leq$  -90  $\mu$ mol/l; G2: -90  $\mu$ mol/l <  $\Delta$ SUA < 0; G3: 0  $\leq$   $\Delta$ SUA < 30  $\mu$ mol/l; and G4: 30  $\mu$ mol/L  $\leq$   $\Delta$ SUA. The group with the most significant increase in SUA (G4) showed higher incidences of in-hospital all-cause death and fatal arrhythmia compared to other groups. This was observed in both the overall population and specific subgroups. An increase in serum uric acid level of  $\geq$ 30  $\mu$ mol/l was significantly associated with in-hospital all-cause death and fatal arrhythmia. This association was independent of baseline serum uric acid levels and renal function. The association was particularly significant for in-hospital fatal arrhythmia across most subgroups and for in-hospital all-cause death in patients aged  $\geq$ 60 years, those with myocardial infarction, and female patients. The study identified cutoff values for SUA increases associated with adverse outcomes: 54.5  $\mu$ mol/l for in-hospital all-cause death and 42.6  $\mu$ mol/l for in-hospital fatal arrhythmia. The study concluded that perioperative increases in serum uric acid are significantly correlated with a higher incidence of in-hospital all-cause death and fatal arrhythmia in CABG patients. This correlation is independent of baseline serum uric acid levels and renal function, suggesting that perioperative  $\Delta$ SUA could provide additional information for identifying patients at risk [42].

Uric acid-lowering drugs, such as xanthine oxidase inhibitors, have shown potential in reducing the risk of cardiovascular events. These therapies were associated with reduced risks of coronary

atherosclerosis, HF, and peripheral vascular disease [43]. The combination of uric acid-lowering therapy with antihypertensive treatment also demonstrated additive protective effects. The study identified 41 overlapping phenotypes associated with uric acid levels through both observational phenome-wide association study (Obs-PheWAS) and polygenic risk score PheWAS (PRS-PheWAS). These phenotypes were primarily related to cardiometabolic diseases. The trajectory analysis conducted in the study illustrated that elevated uric acid levels contribute to the progression of cardiometabolic diseases, eventually leading to death. This highlights the potential impact of uric acid on cardiovascular health. The study found that uric acid-lowering drugs have a protective effect in reducing the risk of several cardiovascular conditions: Coronary atherosclerosis (OR = 0.96, 95% CI: 0.93 - 1.00,  $p$  = 0.049); Congestive HF (OR = 0.64, 95% CI: 0.42 - 0.99,  $p$  = 0.043); Occlusion of cerebral arteries (OR = 0.93, 95% CI: 0.87 - 1.00,  $p$  = 0.044); and Peripheral vascular disease (OR = 0.60, 95% CI: 0.38 - 0.94,  $p$  = 0.025). The combination of uric acid-lowering therapy, such as xanthine oxidase inhibitors, with antihypertensive treatments like calcium channel blockers, showed additive effects. This combination was associated with a reduction in the risk of: Coronary atherosclerosis by 6%; HF by 8%; Occlusion of cerebral arteries by 8%; and Peripheral vascular disease by 10%. The findings support the role of elevated uric acid levels in advancing cardiovascular dysfunction and suggest potential repurposing opportunities for uric acid-lowering drugs in cardiovascular treatment. These results indicate that uric acid-lowering drugs could be beneficial beyond their traditional use for gout, particularly in managing CVD [43].

While elevated uric acid levels are consistently associated with adverse cardiac outcomes, the utility of uric acid as a predictive marker can vary based on the clinical context and patient demographics. Some studies suggest that uric acid may serve as a biomarker for risk stratification, while others highlight its limited predictive value in certain populations, such as those on high-intensity statin therapy. Additionally, sex-related differences in uric acid's prognostic impact underscore the need for personalized approaches in cardiovascular risk assessment.

