Lifestyle Modifications to Have a Healthy Cardiovascular System

By

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Declaration

It is hereby declared that

1. The thesis submitted is my own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Approval

The thesis titled “Lifestyle Modifications to Have a Healthy Cardiovascular System” submitted by Joyita Dhar (19346058), of Spring 2024 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy.

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Ethics Statement

This review does not involve any kind of trials on either animal or human models.

Abstract:

Lifestyle modifications with balanced diet and proper physical exercise is essential to maintain a healthy cardiovascular system. An indiscipline lifestyle may lead to different cardiovascular diseases such as heart failure, coronary artery diseases, stroke, hypertension etc. There are also some other factors which also play a significant role in the cardiovascular system for instance smoking cessation, moderate alcohol consumption etc. Conventionally three main types of diets such as Mediterranean diet, DASH diet and the healthy plant-based diet are necessary to establish a healthy diet. Besides, behavioral changes also pose a crucial role in the cardiovascular system. This review paper on lifestyle modifications to have a healthy cardiovascular system encompasses a systematic review, providing beneficial information about how different lifestyle choices effect cardiovascular results. In this section, the main finding from the paper is summarized with specific concern for the association among cardiovascular risk indicators as well as occurrence of diseases and specific reasons of CVD, diet patterns and exercise, levels of physical activity, some sorts of behavioral changes and stress management strategies.

Keywords: Cardiovascular system, lifestyle modifications, healthy diet, physical activity, risk factors, behavioral changes.

Dedication

This thesis is dedicated to my beloved parents, who have provided me with unwavering support and encouragement throughout my life. As well as, to my late grandmother, whose wisdom and guidance still inspires me.

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List of Acronyms

CVD - Cardiovascular diseases

SFA - Saturated fatty acid

TFA - Trans Fatty acid

CLA - Conjugated linoleic acid

LDL - Low density lipoprotein

SCFA - Short chain fatty acid

MCFA - Medium chain fatty acid

LCFA - Long chain fatty acid

CHD - Coronary heart disease

AHA - The American Heart Association

CAD - Coronary artery disease

NO - Nitric Oxide

AGEs - Advance glycation end products

PAD - Peripheral artery diseases

Chapter 1: Introduction

Cardiovascular disease also referred as CVD is one of the main causes of death. Every year, 57 million people die and CVD accounts for 17 million deaths. Currently, 80% of all CVD mortality occur in low- and middle-income nations (Bovet and Paccaud, 2011). CVD includes peripheral vascular disease, coronary heart disease, and stroke. Since the 1970s, considerable progress has been made in decreasing the death rates from cardiovascular disease (CVD) in the advanced countries, including United states of America. However, the rate of decline differed among various inhabitants, specifically in racial as well as ethnic minorities (Kariuki *et al*., 2019). Approximately, It is estimated that CVD accounts for a quarter of all deaths in Europe and one-third of all deaths in the U.S. (Ravera *et al*., 2016). According to the most recent European Primary Prevention Survey, those who are very susceptible to cardiovascular disease also have unhealthy lifestyles and have insufficient management of their blood pressure, diabetes, and cholesterol (Chlabicz *et al*., 2022). The burden of fatal incidents from CVD is particularly severe in nations with low or middle incomes. Numerous risk factors impact the onset of cardiovascular diseases. A few of these are physical inactivity, insufficient nutrition, tobacco use, diabetes, overweight, high blood pressure, dyslipidemia, excessive alcohol use, along with psychological factors like stress. Besides the probability of having CVD is increased when there are several risk factors present. Additionally, the burden they impose on society and the healthcare system is quite substantial (Ghodeshwar *et al*., 2023).The issue of obesity has escalated into a worldwide health emergency due to the appearance of high-calorie convenience meals and sedentary lifestyles, which has

affected individuals of all ages and socioeconomic backgrounds (Forman and Bulwer, 2006).

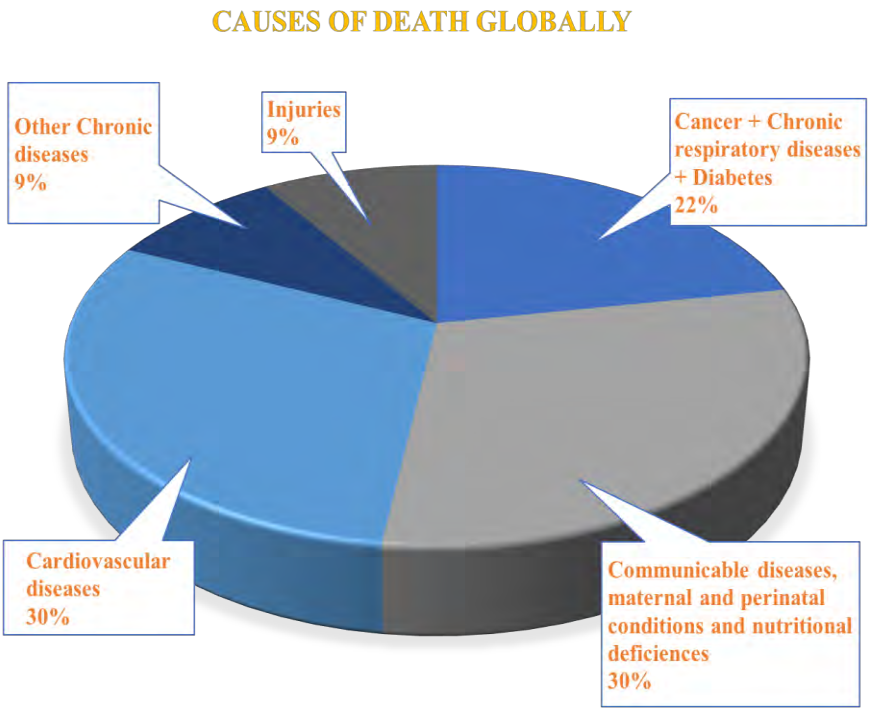

Figure 1: Causes of death globally due to different diseases including CVD (Adapted from Deaton *et al*., 2011).

Exercise and dietary changes are common among people who prefer to avoid being overweight and maintain their fitness. Therefore, with the goal to prevent unnecessary side effects, it is essential to reflect on the advantages and risks of various diets. There are some exceptional diets, first one is the Mediterranean diet, another one is the ketogenic diet, last one is calorie restriction, these have been recommended by recent research and the media to prevent obesity and enhance cardiovascular health (Man *et al*., 2020). Considering this potential risk to cardiovascular health, the importance of

lifestyle and dietary alterations becomes prominent. While utilized together, they have the ability of delaying or completely prevent 74% to 82% of CVD in people who are at high risk (Stampfer *et al.,* 2000). Besides, the American Heart Association (AHA), states that engaging in light to moderate exercise for 30 minutes every single day helps to decrease the possibility of CVD, preferably at 50–70% of maximal estimated heart rate (Golbidi and Laher, 2012.) The prevalence of CVD continues to grow despite major improvements in medical treatments and therapies, largely due to modifiable lifestyle variables. Lifestyle changes, including dietary habits, sporting activities, smoking habits, stress management strategies, and alcohol intake patterns, have been identified as important factors influencing cardiovascular health. Therefore, a strong perception of the intricate connection between lifestyle habits and cardiovascular outcomes, prevention strategies that encourage healthy living and lower the chances of CVD onset as well as progression have grown increasingly necessary (Bashir, 2024). As a result, it has been suggested that the best strategy for managing CVD and its effects is primary prevention of CVD (Zhang and Hu, 2012). A comprehensive strategy stated that CVD prevention can be achieved by lifestyle changes. Changing your lifestyle can affect several risk variables at once, in contrast to pharmaceutical therapies that focus on particular pathways or risk factors. Introducing changes to one's lifestyle can improve cardiovascular health over time. By developing healthy routines, the earliest stages of life and keeping them throughout the life, people may dramatically lower the likelihood of having CVD later on (Ghodeshwar *et al*., 2023). The development of individual, community, administrative, societal, and institutional approaches to promote health-related knowledge, perspectives, skills, and practices also known as health education (Ramôa Castro *et al*., 2017).

