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Research Article

Linking *Dosha* Imbalance to Cardiovascular Disease: Insights from Biochemical and Molecular Pathways—A Narrative Review

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Abstract

Cardiovascular diseases (CVDs) are the leading cause of death globally. Recent estimates from the 2025 heart disease & Stroke Statistics Update indicate about 19.41 million global deaths due to CVD. Key mechanisms include oxidative stress–mediated endothelial injury, chronic low-grade vascular inflammation, and systemic metabolic dysregulation, which together accelerate atherogenesis, and plaque instability. Contemporary biomedical research highlights that chronic stress activates the sympathetic nervous system and hypothalamic– pituitary–adrenal axis. Inflammatory mediators accelerate vascular damage, while obesity, insulin resistance, and dyslipidaemia contribute to atherogenesis. In *Ayurveda* complementary framework in which disease is attributed to the imbalance of the three doshas—Vata, Pitta, and Kapha. Aim: To correlate biochemical pathways with *Doṣha* imbalance for an integrative understanding of cardiovascular disease (CVD) Objectives: To review key biochemical mechanisms in CVD pathogenesis., to integrate modern biomarkers with Ayurvedic concepts for CVD risk assessment. Methods: The methodology for this review involved a comprehensive literature from multiple databases, including PubMed, J-Gate, Google Scholar through MeSH term cardiovascular disease risk and biomarkers and from classical texts. Results: The search retrieved approximately 16,700 articles from Google Scholar, of which 16 were found relevant and included for review; 1,757 articles from PubMed, of which 12 were reviewed; and 1,669 articles from J-Gate, of which 15 were reviewed and Relevant descriptions of *Sthaulya, Medoroga, Hṛdroga, Dhamanīpraticaya*, and *Santarpanajanya Vyadhi* were also reviewed. Discussion: *Vata* aggravation by chronic psychological stress such as *Shoka*, *Bhabya*, corresponds with sympathetic overactivity, resulting in vascular injury. *Pitta* aggravation reflects inflammatory processes, aligning with cytokine-driven vascular inflammation. *Kapha* aggravation as metabolic sluggishness analogous to obesity, hyperlipidaemia, and insulin resistance. Conclusion: CVD arises from psychological, inflammatory, and metabolic disturbances that parallel *Vata*, *Pitta*, and *Kapha* imbalances. Integrating both perspectives offers a holistic framework for prevention and management.

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1. INTRODUCTION

Cardiovascular disease includes a spectrum of disorders of the heart and blood vessels, such as coronary artery disease, cerebrovascular accident, and peripheral artery disease.[i] CVD is a leading cause of death worldwide, particularly in urban areas where lifestyle often contribute to its prevalence.[ii] CVDs are the leading cause of death worldwide. In 2019 17 million premature death occurred because of non-communicable diseases and out of those as much as 38% were linked to CVD. The figure further increased and in 2021 20.5 million death attributed to CVD.[iii]

Risk factors such as dyslipidaemia, hypertension, and diabetes mellitus are predictors of CVD and remain the primary targets for prevention. Three basic components for Pathophysiology of CVD are oxidative stress, Inflammation, Metabolic derangement.

Chronic psychological stress stimulates the sympathetic nervous system (SNS) and hypothalamic–pituitary–adrenal axis via secretion of catecholamines and cortisol. This triggers endothelial dysfunction, and low-grade vascular inflammation via reactive oxygen species and pro-inflammatory cytokines, cause atherogenesis.[v] Chronic inflammation causes endothelial activation and vascular injury through the release of pro-inflammatory cytokines such as IL-6, TNF-α, and CRP. These mediators upregulate adhesion molecules, recruit monocytes, and promote foam cell formation, thereby sustaining atherogenesis. Persistent inflammatory signalling weakens vascular integrity, leading to plaque rupture and thrombus formation.[vi] Metabolic derangement means disturbances in normal biochemical physiological process that create internal environment favouring endothelial dysfunction and vascular inflammation or Metabolic derangement including hyperglycaemia, insulin resistance, dyslipidaemia, and obesity act as a pro-atherogenic state. Insulin resistance leads to lipid imbalance by raising LDL and lowering HDL, accelerating arterial lipid deposition, collectively driving atherogenesis, plaque instability, thereby increasing cardiovascular risk.[vii]

From an *Ayurveda* perspective, these processes reflect *Dosha* Imbalances: Hyperactive SNS, oxidative stress can be compared with *Vata* aggravation and inflammation with Pitta, obesity and metabolic dysfunction represents *Kapha-Dosha* and *Meda-Dushti*.

Biomarkers are tools for linking biochemical pathways with *Dosha* imbalances in the context of cardiovascular disease (CVD). By reflecting specific processes such as oxidative stress, inflammation, and metabolic dysregulation, biomarkers provide measurable correlation with *Vata*, *Pitta*, and *Kapha* disturbances. This integrative mapping allows for a deeper understanding of CVD pathogenesis by bridging *Ayurveda* with modern biomedical insights. Moreover, it facilitates individualized risk assessment and preventive strategies by identifying the pathway and *Dosha* involved.

