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Review Article

Multifactorial Pathway to Cardiovascular Disease Early Risk Detection, Screening and Pharmacotherapy

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ABSTRACT

Cardiovascular disease (CVD) remains the leading cause of global morbidity and mortality, arising from complex interactions among genetic, metabolic, behavioral, and environmental factors. Early detection and preventive screening are essential to reduce disease progression and improve outcomes. This review discusses the multifactorial pathways contributing to CVD, including dyslipidemia, hypertension, diabetes, obesity, and oxidative stress, as well as the role of inflammation and endothelial dysfunction in disease initiation. Current screening approaches, such as biomarker evaluation and imaging modalities, are highlighted for their role in early risk identification. Pharmacotherapeutic strategies—ranging from statins, antiplatelet agents, and antihypertensives to emerging lipid-lowering and antidiabetic drugs—are reviewed for their efficacy in managing cardiovascular risk. The integration of lifestyle modification, early diagnosis, and personalized pharmacotherapy offers a comprehensive framework for reducing the burden of cardiovascular disease.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death worldwide and includes a wide range of problems related to the heart and blood vessels, such as heart attacks, strokes, heart failure, and angina^[1,2]. It not only affects the heart but also the blood vessels that supply vital organs like the brain. In the early 1900s, CVD was responsible for fewer than 10% of deaths globally, but by 2001 this figure had risen to about 30%, and today

around 80% of CVD deaths occur in low- and middle-income countries^[1,3]. While it has long been the top cause of death in wealthy nations, it has now also become the leading cause of death in developing countries, reflecting the epidemiological transition in which chronic diseases like CVD are rising alongside ongoing challenges of infections and malnutrition^[2,3]. Some of the most serious and common forms of CVD include myocardial infarction (heart attack), which happens when blood flow to the heart is

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completely blocked and heart muscle is damaged; congestive cardiac failure (heart failure), where the heart cannot pump blood effectively, causing fatigue, breathlessness, and fluid buildup; stroke, which results from a sudden loss of blood supply to the brain either by blockage or bleeding; and angina pectoris, chest pain caused by reduced blood flow to the heart that often signals more severe problems^[1,2]. Two main processes that contribute to these conditions are atherosclerosis, the buildup of fatty plaques in arteries that can block blood flow and trigger heart attacks or strokes, and arteriosclerosis, the general hardening and stiffening of arteries that reduces smooth blood circulation^[4,5]. High blood pressure (hypertension) is one of the most important risk factors, as it places extra strain on the heart and damages blood vessels over time^[6,8]. With CVD now a major global health issue, it is essential for health systems to strengthen prevention, provide effective treatment, and adopt cost-effective strategies—especially in low-resource settings where the burden is increasing most rapidly^[3,9].

HISTORY

The history of cardiovascular disease (CVD) reflects humanity's evolving understanding of the heart, blood, and circulation, beginning in ancient times when civilizations like Egypt (c. 1550 BCE) recorded early observations of chest pain and atherosclerosis in texts such as the Ebers Papyrus^[10], while Ayurvedic texts in India (1500–500 BCE) described the heart as the seat of consciousness, outlined heart diseases, and even recommended surgery, diet, and exercise for heart health^[11]. Greek physician Hippocrates (460–370 BCE) emphasized the role of lifestyle and diet^[12], while Roman physician Galen (2nd century CE) advanced theories of blood flow that, despite inaccuracies, dominated for centuries^[12]. The Renaissance brought major breakthroughs, with

Andreas Vesalius (16th century) producing detailed anatomical illustrations^[13], and William Harvey (1628) revolutionizing medicine by proving blood circulation and the heart's function as a pump^[14]. By the 19th century, cardiology entered a diagnostic era with René Laennec's invention of the stethoscope (1816)^[15], Bouillaud's link between heart sounds and disease, Marey's sphygmograph for pulse recording^[16], and growing acceptance of post-mortem studies to classify heart pathologies. The 20th century marked a technological revolution: Willem Einthoven's electrocardiogram (1902)^[17], Forssmann's pioneering cardiac catheterization (1929)^[18], the development of open-heart surgery and the heart-lung machine (1953)^[19], echocardiography (1952), pacemakers (1950s), and coronary angiography (1958) transformed diagnosis and treatment. The 1960s–70s ushered in specialized Coronary Care Units, the Framingham Heart Study that identified major risk factors^[20], coronary artery bypass grafting (CABG), the first heart transplant (1967)^[21], and Andreas Gruentzig's balloon angioplasty^[22], followed by implantable cardioverter-defibrillators, CT/MRI imaging, and advanced cardiac drugs in the late century. Entering the 21st century, cardiology has moved toward precision medicine with stents, minimally invasive valve replacements, cardiac resynchronization therapy, and genetic approaches^[23], but despite these remarkable advances, CVD remains the leading global health burden, fuelled by obesity, diabetes, and lifestyle-related risks^[24].

HEART DISEASE IN WOMEN AND MEN:

Heart disease, also known as cardiovascular disease (CVD), is the leading cause of death in both women and men worldwide^[25], but the way it develops, is detected, and treated often differs by gender. In women, coronary artery disease (CAD)



is rising sharply, particularly in India, as more women develop risk factors like diabetes, high blood pressure, and obesity, similar to men[26,27]. Yet CAD in women is often missed or treated late because of the belief that estrogen protects them before menopause, which delays prevention and diagnosis[28,29]. After menopause, when estrogen levels drop, women face a sharp rise in risk, worsened by metabolic syndrome (MetS)—a cluster of conditions including high blood sugar, high blood pressure, belly fat, and abnormal cholesterol—which is more common in women due to reduced physical activity and increased abdominal obesity[30]. Female-specific conditions such as polycystic ovary syndrome (PCOS), pregnancy-induced hypertension, and gestational diabetes further raise long-term CVD risk[31]. Anatomically, women tend to have smaller coronary arteries, are more prone to small vessel disease, and have less developed collateral circulation, making blockages harder to detect and treat[28,29]. They also often show atypical heart attack symptoms compared to men, which adds to delays in diagnosis[32]. On the other hand, men develop CAD at a younger age and continue to face a high burden due to lifestyle risk factors such as smoking, alcohol use, poor diet, stress, and sedentary habits[27,28]. Unlike women, men's chest pain and related symptoms are quickly linked to heart disease, leading to earlier diagnosis, though this can cause subtler signs—like fatigue, indigestion, or mild discomfort in younger men—to be overlooked[28,29]. Metabolic syndrome is also dangerous in men, with their tendency toward abdominal obesity (“apple-shaped” bodies) posing major risks[30]. Male-specific behaviors, including higher smoking and alcohol rates, lower health awareness, and reluctance to seek medical care, further increase vulnerability. Biologically, men typically have larger arteries, which may make interventions like angioplasty easier, but they also develop more extensive plaque buildup

and can face stronger side effects if not closely monitored. Men usually show “classic” heart attack symptoms such as chest pain, arm or jaw pain, and shortness of breath, which makes recognition faster, but younger men remain at risk of being undertreated. Both men and women benefit from gender-specific care, as differences in anatomy, hormones, and responses to medication affect treatment outcomes. For instance, procedures like bypass surgery (CABG) and angioplasty (PCI) already take gender differences into account. However, more research is needed to refine strategies for both sexes, with special focus on prevention in younger men and improved awareness and early detection in women. Recognizing these gender-specific patterns is critical to improving prevention, diagnosis, and treatment, ultimately saving more lives^[25-34].