1.1: Globally prevalence of cardiovascular diseases

Cardiovascular diseases, also known as CVD is responsible for severe death globally as well as it plays a significant influence on the life of people. These comprise a variety of several cardiac as well as vascular disorders, including peripheral arterial disease, failure of the heart, ischemic CVD, and having a stroke (Mensah *et al*., 2020). WHO claims that socioeconomic status, geography, or gender are irrelevant factors in CVD. People of any age, gender, or social class may be impacted. Considering the fact that stroke deaths were five times excessive in poor nations compared in developed nations. Besides, the frequency of possible indicators, frequently occurring diseases, and rate of death are higher among the lower socioeconomic categories in developed nations. In the world, Male and female mortality rates are highest for CVD (Rehan *et al*., 2016). In general, "any features, or condition of an individual that enhances the possibility of acquiring an injury or medical condition" is referred to as a risk indicator, and CVD which is associated with one or more of them. Usually, abnormal blood cholesterol and lipids, body weight (obesity), diabetes mellitus, smoking, physical inactivity, and ethnic background are risk elements for CVD. Low birth weight, folate deficiencies, and infections are among the newly identified risk factors for CVD that are more common among people with the lowest incomes in nations with middle and low incomes (Deaton *et al*., 2011).

Table 1: Variations in cardiovascular disease by geographic regions, risk factors and prevention strategies (Deaton *et al*., 2011) (Yusuf *et al*., 2001)

Origin/ Country	Risk Factors	Prevention
European Origin	• blood pressure • excessive use of alcohol • diabetes • cigarette smoking • poor social conditions • increased cholesterol level in blood • High saturated-fat diets	▪ improved medical and surgical management. ▪ reduction in circulating serum cholesterol. ▪ reduction in smoking rates. ▪ alterations in human behavior, such as food, activity etc.
Japanese	• hypertension • cigarette smoking • low serum cholesterol	▪ reduced prevalence of smoking. ▪ adopting a diet with minimal fat. ▪ regular physical activity. ▪ reducing calorie consumption to avoid obesity.
Chinese	• cigarette smoking • hypertension • diabetes	▪ avoiding tobacco use. ▪ maintaining a "traditional Chinese" dietary regimen.
South Asians:	• hypertension • smoking • diabetes	▪ by promoting physical activity. ▪ reducing smoking.

Hispanics: ➢ Mexican ➢ Cuban-American descent	• smoking • physical inactivity • hypertension • reduced HDL cholesterol level • obesity • diabetes • high cholesterol	▪ initiatives aimed at reducing obesity. ▪ encouraging workout.
West Indies	• hypertension • smoking	▪ smoking cessation. ▪ physical activity.
United States	• hypertension • HDL cholesterol • cigarette smoking • diabetes	▪ managing hypertension which is considered as a notable contributor to cardiovascular disease risk. ▪ modifications of lifestyle. ▪ Prevention along with treatment modalities.

Chapter 2: Reasons of cardiovascular diseases

2.1: Lifestyle factors:

2.1.1: Nutrients affecting cardiovascular system:

Different kinds of nutrients fall into the macro- and micro-nutrient categories according to their content (Zohoori, 2020). The three primary nutrients that the body uses for energy production and metabolism regulation are fatty acids, protein, and carbohydrates (Clemente-Suárez *et al.*, 2022). The body needs carbohydrates to function properly; proteins, which are nitrogenous compounds, that intimately related to evolution, growth and metabolism; and extra fat in meals, which is linked to several diseases, is also a necessary nutrient for the body's growth and development (Tapsell *et al.,* 2019). AHA released a scientific study stating that there is a close association among nutritional habits and cardiovascular health (Tu *et al.,* 2024). Therefore, a comprehensive study showed that in individuals at higher cardiovascular risk, a diet with minimal fat lowers the probability of both mortalities along with non-fatal myocardial infarction (MI) (Karam *et al.*, 2023). Additionally, there is an apparent connection between the onset of CVD and dietary fiber (Soliman, 2019) and antioxidants (Toledo-Ibelles and Mas-Oliva, 2018). These data suggest that investigating the role of more than one food item for the management and prevention of CVD provides different and useful opportunities along with the investigation of dietary patterns. Most importantly, there should be a clear concept about the function and significance of various nutrients in the formation and prevalence of CVD for the purpose of treating and preventing CVD.

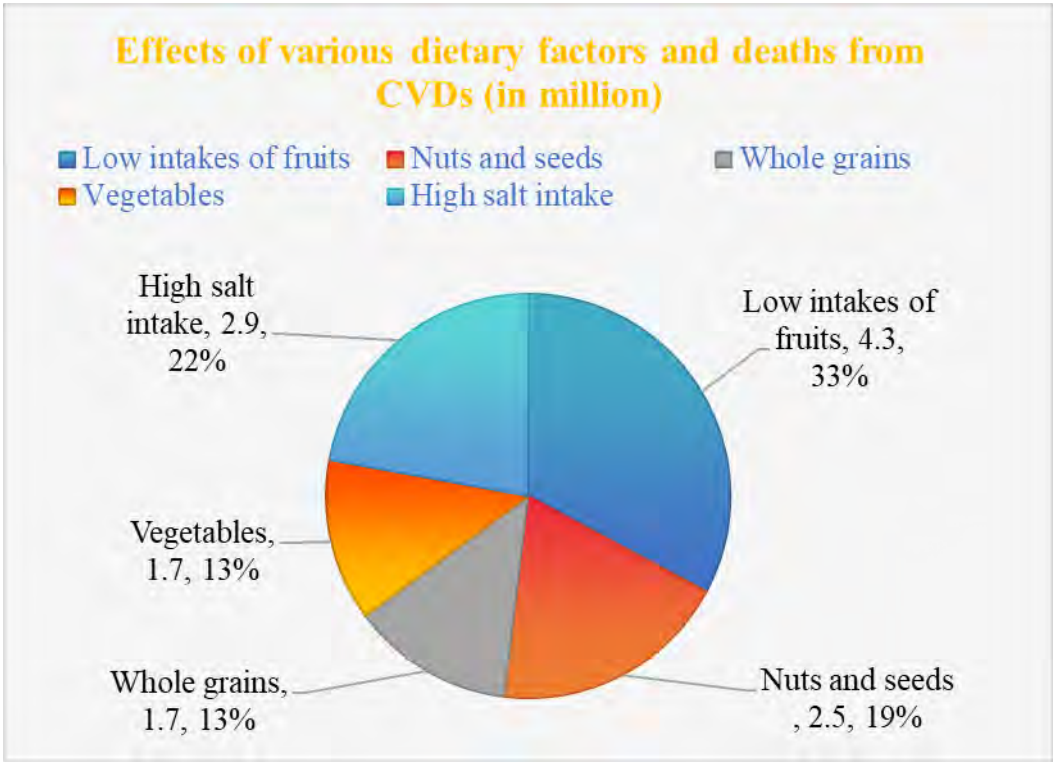

Figure 2: Effects of various dietary factors and deaths from CVDS (in million) (Adapted from Buttar *et al*., 2005).