Aim: To correlate biochemical pathways with *Dosha* imbalance for an integrative understanding of cardiovascular disease (CVD)

MATERIALS AND METHODS

A literature search was carried out across multiple electronic databases, including PubMed, J-Gate, and Google Scholar, using Medical Subject Headings (MeSH) and keywords such as "Biomarkers and CVD Risk", "CVD risk and oxidative stress", "CVD risk and inflammation", "CVD risk and metabolic disarrangement", "*Hridroga*". In parallel, classical texts were reviewed to extract relevant descriptions of *Sthaulya, Medoroga, Hṛdroga, Dhamanipratichaya,* and *Santarpanajanya Vyadhi*.

RESULTS

KEYWORD	Google scholar			Pubmed			J gate		
	Retrieved	screened	reviewed	Retrieved	screened	reviewed	Retrieved	screened	reviewed
Biomarkers and CVD risk	16700	11	05	1757	09	03	1669	10	05
CVD risk and oxidative stress	16900	07	03	487	05	02	1359	03	03
CVD risk and inflammation	16400	04	03	1531	06	03	5953	05	02
CVD risk and metabolic disarrangement	21600	10	06	3219	08	04	89	05	02
Hridroga	400	14	04	02	01	01	102	06	01

DISCUSSION

Oxidative stress-induced Pathophysiology

According to Ayurvedic classics, *Shoka*[viii], *Chinta*, *Bhaya*, *Ati-Vyayama*, fasting, tissue depletion, excessive purification therapies, and intake of dry and inadequate food are important etiological factors responsible for *Vata* aggravation and the development of *Hridroga* [x]. Chronic psychological stress disturbs the equilibrium of *Vata Dosha* and adversely affects the functioning of the *Hridaya*. Modern research has established psychological stress as an independent cardiovascular risk factor. Chronic activation of the sympathetic nervous system and hypothalamic–pituitary–adrenal axis leads to increased catecholamine secretion, autonomic imbalance, elevated blood pressure, endothelial dysfunction, and low-grade systemic inflammation. These alterations contribute to the initiation and progression of cardiovascular disease. Thus, stress-induced cardiovascular dysfunction may be interpreted as a manifestation of *Vata* aggravation affecting the cardiovascular system. In addition to *Vata* aggravation, *Ayurveda* recognizes *Ati-Chintana* as an important causative factor for *Rasavaha Srotodushti* [xiii]. Classical texts describe that excessive intake of heavy, cold, unctuous foods, overeating, and excessive mental stress or overthinking vitiate the *Rasavaha Srotas*. Since *Hridaya* and the *Mahasrotas* are considered the *Moola* of

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Rasavaha Srotas, disturbances in *Rasa* circulation directly influence cardiac function. Sushruta further states that *Rasa Dushti* can contribute to the development of *Hridroga* [xiv]. Therefore, chronic psychological stress may impair cardiovascular health through both *Vata* aggravation and *Rasavaha Srotodushti*.

Oxidative stress results from excessive generation of reactive oxygen species and inadequate antioxidant defense mechanisms. It is commonly associated with chronic inflammation, dyslipidaemia, hyperglycaemia, obesity, endothelial injury, and metabolic disturbances. These processes promote lipid oxidation, vascular inflammation, endothelial dysfunction, and atherosclerotic plaque formation. From an Ayurvedic perspective, such inflammatory and metabolic derangements may be interpreted predominantly as manifestations of *Pitta* and *Kapha* vitiation, often accompanied by *Ama* formation and *Rakta Dushti*.

Aging provides another important pathway linking *Ayurveda* and cardiovascular pathology. *Ayurveda* recognizes *Vriddhavastha* as the period of natural *Vata* predominance. Progressive increase in *Vata* during aging manifests through *Rukshata*, *Kharata*, and *Kathinya* leading to degeneration and loss of tissue elasticity. These features show remarkable similarity to age-related arterial stiffening, reduced vascular compliance, and vascular calcification observed in arteriosclerotic disease [xi]. Therefore, age-associated arterial rigidity and calcification may be interpreted as manifestations of *Vata Vriddhi* affecting the vascular system.

Inflammation induced Pathophysiology

According to Ayurvedic classics, excessive intake of hot, sour, pungent, salty, and alkaline food articles, alcohol consumption, excessive exposure to sunlight, anger, and other heat-promoting factors are important etiological factors responsible for *Pitta* aggravation and the development of *Pittaja Hridroga* [xv]. These factors increase the *Ushna, Tikshna*, and *Drava* qualities of *Pitta*, leading to pathological changes affecting the *Hridaya* and vascular system. From a contemporary perspective, many of these etiological factors promote chronic inflammation, oxidative stress, endothelial dysfunction, and vascular injury. Diets rich in spicy foods, excessive salt, processed foods, and unhealthy dietary patterns have been associated with systemic inflammation and increased cardiovascular risk [xvi]. Excessive sodium intake elevates blood pressure by expanding intravascular volume and increasing vascular resistance, thereby accelerating endothelial injury and vascular inflammation.[xvii]

Chronic alcohol consumption further contributes to cardiovascular pathology through multiple mechanisms. Alcohol stimulates inflammatory pathways involving macrophages and neutrophils, increases pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF-α), and promotes the generation of reactive oxygen species (ROS). Excessive ROS production reduces nitric oxide bioavailability, impairs endothelial function, promotes oxidation of low-density lipoprotein (LDL), and accelerates atherosclerotic plaque formation. [xviii].

