

Coronary Vascular Disease: A General Review wrs to Aetiology

Gagandevi^{1*}, Gyanendra Gupta²

Abstract

Cardiovascular disease (CVD), the foremost cause of mortality worldwide, has surged by 60% globally, reaching 20.5 million deaths in 2021 from 12.1 million in 1990, as per the latest report from the World Health Federation. While this increase is alarming on a global scale, it raises even greater concerns in countries like India where heart ailments are afflicting individuals at a younger age. The escalation of CVD among the younger population in this region is particularly worrisome. The predisposing factors contributing to this trend are multifaceted. Diabetes, obesity, smoking, and alcohol consumption stand out as significant risk factors that contribute to the early onset of heart diseases. These lifestyle choices and health conditions not only exacerbate the likelihood of developing cardiovascular issues but also compound their severity. Addressing this pressing issue demands a multifaceted approach. Central to this effort is the imperative to enhance awareness among the general population regarding the underlying causes of CVD. Educating individuals about the etiology of cardiovascular diseases is paramount to empowering them to make informed decisions about their lifestyles and health behaviors. Through targeted educational initiatives, public health campaigns, and community outreach programs, it is possible to foster a culture of proactive cardiovascular health management. By equipping individuals with the knowledge and resources necessary to mitigate risk factors and adopt healthier lifestyles, we can strive towards stemming the tide of premature CVD-related deaths and fostering a healthier future for generations to come.

Keywords: Cardiovascular disease, World Health Federation, Diabetes, Obesity and Aetiology.

INTRODUCTION

Cardiovascular disease (CVD) has surged to epidemic levels globally, including in India, posing a significant risk of premature disability or death for many individuals. The onset of coronary heart disease (CHD) often manifests with subtle signs and symptoms, undergoing a prolonged latent period before clinical diagnosis. However, coronary artery disease (CAD) remains largely preventable, with abundant resources available to educate and empower individuals.

Author for Correspondence

Gagandevi

E-mail: gagangyan1986@gmail.com

¹Assistant Professor, Department of Rachna Sharir, Bharat Ayurvedic Medical College & Hospital, Muzaffarnagar, Uttar Pradesh, India

²Professor & HOD, Department of Kriya Sharir, Shri Babu Singh Jaysingh Ayurvedic Medical College & Hospital, Farrukhabad, Uttar Pradesh, India

Received Date: February 01, 2024

Accepted Date: February 05, 2024

Published Date: March 01, 2024

Citation: Gagandevi, Gyanendra Gupta. Coronary Vascular Disease: A General Review wrs to Aetiology. International Journal of Biomedical Innovations and Engineering. 2024; 2(1): 36–42p.

The primary culprits behind CHD encompass various risk factors such as sedentary living, hypertension, smoking, and high cholesterol levels. According to the World Health Organization (WHO), hypercholesterolemia alone contributes to over five million premature deaths annually, with smoking and hypertension accounting for approximately five million and seven million deaths, respectively.

Aims and Objectives

To elaborate Cardio vascular disease in detail with aetiology.

Cardiovascular Disease vs. Coronary Heart Disease

Cardiovascular disease (CVD) encompasses a spectrum of heart and blood vessel disorders, including heart attacks, heart failures, and strokes, among others. Coronary heart disease (CHD), also known as coronary artery disease (CAD), is a subset of CVD characterized by the accumulation of fatty deposits within the arteries supplying blood to the heart. This buildup, known as atherosclerosis, leads to narrowed arteries that hinder proper blood flow, ultimately depriving the heart of oxygen and nutrients. Over time, this process can damage the heart muscle and impair its function [1]. Chronic diseases of lifestyle (CDL) encompass conditions like obesity, metabolic syndrome, diabetes, hypertension, and hypercholesterolemia, which develop gradually due to prolonged exposure to risk factors such as poor diet, smoking, sedentary lifestyle, and stress. These conditions predispose individuals to various long-term health issues, including cancers, respiratory ailments, renal problems, and more. Hypercholesterolemia, characterized by high levels of total cholesterol in the blood, significantly increases the risk of CAD. Cholesterol is transported in the bloodstream by different lipoproteins, notably low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Elevated LDL levels, known as "bad" cholesterol, elevate CAD risk, while high HDL levels, termed "good" cholesterol, provide some protective effect against CAD. Family history of premature cardiovascular events also plays a crucial role in CAD risk assessment. Risk factors for CAD are categorized as modifiable and non-modifiable. Modifiable risk factors, such as physical inactivity, obesity, diabetes, high cholesterol, hypertension, and smoking, can be altered through lifestyle changes, potentially reducing CAD prevalence. Non-modifiable factors, like age and family history, cannot be changed but are essential considerations in CAD risk evaluation. Additionally, the presence of multiple risk factors exponentially increases the likelihood of developing CVD [2].