2.1.1.1: Carbohydrates:

It has been determined that eating an unhealthy diet is a noteworthy variable risk component for CVD, which includes heart conditions and stroke. Diets that are overly carbohydrate-based, in particular, have been associated to an increase probability of CVD (Jo and Park, 2023). Although they are not considered intrinsically bad for cardiovascular health, the form and quality of carbs that are ingested determine how they affect the body. Firstly, refined carbohydrates include foods such as white bread, sweet deserts, that are digested, quickly raising levels of insulin and blood sugar almost immediately (Clemente-Suárez *et al*., 2022). This, over time can result in weight gain, high levels of insulin and an increased risk for atherosclerosis as well as other cardiovascular diseases. Diets containing high amounts of refined

carbohydrates have been associated with higher triglycerides, lower HDL cholesterol, as well as with inflammation-all known cardiovascular disease risk factors (Dou *et al.*, 2023). On the other hand, the other type of carbohydrate known as complex carbohydrates for instance whole grains, fruits and vegetables, legumes as well helps to decrease the likelihood of heart disease because of their substantial amount of fiber, thus may both enhance blood vessel wellness and decrease LDL cholesterol (Gastrich *et al*., 2008). There are also an adverse effects of Glycemic Index (GI) foods on CVD. High GI foods, which include white rice and sweetened grain, raise the levels of insulin and blood sugar more quickly and substantially. These effects lead to dysfunction of endothelial cells and oxidative stress, which are two conditions that are linked to cardiovascular disease (Morris and Zemel, 1999).

2.1.1.2: Proteins

Similar to carbs, protein also possess an important impact on the cardiovascular system, despite the fact that it is mostly depending on the sort and source of protein has been ingested. Animal and plant proteins may differ in their ability to lower or increase cardiovascular risk (Lombardi *et al.,* 2020). In the animal-based proteins, the impact of animal protein on cardiovascular health depends critically on its source, which can include animal products like red meat, meat that has been processed, chicken, or fishes. Additionally, saturated fatty acids play a big part in this. Saturated fats, although mostly found in red meats, have the tendency to enhance the quantities of LDL, or "bad," cholesterol and further promote the development of atherosclerosis, or build-up of plaques in the arteries (Richter *et al.*, 2015). Besides, the processed meats contain high amounts of sodium and preservatives, that may induce high BP and consequently hypertension-that can be a significant risk element for CVD (O'Donnell and Yusuf, 2015). On the other hand, diets comprising

vegetable proteins found in legumes, beans, nuts, seeds, and soy reduce the risk for cardiovascular diseases. Even though the type of protein is important, the overall quantity taken can also have an effect on heart health (Campbell, 2019). Moderation is essential since high intake, especially animal protein, might be stressful to the kidneys and have some long-term disadvantages on cardiovascular health. The most important feature of a heart-healthy diet, other than all these things, is to choose lean animal proteins and plant proteins while limiting red and processed meats (Richter *et al*., 2015).

2.1.1.3: Saturated fatty acid:

Saturated fatty acids also known as SFAs has been connected with a higher chance of CVD, given that it has been demonstrated the effect of LDL (low density lipoprotein) cholesterol (Siri-Tarino *et al*., 2010). Saturated fat consumption raises LDL cholesterol in humans relative to all other nutrients, with the exception of trans fats (Mozaffarian *et al*., 2006). Three kinds of fatty acid chains are mainly affected the saturated fat. First one is short chain, second one is medium and last one is long. First of all, short chain fatty acid which is also called SCFA composed of 1-6 saturated carbons whereas medium chain fatty acids also known as MCFA possess 7-12 saturated carbons (Schönfeld and Wojtczak, 2016). Thirteen or additional carbons, which may be saturated or involve one or multiple double bonds, comprise longer-chain fatty acids (LCFAs). For this type of different formation, fundamental features result in variances in absorption, movement, as well as outcome (Papamandjaris *et al*., 1998). As an illustration, MCFA can be absorbed more easily from the GI tract in comparison to LCFA and are delivered direct to the liver for quick oxidation using the portal vein, whereas LCFA accumulate into chylomicrons and pass via system of

lymphocytes, which permits a higher absorption rate by adipose tissue. The oxidization of fatty acids appears to be a preferred process for MCFA, which can get into cells and activate mitochondria despite the need for the carnitine shuttle. For LCFA to enter mitochondria, though, they need the carnitine shuttle. These many metabolic pathways tend to enhance satiety and boost energy expenditure when MCFA take the place of the longer-chain triglycerides in the dietary habits, potentially resulting in weight control (St-Onge and Jones, 2002). Additionally, there are now a few clinical investigations on CVD which specifically look at how MCFA affects CVD risk parameters, although the outcomes of existing studies are not always consistent (Kris-Etherton and Fleming, 2015). Although taking higher levels of longer chain SFA raised the probability of coronary heart disease (CHD) in comparison to the minimum intake group, there was no noticeable rise in CHD risk related with shorter to medium-length SFA consumption according to the Nurse's Healthcare Study (NHS) (Hu *et al*., 1999). Longer chain SFA raised the likelihood of CHD, according to an additional study that included data from study of NHS. This analysis also supported previous findings (Zong *et al*., 2016). Dairy goods, coconut oil in particular, and the kernel of palm oil—sources high in longer-chain SFA—are also popular sources of MCFA. Myristic acid, palmitic acids, and stearic acids are the three saturated LCFA that are most frequently found in the standard American diet (Micha and Mozaffarian, 2010). Therefore, despite being an SFA, stearic acid is unlikely to increase the probability of CVD; this may be because throughout metabolism, it partially desaturases to oleate (Sampath and Ntambi, 2005). Notably, present medical specialist recommendations and guidance focus on lowering LDL and non-HDL cholesterol levels respectively minimize the possibility of CVD, while advantages of raising HDL cholesterol as well are not widely recognized (Goff Jr *et al*., 2013).

2.1.1.4: Trans-fat:

Trans Fatty acid (TFA) is well acknowledged to increased probability of CVD, most likely because to their pro-inflammatory characteristics (Wallace *et al.*, 2009). TFAs encompass trans fats that occur both naturally (ruminant, substances such as cheese and meats) and artificially generated (found, between other things, in various fast foods, baked goods, and margarine). In particular, TFAs like conjugated linoleic acid (CLA) are found in minimal levels in ruminant fat (Brouwer *et al.*, 2013). Observational investigations study on the correlation between TFAs as well as risk (Mozaffarian *et al.*, 2006) and metabolic research reports on the correlation between TFAs and lipoproteins (Katan *et al.*,1995) have shown that manufacturing TFAs adversely affect cardiovascular health by raising of LDL-C level and lowering those of HDL-C, with latter impact being different from that of SFAs (Ascherio *et al.*, 1999).