WORLD OCCURRENCE

Cardiovascular Disease in Europe:

Cardiovascular disease (CVD) remains one of the biggest health challenges in Europe, especially in middle-income countries, with wide gaps influenced by social, environmental, and economic factors. Life expectancy in ESC countries reflects this divide: women born in 2018 are expected to live 80.8 years and men 74.8 years, but people in high-income nations live longer on average (81.6 years) compared to those in middle-income countries (74.2 years). Healthcare spending plays a major role, with wealthier countries investing four times more than middle-income ones, leading to better access and quality of care. Environmental risks like air pollution further widen inequalities, with PM2.5 levels in 2019 twice as high in middle-income countries, and 14 of them exceeding EU safety limits. Obesity is another major threat, affecting more than one in five adults in ESC countries in 2016, with rates similar across income groups but more



than doubling in the past 35 years, fuelling heart disease. The burden of CVD is disproportionately heavy in middle-income countries, where heart disease rates are 30% higher and years lost to poor health or premature death are four times greater than in high-income countries. Meanwhile, age-related conditions such as calcific aortic valve disease have increased sevenfold over the last 30 years, being four times more common in richer countries where longer lifespans and advanced diagnostics drive higher detection. Although cancer is rising as a leading killer—in 15 countries causing more deaths in men than heart disease, and in 5 doing the same for women—CVD still accounts for more deaths overall. Treatment access remains a critical concern, as middle-income countries have far fewer lifesaving procedures such as coronary interventions, pacemakers, defibrillators, rhythm treatments, and open-heart surgeries, exposing a serious care gap compared to wealthier nations. Altogether, these findings highlight the urgent need to address air pollution, expand healthcare investment, tackle obesity, and ensure broader access to essential heart procedures, while also tracking progress toward WHO's 2025 targets for reducing non-communicable diseases^[35-40].

Cardiovascular Disease in Asia:

By 2020, non-communicable diseases (NCDs) such as heart disease and stroke were expected to cause 7 out of every 10 deaths in developing countries, a sharp rise from earlier decades when they caused less than half of all deaths. In the Asia-Pacific region, cardiovascular disease (CVD) makes up a major share of mortality, though the burden varies by country: less than 20% of total deaths from CVD occur in Thailand, the Philippines, and Indonesia; 20%–30% are seen in more urbanized settings like China's cities, Hong Kong, Japan, Korea, and Malaysia; and over 30%–

35% of deaths are caused by CVD in countries like Australia, New Zealand, and Singapore, where coronary heart disease rates exceed 150 deaths per 100,000 people. Stroke is also a serious concern, with the highest death rates (over 100 per 100,000) recorded in Japan, China, and Taiwan. Encouragingly, some countries have made progress: in Australia, between 1986 and 1996, heart disease deaths in people aged 30–69 fell by almost half (46% in men and 51% in women), while in Japan, stroke mortality dropped from around 150 per 100,000 in the early 20th century to about 100 today. However, the trend is not uniform, as CVD deaths continue to rise in places like urban China, Malaysia, Korea, and Taiwan; in China, for instance, the proportion of total deaths due to CVD climbed dramatically from 12.8% in 1957 to 35.8% in 1990. These shifts are strongly linked to rapid urbanization, industrialization, and lifestyle changes that bring poor diets, physical inactivity, and higher stress levels, all of which increase CVD risk. To address this growing epidemic, it is crucial for health authorities across the region to closely monitor these trends and implement effective strategies aimed at reducing cardiovascular risks and saving lives^[41].

Cardiovascular Disease in India:

Cardiovascular disease (CVD) has emerged as the leading cause of death in India at the start of the 21st century, with Indians developing heart problems nearly 10 years earlier than people of European descent and often during their most productive years of life. Unlike Western countries where only about 23% of CVD deaths occur before age 70, in India this number rises to 52%, highlighting the heavy toll of premature mortality. The severity of CVD in India is linked to higher death rates compared to richer nations, compounded by the economic impact—WHO estimates that between 2005 and 2015, the country



lost \$237 billion in healthcare costs and lost productivity due to heart disease. These alarming trends result from a combination of biological factors such as genetics, social challenges like poverty, and the complex interactions between them. Over the past two decades, India has undergone a major health transition: infectious diseases, malnutrition, and maternal and childhood illnesses have declined by more than 50%, while life expectancy has risen from 58 to 65 years. However, with longer lifespans, non-communicable diseases (NCDs) like heart disease, diabetes, and cancer have surged, with two-thirds of NCD-related deaths now caused by CVD. Today, heart disease is the top killer across all parts of India—urban and rural, rich and poor states alike—despite differences in regional risk factors such as smoking, high blood pressure, and diabetes. This reflects India's accelerated epidemiological transition, where the shift from infectious to chronic diseases is happening much faster than in many other countries. To reduce this growing burden, India must address both biological and social drivers of CVD, strengthen prevention through tackling smoking, unhealthy diets, and inactivity, improve healthcare access for early detection and treatment, and implement policies that reduce regional health inequalities^[42].

Racial Disparities in Heart Failure:

Heart failure (HF) shows clear racial and ethnic disparities in the United States, with African-American and Hispanic individuals being more likely to develop the condition compared to White and Chinese populations. Evidence from the Multi-Ethnic Study of Atherosclerosis (MESA) found the highest incidence of new HF cases among African-Americans (4.6 per 1,000 person-years), followed by Hispanics (3.5), Whites (2.4), and Chinese (1.0), while the ARIC study similarly reported that African-American men and women

had the greatest number of new cases and the highest 30-day death rates after diagnosis. These disparities are largely driven by higher rates of risk factors such as hypertension, obesity, and type 2 diabetes, which are more prevalent in African-American, Hispanic, and American Indian groups, and are often accompanied by structural heart changes like left ventricular hypertrophy (LVH) and abnormal heart function without symptoms—both linked to worse outcomes but often underdiagnosed. Importantly, African-Americans are more likely to develop non-ischemic heart failure, which is not caused by blocked arteries and can be harder to detect early. Age of onset also differs significantly, with African-American and Hispanic individuals developing HF at younger ages compared to Whites; for example, the CARDIA study showed that by age 50, 1.1% of Black women and 0.9% of Black men had heart failure, compared with just 0.08% of White women and none of the White men. Looking to the future, as the U.S. population becomes older and more racially diverse—with nearly one-third projected to be of Hispanic origin by 2050—it will be essential to address these disparities through early prevention, better control of risk factors, and culturally tailored healthcare strategies to reduce the unequal burden of heart failure^[43,44].