Modifiable Risk Factors

Modifiable risk factors play a significant role in the development of strokes and coronary artery disease (CAD), accounting for around 80% of cases. The Center for Disease Control and Prevention (CDC) provides insights into the proportional contribution of these factors to CAD. Specifically, physical inactivity contributes approximately 53%, followed by obesity at 34%, hypertension at 32%, smoking at 21%, cholesterol at 15%, and diabetes at 11%. Obesity arises from an imbalance in energy intake and expenditure, leading to the accumulation of visceral (central or abdominal) fat and subsequently increasing the risk of coronary artery disease (CAD). Both genetic predisposition and environmental factors contribute to the development of obesity, ultimately resulting in a surplus of stored fat.

Extensive research underscores obesity as a significant risk factor for CAD and a crucial predictor of its incidence over the long term. Notably, the prevalence of obesity among adults poses a noteworthy CAD risk, with 65% categorized as overweight (BMI ≥ 25 – 29.9 kg.m⁻²) and 31% classified as obese (BMI ≥ 30 kg.m⁻²), consequently elevating the risk of prediabetes. Obese individuals exhibit a higher likelihood of hypertension, dyslipidemia, and diabetes due to coronary microvascular dysfunction and the accumulation of visceral fat [3].

The close proximity of visceral fat to the heart fosters an unfavorable metabolic environment, contributing to microvascular dysfunction. Research, such as that conducted by Hubert et al. (1983), illustrates a 2.5- to 3-fold increase in congestive heart failure (CHF) risk from the leanest to the heaviest individuals, indicating a heightened risk among overweight individuals compared to their leaner counterparts. Additionally, waist-to-hip ratio emerges as a significant predictor of cardiovascular risk, with android fat distribution (weight centered around the midsection) posing a greater CAD risk compared to gynoid fat distribution (weight centered around the hips). The distribution of fat between subcutaneous and visceral compartments varies extensively. Subcutaneous fat constitutes the majority, accounting for over 80%, of total body fat. While men typically have less subcutaneous fat than women,

women seem to exhibit a lower susceptibility to accumulating visceral fat. Numerous studies suggest that excess visceral fat poses a significantly higher risk of coronary artery disease (CAD) compared to excess subcutaneous fat. The elevation of plasma lipids leads to increased hepatic gluconeogenesis, impaired glucose tolerance, and heightened food intake, ultimately promoting visceral adiposity and adipocyte hypertrophy. Consequently, various mechanisms contribute to the development of CAD due to increased adiposity. Moreover, adipose tissue proliferation has been linked to glucose intolerance, endothelial cell dysfunction, dyslipidemia, and hypertension, all of which impact heart function. Weight loss plays a crucial role in decreasing CAD risk. A study conducted by Pascual et al. (2009) revealed that participants with metabolic syndrome who underwent weight loss experienced reductions in systolic and diastolic blood pressures, as well as LDL cholesterol levels. Furthermore, the significance of weight loss extends beyond CAD risk reduction, as it also mitigates other cardiovascular risk factors. This underscores the importance of proactive efforts to achieve weight reduction, ultimately contributing to a lower risk of CAD

Elevated Resting Blood Pressure

Hypertension, affecting one in four adults, stands as a significant risk factor for coronary artery disease (CAD). It is characterized by the pressure exerted on arterial walls during heartbeats, recorded as systolic and diastolic pressures. Blood pressure stages include normal (systolic < 120 mm Hg, diastolic < 80 mm Hg), prehypertension (systolic 120–139 mm Hg, diastolic 80–89 mm Hg), stage 1 hypertension (systolic 140–159 mm Hg, diastolic 90–99 mm Hg), and stage 2 hypertension (systolic \geq 160 mm Hg, diastolic \geq 100 mm Hg). Every 20 mm Hg rise in systolic blood pressure above 115 mm Hg correlates with a 50% increase in cardiovascular mortality. Both systolic and diastolic pressures positively correlate with CAD risk, serving as precursors to various cardiovascular diseases due to increased arterial stress. Hypertension's pathophysiology involves endothelial dysfunction from rapid blood flow increases, exacerbating atherosclerosis. Persistent hypertension fosters arterial plaque buildup over time, culminating in atherosclerosis. Left ventricular hypertrophy, a response to elevated blood pressure and increased heart workload due to obesity, decreases cardiac reserve, raising myocardial oxygen demand and contributing to myocardial ischemia. Left ventricular hypertrophy also heightens the risk of heart failure and sudden death [4].