Disparities in Healthcare Access

Research indicates that healthcare access for Asian women is influenced by a variety of social determinants, including socioeconomic status, immigration status, and cultural factors. These determinants can create barriers to receiving timely and appropriate care for CVD (Table 2). For instance, a study highlighted that social factors significantly

**Table 2:** Summarizes key disparities and their impact on CVD outcomes.

| Disparity                                      | Category          | Impact on CVD care                                                          | Key findings                                                                                             |
|------------------------------------------------|-------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Lack of insurance coverage                     | Socioeconomic     | Delayed diagnosis and treatment                                             | Uninsured women are less likely to receive timely CVD care                                               |
| Lower socioeconomic status                     | Socioeconomic     | Limited access to healthcare facilities and specialists                     | Low-income women have higher rates of untreated hypertension and diabetes, leading to increased CVD risk |
| Geographic barriers (Rural vs Urban)           | Geographic        | Fewer specialized CVD care centers in rural areas                           | Rural women have higher mortality rates from CVD due to delayed interventions                            |
| Gender bias in diagnosis and treatment         | Systemic          | Women's CVD symptoms often misdiagnosed or overlooked                       | Women are more likely to be misdiagnosed after a heart attack compared to men                            |
| Limited access to preventive screening         | Healthcare access | Higher risk of late-stage CVD diagnosis                                     | Women are less likely to undergo routine cholesterol and blood pressure checks compared to men           |
| Cultural and language barriers                 | Cultural          | Reduced likelihood of seeking medical help                                  | Non-English-speaking women have lower CVD screening rates and adherence to treatment plans               |
| Underrepresentation in clinical trials         | Systemic          | Lack of female-specific CVD research leads to ineffective treatments        | Limited participants in CVD clinical trials are women, despite higher mortality rates                    |
| Higher out-of-pocket costs for care            | Socioeconomic     | Medication non-adherence due to financial constraints                       | Women with lower incomes are less likely to adhere to prescribed statins or blood pressure medications   |
| Lack of female-specific guidelines in CVD care | Systemic          | Generalized treatment approaches may not address unique female risk factors | Women with atypical heart attack symptoms receive fewer interventions and have higher mortality rates    |



affect heart health among Asian ethnicities in the United States, emphasizing the role of socioeconomic status and access to healthcare in shaping health outcomes [44]. Moreover, disparities in treatment and care for CVD among Asian women can be exacerbated by the homogenization of Asian categories in health research, which often overlooks the unique experiences of different subgroups [45]. This lack of granularity in data can lead to inadequate understanding and addressing of the specific needs of Asian women in cardiovascular care.

Financial hardship is a critical barrier to healthcare access for many CVD patients, including Asian women. A study examining racial and ethnic inequities in financial hardship among CVD patients found that, despite improvements in access to health insurance following the Affordable Care Act (ACA), significant disparities persisted. The odds of experiencing financial hardship were notably higher for Black and Hispanic patients compared to their White counterparts, suggesting that similar disparities may also affect Asian women [46]. While the ACA has made strides in reducing financial barriers, further initiatives are necessary to address the ongoing inequities faced by racial and ethnic minorities, including Asian women. The need for targeted financial assistance and support systems is evident to ensure equitable access to cardiovascular care.

Furthermore, awareness of CVD as a leading cause of death is critical for prevention efforts. Research indicates that awareness levels among women, including Asian women, have improved over the past decade, yet gaps remain [47]. Increased education and outreach are necessary to ensure that Asian women recognize their risk factors and seek appropriate care.

Despite the growing body of research on cardiovascular health in Asian women, significant disparities in healthcare access and treatment persist. Only a small percentage of practicing cardiologists are women, which may contribute to the underrepresentation of female perspectives in cardiovascular research and treatment [2]. The paper highlights that, Asian individuals, including women, are underrepresented in the cardiology workforce. While Asians make up 18.06% of cardiologists, this is still not proportionate to their presence in the general population, indicating a disparity in representation. Although the paper discusses gender disparities broadly, it does not provide specific findings on Asian women. It notes that only 13% of practicing cardiologists in the United States are women, which includes Asian women, indicating a significant gender gap in the field [2]. This gender disparity in the medical field can affect the quality of care that women receive, further exacerbating health inequities.