PATHOPHYSIOLOGY

Congestive Cardiac Failure:

Congestive heart failure (CHF) occurs when the heart muscle weakens and cannot pump blood effectively, often due to damage from heart attacks (ischemia) or diseases affecting the heart muscle (cardiomyopathy). This impaired pumping reduces blood flow to the body's organs and tissues, causing poor oxygen delivery to cells. In response, the body activates compensatory mechanisms, including narrowing of blood vessels, which increases systemic vascular



resistance to maintain blood pressure and preserve oxygen supply to vital organs. However, this increased resistance places additional strain on the already weakened heart, creating a vicious cycle of worsening cardiac function. Hemodynamic changes in acute heart failure include decreased cardiac output, low mixed venous oxygen saturation, elevated left ventricular filling pressures leading to pulmonary congestion, and increased systemic vascular resistance. If hypotension and acidosis are present, the heart's output is critically low, resulting in lactic acid buildup from inadequate oxygen delivery. The primary goals of treatment in acute heart failure are to improve cardiac output, enhance oxygen delivery, reduce pressures in the heart and lungs, and lower vascular resistance to decrease cardiac workload. Pharmacological management typically involves positive inotropic drugs such as dobutamine and amrinone, which strengthen heart contractions, improve circulation without significantly increasing oxygen demand, and dilate blood vessels to reduce resistance, alongside loop diuretics like furosemide, which remove excess fluid through increased sodium and water excretion, thereby lowering cardiac and pulmonary pressures and alleviating symptoms like swelling and shortness of breath^[45].

Myocardial Infarction:

Myocardial infarction (MI), commonly known as a heart attack, occurs when there is a sudden and complete loss of blood supply to a part of the heart muscle, leading to cell death from oxygen deprivation (ischemia). Most heart attacks are caused by a blood clot blocking a coronary artery, often triggered by the rupture of a fatty plaque in the artery wall. Once blood flow stops, heart muscle cells are deprived of oxygen and nutrients, causing cell death that begins in the inner layer of the heart (sub endocardium) and spreads outward

to the outer layer (sub epicardium). This damage involves both apoptosis (programmed cell death) and necrosis (uncontrolled cell death), and because the adult heart has limited regenerative ability, the damaged area is replaced by scar tissue rather than new muscle cells. The inflammatory response is triggered as dying cells release signals that attract white blood cells to clear dead tissue and damaged components, after which anti-inflammatory signals promote healing. Fibroblasts, influenced by factors such as Transforming Growth Factor- β (TGF- β), transform into myofibroblasts that deposit collagen and extracellular matrix, forming a scar. Following MI, the heart undergoes remodelling, where chambers may enlarge and healthy muscle may thicken to compensate, potentially leading to chronic heart failure if unaddressed. Key factors in this process include the thrombus, ischemia, inflammatory cells, fibroblasts, and hormones like renin, angiotensin, and aldosterone. Complications can include heart failure, arrhythmias, rupture of the heart wall, and pericarditis. Treatment focuses on restoring blood flow quickly through interventions like clot-busting drugs or stents, limiting heart muscle damage, and supporting healing while preventing adverse remodelling using medications such as ACE inhibitors, beta-blockers, and aldosterone antagonists^[46-51].

Blood Pressure:

Blood pressure (BP) is the force exerted by circulating blood on the walls of blood vessels, typically expressed as systolic BP (pressure during heart contraction) and diastolic BP (pressure during heart relaxation). Normal BP regulation involves multiple interrelated systems: cardiac output (CO) and peripheral resistance (PR), where $BP = CO \times PR$, with CO determined by heart rate and stroke volume and PR largely influenced by arteriolar resistance; the autonomic nervous



system, in which sympathetic stimulation increases heart rate, contractility, and vasoconstriction raising BP, while parasympathetic activity lowers heart rate and BP; the renin-angiotensin-aldosterone system (RAAS), activated by low BP or sodium, where renin converts angiotensinogen to angiotensin I, ACE converts it to angiotensin II, causing vasoconstriction and aldosterone release to raise BP; the kidneys, which regulate long-term BP by controlling fluid volume through sodium and water excretion; and hormonal factors such as ADH, which promotes water reabsorption to increase BP, and natriuretic peptides (ANP, BNP), which enhance sodium excretion and lower BP. Hypertension can be primary (essential), accounting for 90–95% of cases with multifactorial causes including genetics, lifestyle, and overactive RAAS or sympathetic nervous system, or secondary, arising from identifiable causes such as renal disease, endocrine disorders, or medications. Mechanisms include increased PR from chronic vasoconstriction or vascular remodeling, elevated CO from sympathetic overactivity, and renal dysfunction leading to volume overload, potentially causing end-organ damage in the heart (LV hypertrophy, heart failure), brain (stroke), kidneys (nephropathy), and eyes (retinopathy). Hypotension occurs when BP is inadequate to perfuse organs and can result from hemorrhage, dehydration, sepsis, heart failure, or autonomic dysfunction, through mechanisms such as reduced CO (e.g., myocardial infarction, bradycardia), decreased PR (e.g., sepsis, anaphylaxis), or diminished blood volume (e.g., bleeding, burns)^[52,58].

Angina Pectoris:

Angina pectoris occurs when the heart muscle (myocardium) does not receive enough oxygen-rich blood to meet its needs. Oxygen is delivered

through the epicardial coronary arteries on the heart's surface and smaller intramyocardial arteries and arterioles that penetrate deeper into the heart tissue. In a healthy heart, these vessels allow smooth blood flow, but atherosclerosis, the buildup of fatty plaques in the coronary arteries, can restrict blood flow. To compensate, the heart uses autoregulation, where small vessels dilate to maintain oxygen delivery during increased demand, such as exercise or stress, aided by vasodilatory substances like adenosine, nitric oxide, prostaglandins, carbon dioxide, and hydrogen ions. Blockages can be fixed, caused by permanent narrowing from plaques; dynamic, due to sudden coronary artery spasms; or mixed, combining both types. The endothelium, the thin inner lining of blood vessels, plays a key role in maintaining heart health by promoting vasodilation, preventing clots, and protecting against plaque formation through substances such as nitric oxide (NO), prostacyclin, tissue plasminogen activator, and endothelin-1. Nitric oxide, produced from L-arginine by nitric oxide synthase, is especially crucial, and endothelial damage from high blood pressure, smoking, or oxidized LDL reduces NO production, increasing the risk of angina and heart disease. Endothelial function can be improved or protected with ACE inhibitors, statins, and regular exercise. The severity of angina is classified by the Canadian Cardiovascular Society (CCS) system: Class I occurs only with strenuous or prolonged activity, Class II with moderate activity such as quickly climbing stairs, Class III during everyday activities like walking one block, and Class IV at rest or with any physical activity^[59-67].