Hypertension presents a notable risk for firefighters and poses a global public health concern. Often dubbed the "silent killer," hypertension can remain asymptomatic for years before precipitating heart attacks or strokes. Lifestyle factors like body weight, exercise, alcohol intake, and diet significantly influence hypertension, which can be effectively managed through lifestyle adjustments, regular physical activity, dietary modifications, and medication

Elevated Fasting Blood Glucose

The concentration of fasting blood glucose (FBG) serves as a marker for steady-state glucose metabolism in the body. Excess adiposity disrupts glucose metabolism primarily by increasing fatty acid supply into the bloodstream. Normally, insulin suppresses hormone-sensitive lipase activity, reducing lipolysis and thereby limiting fatty acid release. However, enlarged adipocytes become less sensitive to insulin's antilipolytic effect, leading to increased fatty acid release and decreased glucose utilization. This imbalance promotes chronic hyperglycemia as fatty acid metabolites impair insulin sensitivity and hinder glucose transport into muscles. Local adipokines also play a role in modifying insulin sensitivity, contributing to insulin resistance [5]. Diabetes mellitus (DM) comprises diseases characterized by elevated blood glucose levels due to defects in insulin production or action. The Framingham Heart Study indicates a two-to-five-fold increase in CAD-related deaths among diabetic individuals. Insulin deficiency or resistance leads to elevated blood glucose levels, damaging arteries and exacerbating CAD. Diabetic individuals often exhibit concurrent risk factors like hypertension and dyslipidemia, further increasing CAD risk. Atheromatous plaque formation and thrombus formation contribute to diabetic macrovascular complications. Microvascular complications, such as CAD, interact with macrovascular complications, leading to myocardial infarction and diabetic foot

development due to impaired blood vessel function. Effective management of risk factors like hypertension, obesity, and dyslipidemia reduces major coronary events in diabetic individuals. Given dyslipidemia's significance, maintaining LDL cholesterol levels below 3.8 mmol.L-1 is crucial for diabetic individuals

Elevated total cholesterol

Lipids are transported in the bloodstream as lipoproteins, which are produced in the liver and consist of apolipoprotein, phospholipid, and cholesterol. These lipoproteins are crucial for cell development and play a role in synthesizing vitamin D and hormones. There are four types of lipoproteins: high-density lipoproteins (HDLs), low-density lipoproteins (LDLs), very low-density lipoproteins (VLDLs), and chylomicrons. Total cholesterol (TC) reflects the sum of these lipoproteins, but the distribution of cholesterol among them is a more accurate predictor of heart disease than total cholesterol alone.

Cholesterol can be obtained from dietary sources or synthesized within the body, serving structural and physiological functions. Dyslipidemia is characterized by elevated total serum cholesterol levels ($TC > 5.2 \text{ mmol}\cdot\text{L}^{-1}$). Elevated triglyceride levels in the blood are associated with increased LDL cholesterol levels and, when accompanied by low HDL cholesterol levels, constitute a dangerous triad known as atherogenic dyslipidemia. This condition is often observed in individuals with premature coronary artery disease (CAD) and underscores the link between dietary cholesterol intake, elevated cholesterol levels, atherosclerotic plaque formation, and endothelial dysfunction.

Sedentary Lifestyle

Failing to engage in physical activity for a minimum of 30 minutes, at a moderate intensity, on at least three days per week over a span of three months is considered a positive risk factor for coronary artery disease (CAD). Research indicates that insufficient physical activity is an independent contributor to CAD risk. Less than 60% of the global population meets the recommended minimum physical activity guidelines set by the American College of Sports Medicine (ACSM) and the United States Centers for Disease Control and Prevention (CDC). As individuals age, physical activity tends to decline, particularly in the presence of chronic illnesses and disabilities [6]. Moreover, a sedentary lifestyle, characterized by low physical fitness, is an independent risk factor for CAD and is associated with an increased risk of stroke and angina. In the absence of exercise, atherosclerosis can rapidly progress, leading to plaque formation in arterial walls and diminished myocardial vascularity. Physical inactivity also influences other CAD risk factors, including low levels of high-density lipoproteins (HDLs), hypertension (HTN), diabetes, and obesity, further elevating the risk of cardiovascular disease. A comprehensive and effective training regimen should incorporate aerobic activities such as walking, cycling, rowing, swimming, or hiking for at least three to five days per week, with sessions lasting 30 to 60 minutes at a low to moderate intensity. Additionally, a resistance training program should be integrated two to three times per week to enhance muscular strength