2.1.1.5: Micro-nutrients:

Micro-nutrients are essential for tissue function maintenance and metabolism. Therefore, consuming sufficient is essential, but administering more supplements to people who don't require them could be dangerous. Excessive micro-nutrients can be a risk factor related to Cardiovascular system (Kura *et al.*, 2019). Clinical benefit is unlikely if this is not the case and is most likely to occur in those who are extremely depleted and at risk of consequences. More work is required to define more accurate markers of micro-nutrient status in terms of their impacts on metabolism and antioxidant levels (Shenkin, 2006). Most micronutrients are involved in cardiovascular health by reducing inflammation and oxidative stress; they also contribute to keeping blood pressure and cholesterol levels within normal limits.

Deficiency and even excess in the important micronutrients, including potassium, magnesium, vitamin B and D, may raise the chances of forming heart diseases (Narayanam and Samuggam, 2021). All the necessary vitamins and minerals may try to decrease the probability of heart diseases by just maintaining their balance with adequate intake of fruits, vegetables, whole grains, nuts, seeds, and lean proteins. On the other hand, too much sodium, extra calcium supplementation, or iron imbalance is harmful to heart health.

2.1.2: Physical inactivity:

Humans are not programmed to be physically inactive. It has been proven that millions of premature deaths annually and a large variety of diseases around the world, among them CVDs, are significantly increased by the "sedentary death syndrome." Moreover, Longer-living species are more effective in maintaining cellular activity than are shorter-living species, according to studies (Fries, 2002). In reality, lifestyle factors represent a considerable portion of the main reasons of mortality—roughly two thirds. Moreover, the reason and medication for severe chronic conditions and disorders is significantly influenced by a sedentary lifestyle; nevertheless, the method by which engaging in physical exercise lowers the incidence of these illnesses and conditions remain poorly understood. (Knight, 2012). Regular physical activity also seemed to possess a beneficial role in the prevention of further death along with rehabilitation patients following the incidence of a myocardial infarction. Indeed, it has been showed that routinely exercise decreases the possibility of early atherosclerotic, cardio related mortality as well as favorably influences multiple major risk components, for instance hypertension, blood lipids, and insulin resistance (Dubbert *et al*., 2002).

2.1.3: Smoking:

It is frequently recognized that smoking has adverse effects and that quitting can have incredible advantages. Avoiding smoking leads to a remarkable one-third reduction in overall mortality (Gallucci *et al*., 2020). In numerous populations, smoking declines significantly reduced the number of cardiovascular events; yet, many people still smoke. In addition, smoking has grown increasingly prevalent across multiple sectors and subgroups, as well as smoking-related mortality. To create new therapies and policies to reduce smoking, and additionally to enhance present behaviors, there is an urgent need for more research and policy initiatives (Mozaffarian *et al.,* 2008). The daily total amount smoked has a dose-response relation to CVD probability but not for CAD, in which risk is increased by exposure even to low levels. So, regarding CVD, there is never a safe amount that one can smoke (Kondo *et al*., 2019).

2.1.4: Excessive alcohol consumption:

The hormetic physiological activity of alcohol causes a variation in CVD risk based on the quantity, frequency, and pattern of consumption (irregular or heavy/binge drinking, which is not consistently characterized) (Chiva-Blanch and Badimon, 2019). There is a high chance of increasing risk of CVD if any individual consumes excessive alcohol. In contrast, moderate drinking has been proven to prevent heart diseases; regarding the type of alcoholic beverage, however, red wine may contribute to negative cardiovascular effects through heavy drinking or chronic alcoholism (Saremi and Arora, 2008).

2.2: Health conditions and their connection with CVDs:

There is a strong association of CVD with other health conditions. Many diseases share common risk factors, or contribute significantly to the development and progression of CVD. Some major health conditions related to CVD are briefly described below:

2.2.1: Hypertension

Table 2: Mechanism of action of hypertension and cardiovascular system (Kannan and Janardhanan, 2014).

Mechanism of action of hypertension and Cardiovascular system
i. Elevated blood pressure: ➢ The heart pumps out more blood ➢ Constriction of blood vessels
ii. Vascular dysfunction ➢ Disruption of endothelium,↓Nitric oxide production, ↓Vasodilation ➢ Arteriosclerosis
iii. Vascular remodeling ➢ Blood vessels wall thickness ➢ ↑ Peripheral resistance, therefore blood pressure increases
iv. Arteriosclerosis ➢ Constantly high pressure causes endothelial cell damage.

v. Target organ damage
➢ Kidney damage, hypertensive retinopathy, heart, stroke

Hypertension is a systemic disease that involves all the blood vessels of the body, as well as an added workload on the heart. This enhances the likelihood of severe cardiac incidents for instance myocardial infarction, stroke, and failure of heart, as well as hypertensive retinopathy along with accelerated atherosclerosis. The blood pressure has to be kept within normal limits to protect against any difficulty of cardiovascular health. This is a flow chart representing the development of hypertension and its involvement with the cardiovascular system, thereby highlighting the important mechanisms of cardiac remodeling, vascular dysfunction, and increased risk from major cardiovascular events.

2.2.2: Blood sugar:

Table 3: Mechanism of action of blood sugar and cardiovascular system (Al-Ishaq *et al*., 2019).

Mechanism of action of blood sugar and Cardiovascular system
i. Blood sugar level
➢ Blood sugar level remains higher than normal range (Hyperglycemia)
ii. Dysfunction of endothelial cells
➢ Damage to endothelial cell which is carried out by the AGEs
➢ Production of ↓Nitric oxide (NO) ⟶ ↓Vasodilation

iii. The process of glycation of proteins and fatty acids ➢ Development of advanced glycation end products (AGEs) ➢ AGEs accumulate exponentially in blood vessels
iv. Oxidative stress and inflammation ➢ persistent inflammation ➢ ↑ Oxidative stress
v. Cardiovascular complications ➢ Coronary artery disease ➢ having a stroke ➢ Peripheral artery diseases (PAD) ➢ Heart failure

In this flow chart, AGEs are formed due to persistently high blood sugar, which causes damage to the blood vessels and decreased nitric oxide synthesis. This will increase the probability of cardiac events like heart attacks, strokes, and heart failure because it triggers inflammation, oxidative stress, and atherosclerosis. Control in blood sugar levels will help keep cardiovascular health good.

2.2.3: High Cholesterol:

Table 4: Mechanism of action of high cholesterol and cardiovascular system (Avci *et al*., 2018)

Mechanism of action of high cholesterol and Cardiovascular system
i. Cholesterol level ➢ ↓ HDL ➢ ↑ LDL
ii. Inflammation ➢ Cells from the immune system penetrate the wall of the vessel ➢ Monocyte develops into macrophages ➢ Foam cell production by macrophages
iii. Dysfunction of Endothelial cell ➢ LDL penetrates the blood vessel wall ➢ Oxidation of LDL to produce Oxidezed LDL
iv. Vascular narrowing ➢ Plaques lower the artery's diameter, therefore limits blood flow ➢ limited blood supply to essential organs including the heart and brain
V. Cardiovascular events ➢ Heart attack ➢ PAD ➢ Weak aortic wall

In this flow chart, high levels of LDL cholesterol initiate a series of processes in the development of endothelial injury and atherosclerotic plaque. The end result is narrowing of the arteries, rupture of plaque, and major cardiovascular events, including strokes and heart attacks. Relating to this, proper cholesterol levels would avoid these results from occurring.