Arteriosclerosis:

Arteriosclerosis is a general term describing the thickening, hardening, and loss of elasticity of arterial walls, most commonly affecting small



arteries and arterioles. Its key pathophysiological features include medial thickening, where smooth muscle cells proliferate and collagen content increases in the tunica media, leading to loss of elasticity and reduced ability of the arteries to expand and contract. This contributes to elevated systolic blood pressure. Additionally, narrowing of the arterial lumen increases vascular resistance, further promoting hypertension. Arteriosclerosis encompasses several types, including atherosclerosis, which is a specific form involving plaque buildup; arteriolosclerosis, affecting small arteries and arterioles and often associated with hypertension and diabetes; and Monckeberg's sclerosis, characterized by calcification of the tunica media^[68-72].

Atherosclerosis:

Atherosclerosis is a type of arteriosclerosis marked by plaque buildup in the walls of large and medium arteries. It begins with endothelial injury caused by risk factors like hypertension, high LDL, low HDL, smoking, diabetes, and inflammation, leading to increased permeability and immune cell adhesion. LDL enters the damaged endothelium, becomes oxidized, and attracts monocytes that turn into foam cells, forming fatty streaks. Inflammatory signals stimulate smooth muscle cells to migrate, proliferate, and produce collagen, forming a fibrous cap over the plaque. Plaques can calcify, rupture, and trigger thrombus formation, causing heart attacks, strokes, or peripheral artery disease. Clinically, atherosclerosis leads to coronary artery disease, cerebrovascular disease, peripheral arterial disease, and aneurysms due to chronic arterial wall weakening^[68-72].

Different Factor Responsible For Disease:

Established Cardiovascular Risk Factors Heart disease is one of the top causes of death and disability for both men and women around the

world. To reduce this burden, it's important to identify people who are at higher or lower risk of developing heart problems. Certain well-known risk factors—such as age, gender, high cholesterol, high blood pressure, diabetes, and smoking—are helpful for predicting heart disease. These are used in tools like the Framingham Risk Score, which helps estimate a person's future risk of developing heart disease. These tools can be adjusted for different populations.

lifestyle Risk Factors :

Focusing on treating high blood pressure, cholesterol, and diabetes has improved heart health in recent decades, with declines in smoking, high cholesterol, and heart-related deaths in countries like the U.S. However, rising obesity and diabetes—driven by poor diet and lack of physical activity—threaten these gains. Often, medical treatment targets the outcomes, such as high blood pressure or cholesterol, rather than the root causes like unhealthy eating, sedentary habits, and excess weight, which also worsen inflammation, clotting, and stress. Lifestyle choices play a major role in heart risk: quitting smoking can reduce death risk by a third, regular exercise lowers cholesterol, blood pressure, blood sugar, and inflammation while boosting mental health, and even 30 minutes of brisk walking most days helps. A healthy diet—including fish, whole grains, fruits, vegetables, nuts, and healthy fats—further reduces risk. Combining lifestyle changes yields the greatest benefits, as studies show a Mediterranean-style diet can lower heart attack or heart-related death risk by 72%, and simple changes like healthy eating plus daily brisk walking can cut diabetes risk by 58%, outperforming some medications. Overall, lifestyle improvements enhance blood sugar, weight, cholesterol, and blood pressure, offering powerful protection for heart health^[79,80,81].

Genetic Risk Factors:

Genetic factors play a significant role in cardiovascular disease (CVD) risk, influencing individual risk factors and their clustering. Studies in twins and families show that traits like obesity, blood pressure, cholesterol, and insulin resistance are partly inherited, with heritability estimates ranging widely—for example, 25%–70% for overall obesity, 48%–56% for visceral fat, 20%–55% for fasting insulin, 26%–60% for LDL cholesterol, and 20%–70% for systolic blood pressure. Some markers, like hs-CRP, show variable heritability across populations. CVD risk factors often cluster together—obesity, diabetes, hypertension, and abnormal cholesterol may co-occur due to shared genetic influences, a phenomenon called pleiotropy, with studies suggesting that around 59% of such clustering is genetic. Family studies confirm that children of parents with diabetes or hypertension are more likely to develop multiple CVD risk factors, and traits like hyperinsulinemia often accompany abnormal lipid profiles. Certain connections, such as between obesity and blood pressure or visceral fat and insulin, reflect shared genetics, while others, like obesity and cholesterol, are influenced more by family environment. Metabolic syndrome, a cluster of conditions that increases heart disease and diabetes risk, appears to arise from multiple overlapping genetic factors rather

than a single gene, with overall heritability estimated at 30%–40%^[76,77,78].

Biochemical Risk Factors:

Risk factors play a crucial role in the development of cardiovascular disease (CVD) by influencing processes like atherosclerosis, inflammation, and thrombosis. Key biochemical markers include elevated blood lipids such as low-density lipoprotein cholesterol (LDL-C) and triglycerides, which promote plaque formation in arteries, while low levels of high-density lipoprotein cholesterol (HDL-C) reduce the protective removal of cholesterol from blood vessels. Elevated fasting glucose and insulin resistance are also significant risk factors, as they contribute to endothelial dysfunction and increase the likelihood of developing type 2 diabetes, which further raises CVD risk. Additionally, markers of inflammation, such as high-sensitivity C-reactive protein (hs-CRP), indicate chronic vascular inflammation and are associated with higher rates of heart attacks and strokes. Other biochemical factors, including elevated homocysteine levels and lipoprotein(a), can promote clot formation and vascular damage. Monitoring and managing these biochemical risk factors, alongside lifestyle interventions, is essential for preventing and reducing the progression of heart disease^[73,74,75].

Table No 1: Different Causes for Cardiovascular diseases.

Disease name	Biochemical causes	Genetic causes	Habitual causes	Day to day living causes
Congestive cardiac Failure	35%	15%	25%	25%
Myocardial Infarction	30%	20%	30%	20%
Hypertension	40%	20%	25%	15%
Angina Pectoris	30%	20%	25%	25%
Arteriosclerosis	35%	15%	30%	20%
Atherosclerosis	40%	20%	25%	15%

THERAPIES

1. Ayurvedic:



Ayurvedic treatment of cardiovascular diseases aims to restore the body's balance using a combination of herbal remedies, dietary modifications, and lifestyle practices. Key medicinal plants include Arjuna (*Terminalia arjuna*) for its cardioprotective and cholesterol-lowering effects, Ashwagandha (*Withania somnifera*) to reduce stress-induced hypertension, and Guggul (*Commiphora mukul*) for lipid-lowering benefits. Other important herbs are Pushkarmool (*Inula racemosa*) for managing angina, Jatamansi (*Nardostachys jatamansi*) for arrhythmias, and Garlic (*Allium sativum*) for its antihypertensive and antithrombotic properties. Common Ayurvedic formulations such as Arjuna Ksheer Pak, Saraswatarishta, Ashwagandharishta, and Medohar Guggulu help strengthen the heart, reduce stress, and regulate lipid levels. These treatments are supported by lifestyle practices like yoga, pranayama (breathing exercises), and a heart-friendly diet, all of which work together to enhance overall cardiovascular health naturally and holistically^[84-87].