Smoking represents another major contributor to endothelial injury and cardiovascular disease. Tobacco smoke contains numerous oxidizing agents and toxic chemicals that directly damage vascular endothelial cells. Smoking increases oxidative stress, promotes LDL oxidation, enhances platelet aggregation, stimulates inflammatory cytokine release, and impairs nitric oxide-mediated vasodilatation. Persistent endothelial injury caused by smoking facilitates monocyte adhesion, vascular inflammation, smooth muscle proliferation, and atherosclerotic plaque development. Consequently, smoking is recognized as one of the strongest modifiable risk factors for coronary artery disease, stroke, and peripheral vascular disease.

Psychological factors such as anger also contribute to cardiovascular risk. Acute and chronic anger activate the sympathetic nervous system and hypothalamic–pituitary–adrenal axis, resulting in increased catecholamine and cortisol release. These neurohormonal changes promote vascular inflammation, endothelial dysfunction, elevated blood pressure, and oxidative stress, thereby increasing susceptibility to cardiovascular events[xix]. Excessive exposure to solar heat and ultraviolet radiation may further contribute to oxidative injury and inflammatory responses [xx]. Although moderate sunlight exposure has beneficial physiological effects, prolonged exposure can induce oxidative stress and inflammatory cascades, potentially aggravating vascular dysfunction in susceptible individuals.

Collectively, these etiological factors create a pro-inflammatory and pro-oxidative internal environment characterized by endothelial dysfunction, vascular inflammation, lipid oxidation, and progressive atherogenesis. From an *Ayurveda* perspective, such pathological changes may be understood as manifestations of aggravated *Pitta* causing *Rakta Dushti*, ultimately *Pittaja Hridroga*. Thus, *Pittaja Hridroga* may be interpreted as a cardiovascular disorder predominantly driven by inflammatory and oxidative mechanisms that promote endothelial injury and atherosclerotic vascular disease.

Metabolic derangement induced Pathophysiology

Over-eating, intake of heavy and fatty food substances, sedentary lifestyle, excessive sleep are the etiological factors of *Kaphaja Hridroga*.[xxi] Numbness, stiffness and heaviness in the precordial area, a stony sensation in the heart region, drowsiness and anorexia are the symptoms of *Kaphaja Hridroga*. These cause and symptoms are having similarity with Angina or Myocardial infarction like disease.[xxii]

Overeating, consumption of heavy, oily, and fatty foods, physical inactivity, and excessive sleep are causes that impair *Dhatvagni*. Hypometabolism leads to abnormal accumulation of adipose tissue and dysregulated lipid metabolism. This results in the formation of *Abaddha Meda Dhatu*, which is excess circulating lipids and increased lipoprotein production beyond physiological thresholds, thereby contributing to atherogenesis and cardiovascular risk.

From a modern biomedical perspective, the same lifestyle factors—high-calorie and high-fat diets, physical inactivity, and sedentary behaviour—promote metabolic dysregulation characterized by hyperlipidaemia, increased visceral adiposity, and insulin resistance. Excessive lipid accumulation leads to

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elevated circulating lipoproteins, particularly low-density lipoprotein (LDL), which undergo oxidation and deposition in arterial walls, initiating atherogenesis. [xxiii]

Vitiation of the *Medovaha Srotas* occurs due to factors such as lack of physical activity, daytime sleeping, excessive consumption of fatty foods, and alcohol intake.[xxiv] Sedentary lifestyle, high-fat diet, and chronic alcohol which leads to dyslipidaemia, endothelial dysfunction, and atherogenesis, which increase the risk of cardiovascular diseases such as angina and myocardial infarction (MI).

The prediction of cardiovascular disease (CVD) risk can do with biomarker-based approaches that reflect stress, inflammation, and metabolic alterations. Stress-related biomarkers such as cortisol, catecholamines, CRP, IL-6, and homocysteine indicate neuroendocrine dysregulation, while inflammatory biomarkers including TNF-α, HS-CRP, ILs, indicate cytokine-driven vascular injury. Metabolic biomarkers such as glucose, HbA1c, apolipoprotein-B, adiponectin, and leptin reveal dyslipidaemia, insulin resistance indicate metabolic derangement.

This integrative framework demonstrates how *Dosha* imbalance mirrors biomedical pathways of CVD. Linking specific biomarkers with *Dosha* tendencies not only provides mechanistic insight but also allows for targeted preventive and therapeutic strategies, where lifestyle and dietary modifications aligned with *Dosha Dushti*.

CONCLUSION

This study demonstrates that biochemical pathways of stress, inflammation, and metabolic dysregulation in CVD closely parallel *Vata, Pitta,* and *Kapha* imbalances in *Ayurveda.* Integrating biomarker insights with *Dosha*-based understanding provides a holistic framework for improved risk assessment, prevention, and personalized management of cardiovascular disease.

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