Cigarette Smoking

Cigarette smoking or tobacco use, whether active or passive, has been recognized for over four decades as a significant risk factor for cardiovascular disease (CVD). The cardiovascular risks associated with tobacco use are compounded when combined with other coronary risk factors such as high cholesterol and hypertension, further elevating the likelihood of CVD. Tobacco use promotes fibrinogen production, accelerates atherosclerosis, and enhances blood clotting, leading to acute coronary events like plaque instability, thrombus formation, and arrhythmias. Additionally, cigarette smoking is linked to increased levels of inflammatory markers, such as C-reactive protein, which serve as predictors of future cardiovascular events across various populations. Exposure to second-hand smoke may also heighten the risk of CVD among non-smokers [7].

Given the numerous health benefits and cost savings associated with smoking cessation, efforts to prevent tobacco use should be encouraged and expanded, particularly in developing countries where

the threat is most severe and where tobacco companies have targeted their marketing efforts for future growth.

Non-Modifiable Risk Factors

Non-modifiable risk factors for coronary artery disease (CAD) include advancing age and family history. Men aged 45 and older and women aged 55 and older face an increased CAD risk. Family history of heart disease manifests at a younger age in men than in women, with significant clinical history or premature death in first-degree relatives under 55 for men and under 65 for women indicating a familial risk. As individuals age, CAD mortality rates rise, with men aged 35–44 facing three times the risk of premature CAD compared to women of the same age, according to Mahan et al. (2008). Thus, the rise in absolute risk becomes clinically significant for men in their mid-40s and for women around the time of menopause [8].

Prevalence of CAD

Global Prevalence of CAD: Strong evidence underscores the combination of modifiable and non-modifiable risk factors for coronary artery disease (CAD) as a leading preventable cause of death, both in developed and developing nations. Developed countries witness CAD accounting for 30 to 50% of all fatalities. Statistics reveal that one in three women and one in two men in their fifties are expected to develop CAD during their lifetimes, with risks escalating due to westernized lifestyles and aging. By 2020, except for sub-Saharan Africa where HIV/AIDS remains predominant, CAD is projected to surpass other causes to become the primary global cause of mortality and morbidity. The burden of CAD extends beyond health implications, encompassing direct and indirect costs that strain public health resources. Direct costs include healthcare expenses related to screening, medication, laboratory tests, and clinical consultations, while indirect costs stem from absenteeism, diminished work productivity, and lifestyle adjustments necessitated by disease management. Prioritizing low-cost interventions that can be universally implemented and yield substantial reductions in CAD risk is imperative, particularly in regions where the burden of the disease is significant [9].

Regional Prevalence of CAD

In India, the occurrence of coronary artery disease (CAD) stands at 21.4% among diabetic individuals and 11% among non-diabetic individuals. Furthermore, CAD prevalence in rural areas is approximately half that observed in urban areas.

CAD Prevention

Due to its prolonged onset, coronary artery disease (CAD) prevention is well-suited for altering risk factors, primarily through lifestyle and behavioral modifications, which carry significant cost-saving potential and public benefits. Prevention historically falls into two categories: primary prevention, occurring before disease manifestation, and secondary prevention, initiated after disease onset. It has since expanded into three intervention types: primordial (prevention of risk factors), primary (treatment of risk factors), and secondary (preventing recurrent cardiovascular events). With CAD prevalence on the rise, there's strong advocacy for making primary prevention the focal point of public health interventions. Primary prevention strategies commonly employ either a population-based approach, targeting community-wide behaviors, or a high-risk approach, concentrating on intervention for a select group of high-risk individuals. While the population approach delivers extensive benefits due to its broad reach, the high-risk approach offers more personalized benefits but with limited impact on the larger community. The American Heart Association (AHA) defines ideal cardiovascular health through a combination of favorable health behaviors, health factors, and absence of clinical CVD. Lifestyle programs for CAD prevention typically include education on diet, weight management, exercise, and smoking cessation, with a significant emphasis on tobacco abstinence. These programs aim to cultivate self-control and self-efficacy among participants by addressing knowledge, skills, and attitudes, empowering individuals to understand and change negative behaviors acquired early in life. Developing such valuable life skills not only reduces CAD risk and healthcare costs but also enhances quality of life, proving to be cardio-protective [10].