Advantages:

Ayurvedic therapy emphasizes holistic healing by addressing the body, mind, and diet. It incorporates herbal cardioprotective drugs such as Arjuna, Guggulu, and Ashwagandha, which support heart health and help manage lipid disorders. The approach also emphasizes detoxification (Panchakarma) and rejuvenation (Rasayana) therapies, promoting long-term disease prevention and maintaining balance of the doshas. Ayurvedic treatments are non-invasive and generally free from severe side effects when administered properly.^[84-87]

Disadvantages:

Ayurvedic treatments are typically slow-acting and not suitable for emergency situations, such as

myocardial infarction (MI) or acute congestive cardiac failure (CCF). Standardized dosing and clinical validation are often lacking, and the interactions between herbal remedies and modern medications are not fully studied. Additionally, the effectiveness of treatment can vary between individuals depending on their body constitution (Prakriti)^[84-87].

Limitations:

Ayurvedic therapy has limited applicability in acute or life-threatening cardiac events and often requires integration with modern diagnostic tools for accurate assessment. The success of treatment also depends heavily on long-term patient compliance and sustained lifestyle modifications^[84-87].

2. Allopathic:

Allopathic treatment of cardiovascular diseases (CVDs) primarily focuses on controlling risk factors such as hypertension, hyperlipidemia, thrombosis, arrhythmias, and heart failure using pharmacological interventions. The following drug classes are widely employed:

1. ACE Inhibitors (e.g., Enalapril, Ramipril)

ACE inhibitors block the conversion of angiotensin I to angiotensin II, leading to vasodilation, reduced aldosterone secretion, and decreased sodium and water retention. These effects lower blood pressure and reduce mortality in heart failure

2. Beta-blockers (e.g., Metoprolol, Bisoprolol)

By antagonizing β_1 -adrenergic receptors, beta-blockers decrease heart rate and myocardial contractility, reducing oxygen demand and improving survival in heart failure patients



3. Calcium Channel Blockers (e.g., Amlodipine)

These drugs inhibit L-type calcium channels in vascular smooth muscle, producing vasodilation, decreased afterload, and lowered blood pressure

4. Diuretics

- *Loop Diuretics (e.g., Furosemide)* increase sodium and water excretion by inhibiting the $\text{Na}^+\text{-K}^+\text{-2Cl}^-$ cotransporter in the loop of Henle, reducing blood volume and edema.
- *Thiazide Diuretics (e.g., Hydrochlorothiazide)* inhibit the $\text{Na}^+\text{/Cl}^-$ symporter in the distal tubule, lowering blood pressure through volume reduction

5. Statins (e.g., Atorvastatin, Rosuvastatin)

Statins inhibit HMG-CoA reductase, decreasing LDL cholesterol and significantly reducing the risk of myocardial infarction and stroke

6. Antiplatelet Agents

- *Aspirin* irreversibly inhibits COX-1, decreasing thromboxane A_2 synthesis and platelet aggregation.
- *Clopidogrel* inhibits the ADP P_2Y_{12} receptor, reducing platelet aggregation and the risk of cardiovascular events

7. Nitrates (e.g., Nitroglycerin)

Nitrates act as nitric oxide donors, increasing intracellular cGMP in vascular smooth muscle. This results in vasodilation, reduced preload, decreased myocardial oxygen demand, and relief from angina symptoms

8. Digoxin

Digoxin inhibits the $\text{Na}^+\text{/K}^+\text{-ATPase}$ pump, increasing intracellular calcium via the $\text{Na}^+\text{/Ca}^{2+}$

exchanger, thereby enhancing myocardial contractility. It is mainly used in heart failure with reduced ejection fraction (HFrEF)

9. Anticoagulants

- *Warfarin*, a vitamin K antagonist, inhibits the synthesis of clotting factors II, VII, IX, and X, preventing thromboembolism in atrial fibrillation and post-MI patients.
- *Direct Oral Anticoagulants (DOACs, e.g., Apixaban, Rivaroxaban)* directly inhibit Factor Xa or thrombin, providing effective anticoagulation without the need for routine INR monitoring

These medications are often used in combination, individualized to patient needs, and require careful monitoring to optimize outcomes in CVD^[88-96].

Advantages

Allopathic management of cardiovascular diseases (CVDs) offers rapid and effective intervention in acute and emergency situations, such as myocardial infarction, angina, and congestive heart failure. Treatments are evidence-based, following standardized clinical protocols with well-defined drug dosages. Advanced medical technologies, including angioplasty, coronary artery bypass grafting, and pacemaker implantation, provide both immediate and long-term benefits. Pharmacological therapies allow effective symptomatic control and management of long-term risk factors such as hypertension and hyperlipidemia. Furthermore, allopathic care is well-regulated, widely available, and integrated within structured healthcare systems^[88-96].

Disadvantages

Despite its effectiveness, allopathic treatment carries certain drawbacks. Long-term use of medications may lead to adverse effects, including



kidney dysfunction, fatigue, or electrolyte imbalances. Polypharmacy is common in chronic CVD, increasing complexity and treatment burden for patients. Treatments often prioritize symptom management over addressing underlying lifestyle causes, leading to dependency on lifelong medications in many cases^[88-96].

Limitations

Allopathic care may inadequately address psychological, emotional, and dietary factors essential for holistic cardiovascular health. High costs associated with drugs, interventions, and surgeries can limit accessibility. Additionally, over-medicalization in some contexts may reduce individualized care, overlooking patient-specific needs and long-term preventive strategies^[88-96].

3. Unani

Unani treatment of cardiovascular diseases (Amraaz-e-Qalb) focuses on restoring balance among the four humors—blood, phlegm, yellow bile, and black bile—and enhancing tabiyat (vital force) to improve heart function. The approach aims to strengthen the heart (Qalb), improve blood flow, and reduce inflammation. Several herbal drugs are commonly used: Zarnab (*Taxus baccata*) acts as a cardiogenic by prolonging myocardial action potential and enhancing cardiac output through calcium channel blocking activity; Arjun (*Terminalia arjuna*) provides cardioprotective, antihypertensive, and lipid-lowering effects, largely due to its flavonoids and coenzyme Q10-like compounds that improve endothelial function; Sana Makki (*Cassia angustifolia*) helps reduce blood viscosity and manage hypertension through mild diuretic and laxative actions; Khar-e-Khasak (*Tribulus terrestris*) functions as a diuretic and vasodilator, lowering blood pressure via nitric oxide-mediated smooth muscle relaxation; and Sandal Safed (*Santalum album*) serves as a cardiac

and nerve tonic for palpitations and tachycardia due to its soothing effects on cardiac tissue. Classical Unani formulations such as Khamira Abresham Hakim Arshad Wala, Khamira Gawzaban Ambari, and Majoon Dabidul Ward are polyherbal compounds designed to strengthen the heart muscle, regulate rhythm, and support overall cardiac function. These preparations often include Abresham (*Bombyx mori* silk cocoon) and Gul Gawzaban (*Borago officinalis*), which act as cardio-neurotonics and antioxidants. Pharmacologically, Unani drugs exert antioxidant, anti-inflammatory, calcium channel-blocking, and mild beta-blocking effects, making them suitable for long-term management of chronic cardiac conditions under professional supervision^[97-101].