To address the disparities in healthcare access for Asian women with CVD, several recommendations can be made. First, it is essential to disaggregate data on Asian subgroups to better understand the specific needs and challenges faced by different communities [45]. This approach can inform more effective public health strategies and interventions. Second, increasing awareness and education about CVD risk factors and symptoms among Asian women is crucial. Culturally tailored health education programs can empower women to seek care and advocate for their health needs. Lastly, policymakers should consider implementing targeted financial assistance programs to alleviate the burden of healthcare costs for low-income Asian women. By addressing the social determinants of health and ensuring equitable access to care, we can work towards reducing the disparities in CVD outcomes among Asian women.

## Role of AI

The increasing prevalence of CVD among Asian women has

raised significant public health concerns. As traditional diagnostic and treatment methods may not fully address the unique risk factors and manifestations of CVD in this demographic, the integration of AI offers promising avenues for improving outcomes. This section explores the role of AI in understanding, diagnosing, and managing CVD specifically in Asian women.

CVD manifests differently across various populations, with Asian women experiencing unique risk factors and outcomes. Studies indicate that Asian women may have a higher relative increase in heart disease compared to their male counterparts and women from other ethnic backgrounds [48]. This disparity necessitates tailored approaches to prevention and treatment, which AI can facilitate through enhanced data analysis and predictive modeling. Research has identified several risk factors specific to Asian women, including metabolic syndrome, diabetes, and hypertension. However, the understanding of these factors in the context of CVD remains limited. ML algorithms have been employed to analyze multi-ethnic cohorts, revealing age-related patterns and risk factors that are particularly relevant to Asian women [49]. By leveraging these algorithms, healthcare providers can better identify at-risk individuals and implement preventive measures.

AI technologies are increasingly being utilized to improve diagnostic accuracy and screening processes for CVD. For instance, cardiac magnetic resonance imaging has been recognized as a gold standard for assessing cardiac function, and AI-enhanced imaging techniques are being developed to optimize this process [50]. These advancements are crucial for Asian women, who may present with atypical symptoms that are often overlooked in traditional diagnostic frameworks.

The application of ML in predictive analytics has shown promise in enhancing diagnostic and predictive accuracy for CVD in Asian populations. Recent studies highlight the potential of ML and deep learning to address the specific needs of South-Asian populations, thereby improving risk stratification and management strategies [51]. By utilizing AI-driven tools, clinicians can better predict in-hospital mortality and other critical outcomes, ultimately leading to improved patient care [49]. AI has the potential to significantly improve health outcomes for Asian women with CVD. By integrating AI/ML-based tools into clinical practice, healthcare providers can enhance the screening and diagnosis of CVDs [52]. These tools not only streamline the diagnostic process but also facilitate personalized treatment plans that consider the unique risk profiles of Asian women. AI algorithms have been used to predict in-hospital mortality for Asian women with ST-elevation myocardial infarction (STEMI), showing superior performance compared to conventional risk scores. These models incorporate gender-specific predictors, enhancing the accuracy of mortality predictions [53].

The role of AI in addressing health disparities is particularly relevant in the context of CVD among Asian women. Research indicates that certain non-cardiovascular comorbidities, which are more prevalent in Asian populations, can exacerbate the morbidity and mortality associated with heart disease [54]. AI can help identify these comorbidities early, allowing for more comprehensive management of patients' health. As the field of AI continues to evolve, its applications in CVD management for Asian women are expected to expand. Future research should focus on developing AI tools that are specifically tailored to the unique characteristics of Asian populations, ensuring that these technologies are both effective and culturally sensitive. For instance, initiatives like PowerAI-CVD aim to create Chinese-specific AI-powered risk stratification tools, which could serve as a model for