DISCUSSION AND RESULT

Educating patients and their families about the disease is a crucial benefit of early diagnosis. Patients should be informed about the disease's progression, available treatments, and its causes, particularly its etiology. Indians face a heightened risk of heart attacks at a younger age compared to Western populations due to various factors including dietary habits, high rates of diabetes, hypertension, dyslipidemia, genetic predisposition, increasing obesity rates, sedentary lifestyles, and smoking habits. The cardiovascular disease (CVD) epidemic among Indians is characterized by a higher relative risk burden, earlier onset of symptoms, increased case fatality, and more premature deaths. However, prevention of heart disease is within our control. This can be achieved by adopting a diet rich in fruits and vegetables while minimizing added sugars and saturated fats, prioritizing stress management and adequate sleep, quitting smoking, reducing alcohol intake, and aiming for at least 10 minutes of daily exercise. These lifestyle changes are essential for preventing CVD.

CONCLUSION

Common risk factors for coronary artery disease (CAD) among the general population include a lack of physical activity, obesity, prediabetes, dyslipidemia, and increased waist circumference. Moreover, high blood pressure was found to be inversely related to the level of physical activity. Many individuals diagnosed with cardiovascular disease (CVD) were observed to be obese based on body mass index (BMI) and waist-to-hip ratio (WHR), smokers, and were prescribed blood pressure and cholesterol-lowering medications.

Hence, it is essential for healthcare professionals to educate the general population about their cardiovascular risk factors and the advantages of adopting a healthy lifestyle. Providing CAD education could serve as a significant strategy in reducing cardiovascular risk. By raising awareness about the impact of modifiable risk factors such as physical inactivity, poor dietary habits, and smoking on heart health, individuals can be empowered to make informed decisions about their lifestyle choices.

Furthermore, education can help individuals understand the importance of regular physical activity, maintaining a healthy weight, managing blood sugar and lipid levels, and avoiding tobacco use. By incorporating preventive measures into their daily lives, such as engaging in regular exercise, following a balanced diet, and undergoing routine health screenings, individuals can significantly reduce their risk of developing CAD and other cardiovascular conditions. Ultimately, CAD education plays a pivotal role in promoting heart health and preventing the onset of cardiovascular disease in the general population.

REFERENCES

1. American Heart Association (2009). Heart disease and stroke statistics 2010 update: A report from the American Heart Association. *Circulation*, 121, e46-e215. Doi 10.1161/CIRCULATIONAHA.109.192667
2. Barr, D., Reilly, T., & Gregson, W. (2011). The impact of different cooling modalities on the physiological responses in fire-fighters during strenuous work performed in high environmental temperatures. *European Journal of Applied Physiology*, 111(6), 959–967.
3. Barreto, S. M., Miranda, J. J., Figueroa, J. P., Schmidt, M. I., Munoz, S., Kuri-Morales, P. P., & Silva, J. B. (2012). Epidemiology in Latin America and the Caribbean: current situation and challenges. *International Journal of Epidemiology*, 41(2), 557–571.
4. Capewell, S., Morrison, C. E., & McMurray, J. J. (1995). Contribution of modern cardiovascular treatment and risk factor changes to the decline in coronary heart disease mortality in Scotland between 1975 and 1994. *Heart*, 81(4), 380–386.
5. Dalton, M., Cameron, A. J., Zimmet, P. Z., Shaw, J. E., Jolley, D., Dunstan, D. W., & Welborn, T. A. (2003). Waist circumference, waist-hip ratio and body mass index and their correlation with cardiovascular disease risk factors in Australian adults. *Journal of Internal Medicine*, 254(6), 555–563.

6. Franklin, B. A. and Cushman, M. (2011). Recent advances in preventive cardiology and lifestyle medicine: A themed series. *Circulation*, 123, 2274–2283.
7. Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *Jama*, 303(3), 235–241.
8. Gaziano, J. M., Hennekens, C. H., O'Donnell, C. J., Breslow, J. L. and Buring, J. E. (1997). Fasting triglycerides, high-density lipoprotein, and risk of myocardial infarction. *Circulation*, 96, 2520–2525
9. Kumada, M., Kihara, S., Sumitsuji, S., Kawamoto, T., Matsumoto, S., Ouchi, N., & Nakamura, T. (2003). Association of hypoadiponectinemia with coronary artery disease in men. *Arteriosclerosis, thrombosis, and vascular biology*, 23(1), 85–89.
10. Prabhakaran, D., & Yusuf, S. (2010). Cardiovascular disease in India: lessons learnt & challenges ahead. *Indian journal of medical research*, 132(5), 529.