Advantages

Unani medicine offers a holistic approach to cardiovascular health by focusing on balancing the four humors (Akhlāt) and enhancing overall vitality. It emphasizes diet-based therapy (Ilaj bil Ghiza), herbal remedies, and regimental therapies (Ilaj bil Tadbeer) to strengthen the heart (Muqawwi-e-Qalb) and support detoxification. Herbs such as Zarnab, Qaranfal, and Arjun are traditionally used for their cardioprotective effects, promoting long-term heart health and general well-being^[97-101].

Disadvantages

The system lacks immediate efficacy in acute cardiac events, such as myocardial infarction or decompensated heart failure. Scientific validation and modern research on the efficacy and safety of Unani treatments remain limited. Standardization of dosage, purity, and potential interactions with other drugs is often inadequate. Additionally, treatment outcomes in chronic cardiovascular conditions may take time to become noticeable^[97-101].



Limitations

Unani therapy is not suitable for emergency management of life-threatening cardiac conditions and often relies heavily on traditional texts, requiring modernization and clinical validation. Access to trained Unani practitioners may also be limited in certain regions, which can restrict its practical application^[97-101].

4. Nutraceuticals

Nutraceuticals—bioactive compounds derived from food—play an important role in the prevention and adjunct treatment of cardiovascular diseases (CVDs) due to their antioxidant, anti-inflammatory, lipid-lowering, and antihypertensive properties. Omega-3 fatty acids from fish oil (EPA and DHA) reduce triglycerides, decrease platelet aggregation, and lower the risk of myocardial infarction and sudden cardiac death. Coenzyme Q10 (Ubiquinone) supports mitochondrial ATP production and provides cardioprotection in heart failure and hypertension by improving endothelial function and reducing oxidative stress. Plant sterols and stanols, found in nuts, seeds, and fortified foods, lower LDL cholesterol by inhibiting intestinal absorption of dietary cholesterol. Garlic supplements, standardized for allicin, exhibit antihypertensive and lipid-lowering effects through inhibition of HMG-CoA reductase and ACE enzyme activity. Resveratrol, a polyphenol in red grapes and berries, enhances endothelial function and exerts anti-atherosclerotic effects via sirtuin activation and nitric oxide pathways. L-Arginine, a nitric oxide precursor, promotes vasodilation and improves endothelial function, especially in hypertensive or endothelial-dysfunctional patients. Additionally, folic acid, vitamin B6, and vitamin B12 reduce homocysteine levels, helping prevent atherosclerosis. While generally safe and well-tolerated, nutraceutical use should be

evidence-based and tailored, particularly in patients receiving pharmacological therapies, to avoid interactions and maximize cardiovascular benefits^[102-108].

Advantages

Nutraceuticals support cardiovascular health through natural compounds such as Omega-3 fatty acids, Coenzyme Q10, L-arginine, and antioxidants. They help control key risk factors including dyslipidemia, oxidative stress, and endothelial dysfunction, making them useful in the prevention and adjunctive treatment of hypertension, atherosclerosis, and other CVDs. When used appropriately, they are generally safe and non-toxic^[102-108].

Disadvantages

The quality, bioavailability, and regulation of nutraceutical supplements can be inconsistent. Their therapeutic effects are often slow to manifest, making them unsuitable for acute care. Overuse or self-prescription may cause nutrient imbalances or toxicity, and clinical evidence supporting their efficacy is still emerging for many products^[102-108].

Limitations

Nutraceuticals cannot replace standard medical therapy for acute or severe conditions such as myocardial infarction (MI) or congestive cardiac failure (CCF). Their effectiveness is significantly reduced without concurrent lifestyle modifications, and they are often not covered by insurance or public healthcare systems, limiting accessibility for some patients^[102-108].

5. Homeopathic

Homeopathy approaches cardiovascular diseases (CVDs) by focusing on the individual's



constitution, symptoms, and emotional state, using highly diluted remedies aimed at stimulating the body's self-healing mechanisms. Commonly used remedies include *Crataegus oxyacantha* (Hawthorn), considered a cardiac tonic for congestive heart failure, hypertension, and arrhythmias; its flavonoids and procyanidins may have positive inotropic and vasodilatory effects. *Digitalis purpurea* is used for irregular pulse and heart failure with slow, weak pulses, acting pharmacologically to inhibit Na^+/K^+ -ATPase and improve myocardial contractility. *Strophanthus hispidus*, containing cardiac glycosides similar to digoxin, is employed for cardiac weakness and valvular disease. *Aurum metallicum* is indicated for arteriosclerosis, palpitations, and hypertension associated with depression and anxiety, addressing the emotional component often emphasized in homeopathy. *Adonis vernalis* is used for mitral valve insufficiency and weak heart with edema, enhancing contractility through its cardiac glycosides. While high dilutions (above 12C or 24X) lack pharmacologically active compounds, lower dilutions or mother tinctures may still contain bioactive substances. Although clinical evidence is limited and controversial, some observational and pilot studies suggest that individualized homeopathic treatments, especially when combined with lifestyle modifications and conventional care, may help manage symptoms in chronic cardiovascular conditions^[109-114].

Advantages

Homeopathic treatment for cardiovascular diseases offers a personalized approach that

considers an individual's physical symptoms, emotional state, and overall constitution. It may help manage chronic conditions such as mild heart failure, palpitations, and hypertension, often with minimal side effects when properly administered. Additionally, homeopathy can complement lifestyle modifications and conventional medical treatments, supporting overall well-being and symptom management in long-term care^[109-114].

Disadvantages

The effectiveness of homeopathic remedies is limited due to their high dilution, which often results in little to no measurable pharmacological activity. Clinical evidence supporting their use in cardiovascular disease is limited and controversial. Homeopathy acts slowly, making it unsuitable for acute or emergency conditions like myocardial infarction or decompensated heart failure. Its success heavily depends on the skill of the practitioner and individualized prescription, which can result in variable outcomes^[109-114].

Limitations

Homeopathic treatment cannot replace conventional medical care in life-threatening cardiac events. Its benefits are primarily supportive rather than curative, requiring long-term compliance and careful monitoring. Patient outcomes can vary widely depending on disease severity, constitution, and adherence to therapy, positioning homeopathy as an adjunctive therapy rather than a primary intervention for cardiovascular diseases^[109-114].