2.2.4: Diabetes:

Table 5: Mechanism of action of Diabetes and cardiovascular system (Marks and Raskin, 2000) (Dal Canto *et al*., 2019)

Mechanism of action of Diabetes and Cardiovascular system
i. Insulin resistance ➢ ↑ Blood glucose (hyperglycemia) ➢ ↓ Insulin sensitivity
ii. Vascular dysfunction ➢ ↓ Vasodilation ➢ High blood pressure
iii. Vascular damage ➢ Impacts very small vessels such as retinopathy and nephropathy ➢ Impacts massive vessels, for instance coronary arteries and brain arteries
iv. Metabolic effects ➢ ↓ HDL, ↑ LDL, ↑ Triglycerides ➢ ↑ Oxidative stress ➢ ↑ Free fatty acids

v. Cardiac stress ➢ Myocardial burden imposed through vascular resistance along with hypertension ➢ CAD
vi. Chronic inflammation ➢ Potent cytokines for inflammation ➢ Sustained vascular damage
vii. Cardiac remodeling ➢ Hypertrophy of the left ventricle, diastolic imbalance ➢ The heart muscle has fibrosis and rigidity
viii. Higher risk of cardiovascular disease ➢ Heart failure ➢ PAD ➢ Having a stroke

The following flowchart shows the pathways by which diabetes promotes cardiovascular diseases, such as heart failure, CAD, and stroke, especially through mechanisms as follows: insulin resistance due to diabetes, high blood sugar level, and vascular damage.

2.2.5: Obesity:

Table 6: Mechanism of action of obesity and cardiovascular system (Ortega *et al*., 2016)

Mechanism of action of Obesity and Cardiovascular system
i. Increased Adipose Tissue ➢ Excessive consumption in calories → an increase in the development of fat particularly visceral fat ➢ **Adipocytes (fat cells)** → generate mediators of inflammation for instance, TNF-α, IL-6 and adipokines (e.g., leptin, adiponectin)
ii. Insulin Resistance ➢ Insulin resistance is an outcome of excess fat, particularly in the liver and muscles ➢ Hyperglycemia and hyperinsulinemia can be triggered by insulin resistance ➢ Hyperglycemia contributes to endothelial cell breakdown and oxidative stress, that consequently cause atherosclerosis.
iii. Hypertension ➢ Renin-angiotensin-aldosterone system (RAAS) activation, and physical constriction of kidneys are some of the processes by which obesity raises vascular resistance. ➢ High BP promotes degeneration of blood vessels as well as heart.
iv. Systemic Inflammation ➢ Systemic inflammation is facilitated by cytokines and adipokines, such as leptin. ➢ Chronic moderate inflammation causes dysfunction of endothelial cells, atherosclerosis, including blood vessel damage.

v. Atherosclerosis

- Plaque accumulation in the arteries is facilitated by inflammatory mediators and elevated low-density lipoprotein cholesterol
- Blood flow is decreased and artery constriction occurs as a result
- A plaque rupture can result in strokes or heart attacks.

vi. Lipid Dysregulation

- Elevated body fat ↑ LDL cholesterol, ↑ triglycerides, and ↑ free fatty acids, which aggravates atherosclerosis and compromises cardiac health.

vii. Cardiac Remodeling and Heart Failure

- A rise in blood volume along with cardiac output are caused by obesity in order to supply the additional body mass.
- Heart failure results from the weakening and enlargement of the heart (cardiac hypertrophy).

This is the flowchart showing how obesity enhances visceral fat accumulation, which contributes to insulin resistance, inflammation, dyslipidemia, and hypertension. The incidence of CVD is in large part dependent upon these variables, which also promote endothelial dysfunction and atherosclerosis. Finally, heart attacks, strokes, and heart failure will occur as a result of having a hard heart over time, leading to left ventricular hypertrophy.

2.3: Age and gender:

There are well-documented inequalities between men and women in a significant number of cardiovascular diseases (CVDs) in regards to their epidemiology, etiology, clinical presentations, therapeutic effects, and outcomes. On the one hand, such variations result from sex differences—biological distinctions between men and women (Gao *et al*., 2019). These result from variations in the expression of genes derived from the sex chromosomes, which in turn cause variations in sexual hormones. These variations in ultimately cause variations in the expression of genes and the mechanism of cardiac process, vascular wellness along with NO signaling, stress-induced cardiac remodeling, and the metabolism of drugs by cytochrome activity specific to a particular sex (Suman *et al*., 2023).

2.4: Stress:

Psychological stress has been implicated in CVD on a quantity of various steps-from induction of acute cardiac events through to the formation of CHD over long periods (Steptoe and Kivimäki, 2012). Acute exposure to psychological stressors may precipitate an acute myocardial infarction by disrupting the inflammatory and hemostatic and autonomic systems (Bonde, 2008). In prospective observational studies, long-duration stress at corporate and in personal life was corelated with a prevalence of CHD that was roughly 40–50% higher (Backé *et al.*,2012). It therefore means that increased evidence of over time stress, for example collective exclusion as well as employment-linked stress is related to an undesirable outcome for the people who developed CHD (Quick, 1990). Although the future prospects of sufferers from severe CHD remain mixed, the stress-management therapies have really helpful to reduce the patient's stress (Brotman *et al.*, 2007*)*.

2.5: Environmental factors:

The onset and the extent of CVD can be eminently modified by exposure to environmental factors for which an individual has limited control. According to WHO, one of the major global environmental health concerns has been polluted air (Cosselman *et al.*,2015). Around 80% of mortality occurs for the polluted air around the world that may lead to stroke and ischemic heart conditions (Bhatnagar, 2004). Just like CAD, early stages and development of CVD are facilitated by metals, cadmium, lead, and arsenic among the most common of all the Ten environmental pollutants of concern as outlined by the WHO (Cesaroni *et al.,* 2014). Other known influential factors differently affecting the mechanisms producing these effects on cardiovascular risk factors are high levels of cholesterol, BP, and condition of blood vessels. By frequency of the exposure, the legislative initiatives which minimize the impact on the environment can improve cardiovascular health for people all over the world (Rom *et al.,* 2013).