**Table 3:** Summary of key AI applications in women’s cardiovascular health.

| AI application                                            | Category               | Impact on CVD                                        | Key findings                                                                                                  |
|-----------------------------------------------------------|------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| AI-based stroke risk prediction [57]                      | Risk assessment        | Enhances early detection of stroke risks in women    | AI models using retinal imaging improved risk prediction accuracy for women with hypertension and diabetes    |
| ML for CVD risk in elderly women [58]                     | Predictive analytics   | Identifies high-risk populations in rural areas      | AI accurately predicted CVD risk in elderly postmenopausal women in North-East India                          |
| MRI-based AI for AF detection [59]                        | Diagnostic imaging     | Improves AF detection in women post-stroke           | AI models identified underlying AF in female stroke patients with higher sensitivity than traditional methods |
| AI in nonobstructive CAD in women [60]                    | Diagnostic support     | Addresses gender bias in CAD detection               | AI-assisted imaging improved diagnosis accuracy in women with ischemic heart disease                          |
| ML in cardiac surgery mortality prediction [61]           | Risk prediction        | Predicts post-surgery mortality in women             | AI models using stress hyperglycemia ratio improved survival predictions in female cardiac surgery patients   |
| AI-guided personalized AF treatment [62]                  | Treatment optimization | Optimizes individualized treatment for women with AF | AI-driven treatment strategies improved AF management and outcomes in women                                   |
| Wearable AI devices for women’s heart health [63]         | Remote monitoring      | Enhances real-time heart health monitoring           | AI-integrated wearables provided early alerts for abnormal heart rates in women                               |
| AI in cardiopulmonary transit time (CPTT) prediction [64] | Imaging analysis       | Predicts cardiac function in women with CAD          | AI models using PET/CT improved CPTT analysis, benefiting female CAD patients                                 |

similar efforts across other Asian communities [55]. In Singapore, AI systems like CardioSight utilize real-time data to identify at-risk individuals and facilitate preventive interventions, demonstrating the potential of AI in primary prevention of CVD [56].

In summary, the integration of AI in the management of CVD presents a transformative opportunity for improving health outcomes among Asian women. By leveraging AI’s capabilities in predictive analytics, diagnostic imaging, and personalized treatment strategies, healthcare providers can address the unique challenges posed by CVD in this demographic (Table 3). Continued research and development in this area will be essential to fully realize the potential of AI in enhancing cardiovascular health for Asian women.

**Conclusion**

The landscape of cardiology in Asian women is shaped by a complex interplay of cultural perceptions, biological differences, and healthcare access disparities. As CVD prevalence continues to rise among this population, urgent and targeted prevention and treatment strategies are necessary to address their unique needs. Continued research and advocacy are essential to bridge existing gaps in understanding and care, ultimately improving cardiovascular health outcomes for Asian women. The prevalence and mortality rates of CVD among Asian women present a significant public health challenge. With rising rates of CHD and stroke, particularly in South Asia, implementing targeted interventions is crucial. These interventions must address unique risk factors such as genetic predisposition, lifestyle influences, and healthcare access barriers. A multifaceted approach that includes lifestyle modifications, improved healthcare accessibility, and awareness campaigns will be vital in combating this growing epidemic. Additionally, public health initiatives and continued research efforts are needed to mitigate the impact of CVD and enhance health outcomes.

Sex differences in CVD among Asian women highlight variations in risk factors, healthcare access, and treatment outcomes. Addressing these disparities requires a comprehensive approach that includes tailored prevention strategies, increased awareness, and improved access to care. Healthcare providers must integrate these considerations into their practices to enhance the cardiovascular health of Asian women effectively. Research must continue to evolve to refine and implement solutions that account for these differences, ensuring more equitable and effective treatment strategies. Disparities in healthcare access for Asian women with CVD are influenced by social determinants, financial hardship, and systemic inequities. Addressing these disparities

necessitates a multifaceted approach that includes targeted research, community engagement, and policy reform. By prioritizing the unique needs of Asian women, healthcare systems can move toward greater equity and improved cardiovascular health outcomes for all.

While AI holds great promise in enhancing cardiovascular care for Asian women, challenges such as data bias and integration into healthcare systems must be addressed. Ensuring that AI models are inclusive and representative of diverse populations will enhance their effectiveness and reliability. Ongoing research and collaboration between technologists and healthcare professionals are crucial to fully realize AI’s benefits in CVD management for women. By leveraging AI responsibly, healthcare systems can further refine diagnostics, treatment plans, and patient outcomes, ultimately advancing cardiovascular care for Asian women in meaningful ways.

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**Conflict of Interest**

None.

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