Table No 2: Comparison Table Consisting Of All Therapies

Aspect	Allopathic	Ayurvedic	Unani	Neutaceuticals	Homeopathic
Key drugs	Statin, ACE inhibitors, beta blockers, diuretic, aspirin, etc.	Arjuna, Garlic, Guggul, Ashwagandha, Triphala.	Arjuna, Qust sibr, zanjabeel, Traditional decoction.	Omega 3 plant sterols, Red yeast rice, Vitamins.	Diluted plant/ Mineral (Arnica Naja)

Success Rate	Very high large RCTs (20 -50 % risk reduction)	Moderate some human trials , mostly mild risk factor improvement.	Low traditional use, little modern trial data.	Moderate some proven agents (e.g. omega 3 sterol) many unproven claim.	Very low- NO strong evidence for mortality reduction.
Failure Rate	~10-30% non-adherence, ADRs or treatment resistance side effect common.	~30-50% Depend on preparation inconsistent result, slow Onset.	>50% Poor standardization lack of reproducible result.	40-60% ineffective (many supplements unproven) variable patient response .	>70% lack measurable effect in trials high placebo dependence.
Marketed Preparation	Genetic + Branded tablet, capsule, injectable .	Churna, Tablet, Decoction, capsule (e.g. Arjuna caps)	Decoction, syrup, unani pills (e.g. Khamira Gawzaban Amburi)	Heart health capsule , omega 3 oils, sterol fortified foods .	Pillu, globules, drops from brand like SBL schwabe, etc.
Marketed Consumption	Rs 30,000 + Cr/ year (India) fastest growing category >60% patient with CVD use regularly.	Rs 90,000 + Cr/ year (2024est) ~ 30% of population uses AYUSH in some form.	Regionally used in India/ Middle East minor market share.	Rs 26,000 + Cr/year (India) Growing 15-20 %/ year popular in urban users.	Rs 3,000 + Cr/year mostly for minor chronic Complaint CVD use limited.
Gender Wise Consumption	M>F (CVD Prevalence higher in men) medication uses align.	Equally used in men and women often driven by cultural or family Preference.	No reliable data.	Urban females more active in preventive supplement use .	More women user overall CVD specific gender data not available.
Complaints	Bleeding, Hypotension, liver enzyme, ED, GI issue.	GI upset (Garlic) herb drug interaction, rare contamination issue .	Heavy metals, adulterant, no clinical surveillance.	Allergies , interactions with drugs overdoses often underreported.	Minimal direct ADRs but risk via delayed therapy low satisfaction in CVD.
Advantages	Proven life Saving effect rapid action high standardization .	Natural preventive Culturally accepted multiple targeted	Traditional and Personalized minimal systemic side effect .	Preventive, Flexible dosing natural appeal.	Non Toxic, highly individualized no side effects reported.
Disadvantages	Side effect , high cost for branded drugs needs regular monitoring.	Variability in preparation , lack of long Term Outcome data .	Poor modern clinical validation unregulated in many areas.	Overuse , misleading marketing low regulation .	No efficacy in acute / severe disease risk of relying solely on placebo.

NEW DRUG APPROVED

1. Vutrisiran (Amvuttra) – Transthyretin-Mediated Amyloid Cardiomyopathy (ATTR-CM)

In March 2025, the FDA approved vutrisiran (Amvuttra) for the treatment of cardiomyopathy caused by wild-type or hereditary transthyretin-mediated amyloidosis. Clinical studies have shown that vutrisiran reduces cardiovascular mortality, decreases hospitalizations, and lowers the incidence of urgent heart failure visits, providing a significant therapeutic benefit for affected patients^[115-120].

2. Widaplik (GMRx2) – Triple Combination for Hypertension

On June 9, 2025, the FDA approved Widaplik, the first single-pill triple therapy for initial treatment of hypertension. This combination drug contains telmisartan, amlodipine, and indapamide, and has demonstrated superior blood pressure control compared with standard therapies, while maintaining good tolerability in patients^[115-120].

Near-Term Breakthroughs (Phase 3 Results & Regulatory Pipeline)

Baxdrostat – Aldosterone Synthase Inhibitor for Resistant Hypertension

Phase 3 trials of **baxdrostat** have shown that it significantly lowers systolic blood pressure by approximately 9–10 mmHg in patients with treatment-resistant hypertension. Although not yet FDA-approved, regulatory submission is expected in the near future, with potential availability projected in 2026^[115-120].

Clinical Trial Data

1. Acoramidis (Attruby) – Transthyretin Amyloid Cardiomyopathy (ATTR-CM)

Acoramidis, approved by the FDA in November 2024 and by the European Union in February 2025, is designed to treat transthyretin amyloid cardiomyopathy. In the Phase 3 Attribute-CM trial involving 632 patients, the drug demonstrated a 42% reduction in all-cause mortality and cardiovascular-related hospitalizations compared to placebo over a 30-month period. This therapy is significant as it is the first and only treatment with an official label specifying near-complete transthyretin (TTR) stabilization^[115-120].

2. Enlicitide Decanoate – Oral Cholesterol-Lowering Drug

Developed by Merck, Enlicitide Decanoate targets hypercholesterolemia. In a 24-week late-stage clinical trial, the drug significantly lowered LDL (“bad”) cholesterol compared to placebo. Additionally, it showed positive outcomes in two late-stage trials earlier this year, reinforcing its potential as an effective therapy for hyperlipidemia^[115-120].

3. Tryngolza (Ionis Pharmaceuticals) – Triglyceride-Lowering Injection

Tryngolza, developed by Ionis Pharmaceuticals, is administered as an injection to lower triglyceride levels. In a Phase 3 study, it reduced triglycerides by 70% over six months and decreased the frequency of pancreatitis attacks by 85% over a year. The drug aims to expand its market beyond rare inherited conditions to over 2 million high-risk patients^[115-120].

4. Aficamten (Cytokinetics) – Obstructive Hypertrophic Cardiomyopathy (oHCM)

Aficamten, developed by Cytokinetics, was evaluated in the MAPLE study for the treatment of obstructive hypertrophic cardiomyopathy. The drug outperformed beta blockers in improving



exercise capacity and reducing left ventricular pressure. An FDA decision regarding approval is expected by December 2025^[115-120].

5. Baxdrostat (AstraZeneca) – Hard-to-Control High Blood Pressure

Baxdrostat, developed by AstraZeneca, targets patients with difficult-to-control hypertension. In a Phase 3 trial, it lowered systolic blood pressure by an average of nine points. The drug is anticipated to launch in 2026^[115-120].

NOVEL DRUG THERAPIES

1. PCSK9 Inhibitors

PCSK9 inhibitors, including Alirocumab and Evolocumab, are monoclonal antibodies that block the protein PCSK9. PCSK9 normally degrades LDL receptors in the liver; by inhibiting this protein, these drugs increase LDL receptor levels, enhancing the clearance of LDL cholesterol from the bloodstream. They are primarily used to treat hypercholesterolemia in patients who do not achieve sufficient LDL reduction with statins. The benefits include substantial LDL lowering and a decrease in cardiovascular events^[121-129].

2. SGLT2 Inhibitors

Drugs such as Empagliflozin, Dapagliflozin, and Canagliflozin were initially developed for type 2 diabetes. They inhibit the sodium-glucose co-transporter 2 (SGLT2) in the kidneys, promoting glucose excretion. Beyond glucose control, these agents provide cardiovascular benefits, including reduced hospitalization for heart failure and improved cardiovascular mortality. They are used in patients with heart failure, with or without diabetes, as well as in chronic kidney disease^[121-129].