2.6: Other medical conditions (Psychiatric disorders and CVD):

People with psychiatric disorders are more prone to metabolic syndrome (Ryan and Thakore, 2002). The "life-threatening quartet" of risk components, including obesity, high BP and inadequate amount of insulin, cluster together in the metabolic syndrome, a set of circumstances that create a higher chance of CVD and mortality (Sicree, 2003). That is why this is so alarming (McIntyre *et al.,* 2003). Moreover, individuals with depression are also at higher rates compared to those who do not, having 1.5-2.0 times higher comparative probability of developing coronary artery disease (Lett *et al.,* 2004). Individuals with affective disorders, major depressive conditions, and manic-depressive illness actually experience a significantly greater

number of fatal events related to the circulatory system than individuals without the illness (Angst *et al.*, 2002). Similar to bipolar and unipolar individuals, schizophrenic patients have an elevated incidence of CVD; for example, the possibility of myocardial infarction is twice as high compared with subjects without the disorder (Enger *et al.,* 2004). Patients with schizophrenia have more risk components for disease which may connected with increased CVD risk. The modifiable variables include smoking, being overweight (Allison *et al.,* 1999), hypertension, and dyslipidemia (Davidson *et al.,* 2001.,) while the non-modifiable variables are sex, family history, background information, and aging. When approaching cardiovascular risk in schizophrenia, diabetes is among the most important but not the only metabolic risk factor of concern (Dixon *et al.,* 2000.,). The diabetic mellitus patients have an increased risk of CVD, which accounts for 70-80% of their deaths (Herman, 2017).

2.7: Unhealthy sleep patterns:

It is concerning that the association between inadequate sleep and CVD remains frequently under-recognized, especially considering that 50–70 million older adults in the US struggle with sleeping disorders or inadequate sleep (Kaminsky *et al*., 2022). The epidemiological literature has provided the spotlight on the correlation among the length of sleep, possible threat for CVD, and challenging CVD outcomes (Watson *et al*., 2015). Given a U-shaped connection between inadequate sleep and CVD consequences, the majority of recommendations recommend getting 7–8 hours of sleep every night for the greatest possible benefit (Cappuccio *et al*., 2011).

Chapter 3: Diets to have a healthy cardiovascular system:

Exercise and dietary medications are the illustrations of changes in lifestyle that are effective for controlling and preventing CVD and have undergone extensive research (Diab *et al*., 2023). Several observational studies demonstrated the benefits of exercise and dietary modifications in both treating and preventing CVD. The AHA has determined the "Life's Crucial 8" cardiovascular wellness indicators, which consist of a healthy diet, enough physical activity, adequate sleep, a history of nicotine, BMI, blood lipid levels, blood sugar levels, and BP, as well as a balanced diet (Lloyd-Jones *et al*., 2022). According to AHA's healthy diet statistic, less than 1% of US individuals met the "ideal" standards in 2013–2014 (Benjamin *et al*., 2019).

3.1: Established heart healthy diets:

A heart-healthy diet along with additional changes to your lifestyle form the foundation of all CVD prevention strategies (Diab *et al*., 2023). The most common cardio metabolic risk factors - dyslipidemia, hypertension, diabetes, and extra abdominal fat can all be impacted by changes to diets (Badimon, *et al*., 2019). According to nutrition studies, a healthy diet should include substantial quantities of fruits and veggies, whole grains products, legumes as well and non-starchy vegetables which contains relatively small to moderate portions of nuts, fish and seafood, lean protein sources, reduced-fat dairy goods, and plant-based oils (DeSalvo *et al*., 2016). The most reliable evidence for minimizing CVD can be identified in three main dietary patterns, which are detailed below: First one is Mediterranean diet, second one is DASH diet, and last one is the healthy plant-based diet.

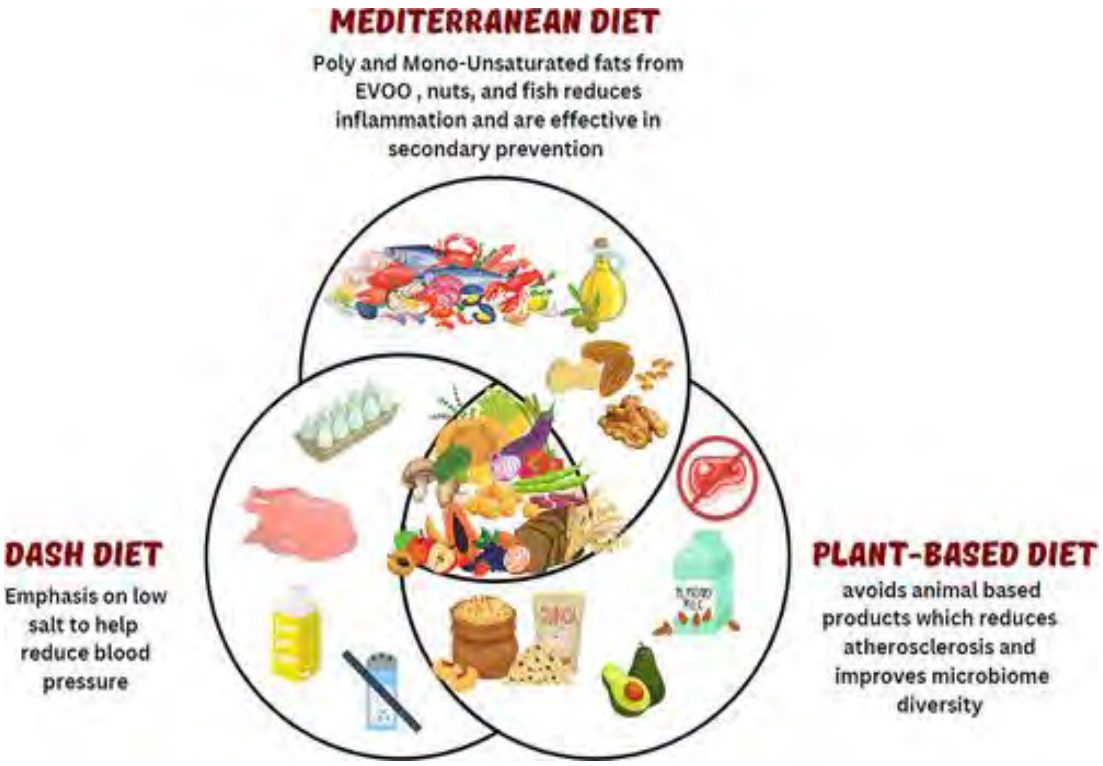

Figure 3: Three dietary patterns that promote heart health (Adapted from Diab *et al*., 2023).

3.1.1: Mediterranean diet:

One of the most appreciated diet plans for heart cardiovascular wellness is the Mediterranean diet. There is no specific Mediterranean diet; instead, a group of diatery patterns are often referred to as the "Mediterranean diet". This is acknowledged by the American Heart Association. This is probably due to the large area—which extends from portions of Europe to the Middle East and East Africa—where a Mediterranean diet is popular (Vargas *et al*., 2021). The diet known as Mediterranean diet was originated upon the eating patterns of the Mediterranean seaside nations such as Italyand Spain which is full of fruits, whole grains, kidney bean, raw almonds, aromatic herbs and additional virgin olive oil (Belardo *et al*., 2022). It additionally allows for an adequate number of protein-rich foods like fish

and poultry, a moderate consumption of alcoholic beverages, a little quantity of red meat with desserts (Fischer *et al.,* 2020). By definition, the Mediterranean diet minimizes or entirely eliminates a number of the main contributors to CVD associated with the typical American diet, including red meat, highly processed refined carbohydrates and sugary treats, and saturated fat (Gantenbein and Kanaka, 2021).