3. GLP-1 Receptor Agonists

Liraglutide and Semaglutide mimic the action of glucagon-like peptide-1 (GLP-1), enhancing insulin secretion, suppressing glucagon, and promoting weight loss. They are used in type 2 diabetes and obesity, particularly in patients with cardiovascular risk. These agents have demonstrated a reduction in major adverse cardiovascular events (MACE)^[121-129].

4. Inclisiran

Inclisiran is a small interfering RNA (siRNA) therapy that inhibits hepatic production of PCSK9. It is used for hypercholesterolemia management and offers the advantage of a long-acting effect, with only biannual administration, while efficiently lowering LDL cholesterol^[121-129].

5. Bempedoic Acid

Bempedoic acid works by inhibiting ATP citrate lyase, an enzyme upstream of HMG-CoA reductase (the target of statins), reducing cholesterol synthesis. It is used as an adjunct to statins in patients with hypercholesterolemia. Its key benefit is LDL reduction with a lower risk of muscle-related side effects compared to statins^[121-129].

6. Antisense Oligonucleotides (ASOs)

ASOs, such as Mipomersen, target apolipoprotein B mRNA to decrease LDL production. They are indicated for severe hypercholesterolemia, including familial hypercholesterolemia, and offer the potential for targeted gene-level intervention^[121-129].

7. Novel Antithrombotic Agents

Experimental therapies like Factor XIa inhibitors aim to reduce thrombosis risk by targeting specific coagulation factors. These agents may provide antithrombotic benefits with potentially lower



bleeding risk compared to traditional anticoagulants. They are currently under clinical investigation for the prevention of stroke and venous thromboembolism^[121-129].

8. Anti-inflammatory Therapies

Drugs such as Canakinumab, an IL-1 β inhibitor, target inflammation, which contributes to the progression of atherosclerosis. The CANTOS trial demonstrated that Canakinumab can reduce cardiovascular events independently of lipid levels. However, its high cost and increased risk of infections remain challenges^[121-129].

WORLD HEALTH ORGANIZATION (WHO)

The World Health Organization (WHO) plays a pivotal role in the prevention and management of cardiovascular diseases (CVDs), focusing on strategies to reduce complications and improve quality of life rather than providing a direct cure. One of its major initiatives is the Global Hearts Initiative, which aims to lower the global burden of CVDs by promoting best practices in prevention, early diagnosis, and treatment. This initiative includes technical packages such as HEARTS, which emphasizes improving cardiovascular health in primary care through healthy lifestyle promotion, evidence-based treatment protocols, access to essential medicines and technology, risk-based management, team-based care, and systems for monitoring. Complementing this, the Package of Essential Noncommunicable (PEN) Disease Interventions targets low-resource settings by offering simple, cost-effective strategies to detect and manage conditions like hypertension and diabetes at the primary care level. WHO also supports monitoring and surveillance by developing tools and systems to collect accurate data on CVDs and track progress toward global targets, such as reducing premature mortality from CVDs by 25% by 2025.

In addition, the organization provides policy guidance to help governments address major CVD risk factors, including tobacco use, unhealthy diets, physical inactivity, and harmful alcohol consumption. Finally, WHO emphasizes capacity building by training healthcare workers and equipping them with resources for improved management and prevention of cardiovascular diseases, ensuring that countries are better prepared to reduce the overall burden of these conditions^[130,131,132].

NATIONAL RURAL HEALTH MISSION (NRHM)

The National Rural Health Mission (NRHM), launched by the Government of India in 2005, was primarily aimed at improving the availability and accessibility of quality healthcare services in rural areas, particularly for vulnerable populations. Although initially focused on maternal and child health and communicable diseases, NRHM has progressively expanded its scope to address noncommunicable diseases (NCDs), including cardiovascular diseases (CVDs), which are a leading cause of morbidity and mortality in India. CVDs such as coronary artery disease, stroke, and hypertension require continuous care, early diagnosis, lifestyle modification, and long-term management rather than a one-time cure, and NRHM contributes to controlling this burden through a multifaceted approach involving healthcare infrastructure strengthening, community engagement, capacity building, and service delivery improvements.

A key component of NRHM is the strengthening of rural healthcare infrastructure through the upgradation and better equipping of Primary Health Centres (PHCs) and Community Health Centres (CHCs), which serve as the first point of contact for rural populations. These facilities provide essential screening and treatment services



for hypertension, diabetes, and other cardiovascular risk factors. By improving the availability of diagnostic tools such as blood pressure monitors and glucometers, along with essential medications, NRHM ensures that rural patients can access timely care locally, increasing the likelihood of early diagnosis and effective disease management.

Community-based screening and early detection form another cornerstone of NRHM's strategy. Frontline health workers, including Accredited Social Health Activists (ASHAs), Auxiliary Nurse Midwives (ANMs), and Anganwadi workers, are trained to conduct regular screenings, identify individuals with risk factors such as high blood pressure or elevated blood sugar, and refer them for further evaluation and treatment. Early identification of these conditions is critical, as many patients remain asymptomatic in the initial stages, and timely intervention can prevent progression to severe cardiovascular events.

Recognizing the growing burden of NCDs, NRHM has also integrated noncommunicable disease services into its primary healthcare framework. Standardized protocols for managing hypertension, diabetes, and other cardiovascular risk factors have been implemented, along with ensuring the availability of essential medicines such as antihypertensives and statins. This integration allows for continuous, long-term care and monitoring of patients with chronic conditions, which is vital for preventing complications and improving health outcomes.

Health education and behavior change communication are emphasized to reduce CVD risk factors. Through community meetings, counseling sessions, and home visits, health workers educate rural populations about modifiable risks, including tobacco cessation, reduced salt and saturated fat intake, physical

activity, and stress management. By raising awareness and promoting healthier lifestyles, NRHM aims to lower the prevalence of cardiovascular risk factors and reduce the incidence and severity of CVDs.

NRHM also prioritizes strengthening referral systems and emergency care, which is particularly critical for acute cardiovascular events such as myocardial infarction and stroke, where timely intervention is life-saving. Programs like Janani Express and Emergency Response Services facilitate rapid transport of patients to higher-level facilities equipped with specialized care, thereby reducing mortality and disability.

Finally, NRHM invests heavily in the capacity building of healthcare workers, providing training for doctors, nurses, and frontline staff on the latest guidelines for CVD management. Continuous workforce development helps overcome skill gaps and ensures the consistent delivery of evidence-based screening, diagnosis, treatment, and follow-up care across rural health facilities, enabling effective long-term management of cardiovascular diseases^[133,134].

CONCLUSION

Cardiovascular disease arises from multiple interacting factors including genetics, biochemistry, and lifestyle habits. Effective control requires early detection, preventive care, and evidence-based pharmacotherapy. While modern medicine provides rapid and proven treatments, traditional systems like Ayurveda, Unani, and nutraceuticals offer valuable supportive benefits when scientifically integrated. Global and national programs such as WHO's Global Hearts and India's NRHM are vital for improving awareness, screening, and equitable healthcare access. A combined strategy involving lifestyle modification, personalized therapy, and



community-level prevention is essential to reduce the global burden of heart disease and promote long-term cardiovascular health.

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