3.1.2: DASH diet:

DASH diet was established in 1997 for the purpose of prevent as well as treat hypertension which is an elevated risk for cardiovascular disease (Appel *et al*., 1997). DASH diet restricts foods and drinks with sugar additives, sweets, fatty meats and dairy goods which is full-fat, while prioritizing vegetables, whole grains, fruits, meat, poultry, fish, nuts, as well as seeds (Eckel *et al*., 2014). The daily allowance of salt in the DASH diet is limited to 2300 mg. It meets with the American Nutritional Guidelines' requirement that an individual's daily salt intake be limited to 2300 mg (Wickman *et al*., 2021). A low-sodium variant of DASH restricts daily sodium consumption at 1,500 mg (Filippou *et al*., 2022). By minimizing the LDL cholesterol, BP, and overall cholesterol level all these factors that are taken into consideration in atherosclerotic cardiovascular disease (ASCVD) threat score—the DASH diet significantly reduces cardio metabolic risk. This, in consequently, improves cardiac function and lowers the chance of diabetes (Sacks *et al*., 2001) (Kucharska *et al*., 2018).

3.1.3: The healthy plant-based diet:

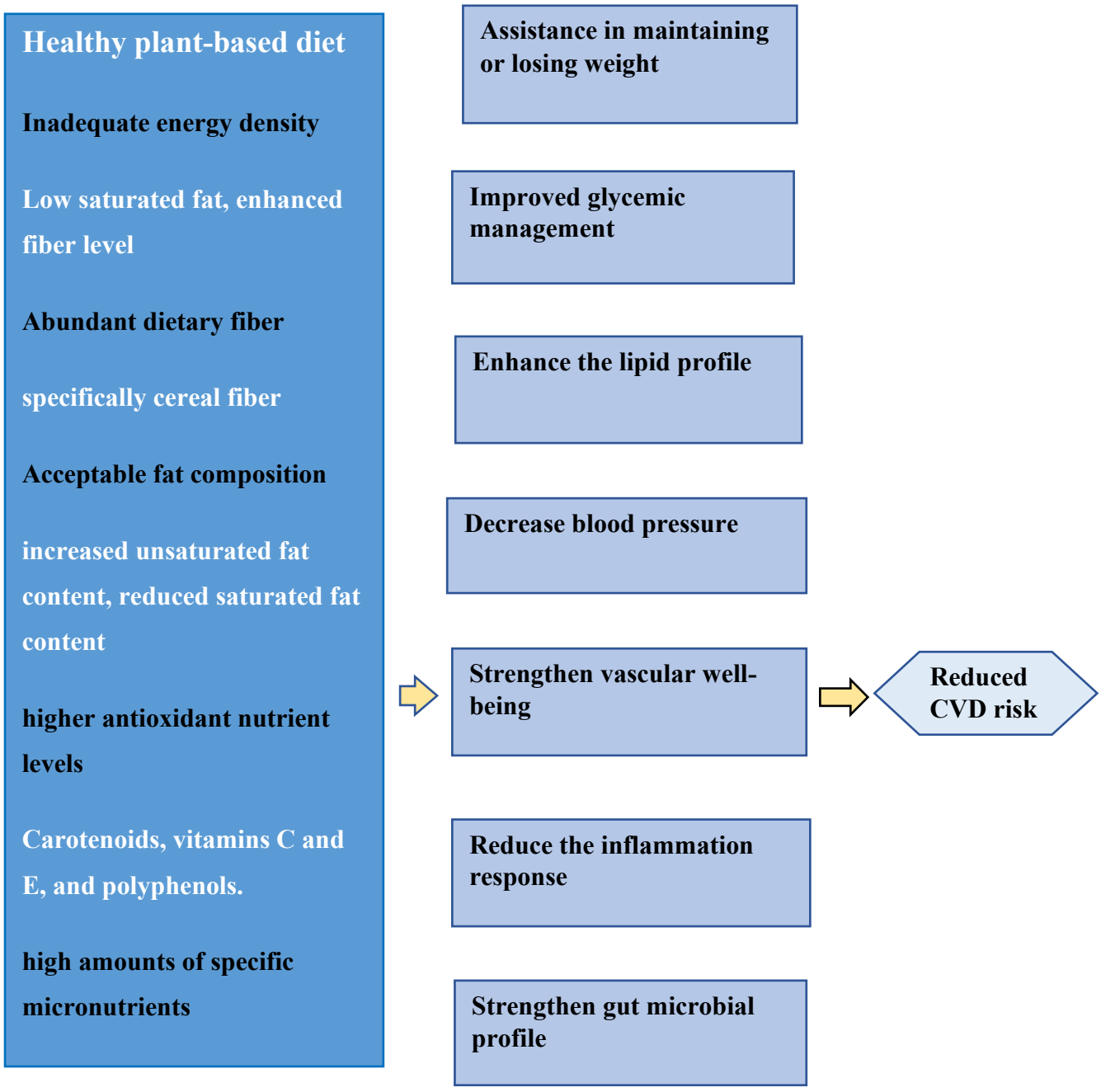

Figure 4: Possible pathways that underlie a healthy plant-based diet's impact on cardiovascular health (Satija and Hu, 2018).

A healthy healthy plant-based diet has a great impact in cardiovascular disease. It was successfully established that a diet composed of plants lowers the probability of CVD (Jabri *et al*., 2021).

3.2: Emerging or controversial diets:

The outcome of other recently developed dietary habits on cardio metabolic risk have been investigated; these are more challenging since there is inadequate data to assess their long-term cardiovascular advantages or inconsistent evidence about their net cardiovascular beneficial effects. The diet known as the Keto Diet and Intermittent fasting are two of the most promising ones, and they are both covered here (Diab *et al*., 2023).

3.2.1: The keto diet:

The ketogenic (or "keto") diet usually defined by consumption of moderate amounts of protein, high fat, and very low carbohydrates (VLC) (O'Neill and Raggi, 2020). The ketogenic diet class categorized daily energy intake into three categories (Kirkpatrick *et al.*, 2019). The dietary macronutrients of the standard ketogenic diet are composed of nearly 55%–60% fat, 30%–35% protein, and 5%–10% carbs (Brouns, 2018). According to time on, low- or very-low-crab dieting that usually follow the same guidelines of high-fat low-carbohydrate diets have also been recommended, along with variations on the ketogenic diet designed to increase compliance but without inducing ketosis (Kirkpatrick *et al*., 2019). However, certain adverse effects that restrict people from following the ketogenic diet include increased levels of overall cholesterol level, triglycerides, LDL-C, non-HDL cholesterol as well as total apoB, these all can enhance the potential threat of cardiovascular disease (Mansoor *et al.*, 2016). Moreover, some mixed scientific records regarding LDL-C on

ketogenic diets (Retterstøl *et al*., 2018), some people may experience a substantial raise in LDL-C. If underlying background susceptibility is present, this sharp rise in LDL-C levels could speed up the development of hyperlipidemia (Goldberg *et al*., 2021). Moreover, a current meta-analysis discovered that in people of normal weight, ketogenic diet had adverse impacts on LDL-C, apoB, and overall cholesterol levels (Joo *et al*., 2023). Before implementing a ketogenic diet, it is essential to carefully assess the possible unfavorable effects on cholesterol, especially who have CVD are at high risk, for instance those with type 2 diabetes. Patients should have their lipid levels monitored, who maintains a ketogenic diet (Diab *et al*., 2023).

3.2.2: Intermittent Fasting/Intermittent Energy Restrictions:

The three main objectives of intermittent fasting (IF), sometimes referred to as intermittent energy restriction, aim to minimize oxidative stress, synchronize feeding and circadian rhythms, and induce a state of ketosis through prolonged fasting intervals (Dong *et al.,* 2020). Although there is currently limited data and a shortage of long-term trials, the IF approach may be beneficial for cardiovascular health (Tinsley and Horne, 2018). The benefits of intermittent fasting (IF) for cardiovascular health were compared to continuous calorie restriction in a current systematic review of RCTs. Findings showed that while IF was much more effective in promoting weight loss, besides the potential risk factors for cardiovascular and metabolic conditions were not considerably reduced by it (Allaf *et al.*, 2021).

Chapter 4: Physical activities to have a healthy cardiovascular system

The cardiovascular system is greatly impacted by physical activity. Engaging in daily physical exercise is essential for maintaining cardiovascular health as it positively impacts various physiological systems that are involved in the various activities of Cardiovascular system. Engaging in daily physical exercise is essential for maintaining cardiovascular health as it positively impacts various physiological systems that are involved in heart function. Participation in moderate-intense aerobic activities, like riding a bicycle, brisk walking, swimming, or jogging, has been linked to improvements in lipid profiles, blood pressure reductions, improved insulin sensitivity, as well as keeping of a healthy body weight, based on epidemiological studies and randomized controlled trials (Nystoriak and Bhatnagar, 2018). Additionally, research indicates that introducing high-intensity interval training (HIIT) intervals to workout routines may provide significant cardiovascular advantages, such as improving metabolic health, endothelial function, and aerobic capacity. Limiting sitting time and enhancing incidental movement throughout the day are two examples of physical activity programs that target sedentary behavior and have shown promise in improving cardiovascular risk profiles and lowering sedentary-related adverse health effects (Bashir, 2024). It's essential to remember that exercise has positive impacts on the cardiovascular wellness that are influenced by dose, implying that increased physical activity frequently result in greater risk reduction. For most effective cardiovascular health, the AHA recommends engaging in exercises that strengthen the muscles at a minimum twice every week along with 150 minutes of moderately intense aerobics as well as 75 minutes of vigorous aerobics per week. (Ghodeshwar *et al*., 2023).

4.1: Aerobic exercises:

Exercises that elevate heart rate and promote healthier cardiovascular health are referred to as aerobic exercise, sometimes called cardiovascular or endurance exercise. Consistent aerobic exercise develops heart muscle, increases heart function, besides enhances blood circulation throughout the entire body, which all contribute to improved cardiovascular health. Aerobic exercise has several advantages, such as lowered resting heart rate, enhanced intake of oxygen, higher cardiac activity with improved blood vessel performance. Practicing in aerobic activity has been scientifically linked with reduced chance of CVD, for instance CAD, HF as well as having a stroke. It increases HDL cholesterol and minimizes triglycerides, as well as overall cholesterol. In addition, aerobic exercise lowers BP, reduces inflammatory conditions, improves responsiveness to insulin and helps with managing weight (Ghodeshwar *et al*., 2023).

4.1.1: Cycling:

Cycling is an aerobic activity that requires no weight bearing and activates the vast lower body muscle groups. It can be carried out individually or in groups, in therapeutic settings as well as externally (Zachariah and Alex, 2017).

4.1.2: Aquatic:

People with cardiovascular diseases have employed an assortment which is composed of water activities, such as aqua-aerobics and deep-water jumping. This group of individuals will probably benefit most from exercising in the water since floating minimizes the need for weight-bearing. The general assumption within patients that this particular type of exercise helps their functional abilities contributes to support this. (Metsios *et al*., 2008).

4.1.3: Walking and running:

Walking and running are the most familiar physical activity that could reduce blood pressure, strengthen the heart, raise HDL, and lower LDL cholesterol, and encourage the rate of weight loss, thereby improving heart health. They also reduce the possibility of heart conditions, stroke, and atherosclerosis by enhanced circulation, improved insulin sensitivity, and reduced inflammation. The daily physical activities decrease the probability of cardiovascular event, by keeping and preventing the important CVD risk factors: obesity, diabetes, and hypertension (Rankin *et al*., 2012).

4.2: Resistance training:

Resistance training, commonly referred to as strength or weight training, is the process of building muscle using resistance or weights. Resistance training helps the cardiovascular system in addition to the muscle tissue, although its main goals are strength and endurance. By increasing the amount of HDL cholesterol, decreasing resting BP and improving the sensitivity to insulin; resistance exercise can enhance cardiovascular health. It optimizes cardiovascular risk factors by decreasing body fat and increasing muscle mass, which improves total body composition. (Ghodeshwar *et al*., 2023).

4.3: A combination of aerobic and resistance exercises:

When resistance as well as aerobic training are combined into a single exercises program, it's referred to as combined training. This form of exercise improves cardiovascular health and general fitness by combining the advantages of resistance and aerobic training. It has been proven that combined training is beneficial in boosting insulin sensitivity, lowering blood pressure, and improving lipid profiles. As contrasting to either aerobic or resistance training alone, it can result in greater enhancements in muscle growth and lower body fat in terms of body composition. Those who want to control several cardiovascular risk factors, maintain a healthy weight, and obtain entire cardiovascular fitness would benefit most from combined exercise. (Ghodeshwar *et al*., 2023).

Chapter 5: Behavioral changes to have a healthy Cardiovascular system

5.1: Moderate alcohol consumption:

Several populations experience a decrease in cardiovascular events if individuals consume alcohol in moderately. Other alcoholic beverages also exhibit this association, in addition to wine. Consuming alcoholic beverages is not suggested for just the purpose of probability of CVD, in comparison with other dietary components that may be beneficial. Enhanced probability of breast cancer, physical abuse, car and collisions at work, hypertension, hypertriglyceridemia, liver damage, and other major negative health and social effects are all linked to high alcohol consumption, that is additionally addictive (Lichtenstein *et al*., 2006).

5.2: Stress management:

There are several stages at which the stress process can be altered that may be significant in managing and preventing cardiovascular disease. There are several stages at which the stress process can be altered that may be significant in managing and preventing cardiovascular disease. These consist of adjustments to how stressful environments are experienced, such as by changing work procedures; adjustments to how people emotionally react to stressful situations, such as by strengthening psychological strategies for coping or changing cognitive assessments; and adjustments to how the body reacts to stress, such as by methods of relaxation or medication. Stress management has frequently been incorporated into intervention packages in addition to dietary adjustments, medication instruction, and physical activity, which makes it challenging to differentiate between the unique benefits of stress reduction on itself (Steptoe and Kivimäki, 2012).

5.3: Smoking cessation:

In worldwide, the use of tobacco contributes significantly to preventable cardiovascular morbidity and mortality, which makes it an essential modifiable risk factor for CVD. A dose-response correlation among cigarette smoking and cardiovascular threat has been repeatedly shown by epidemiological studies and meta-analyses. Both active smoking and secondhand smoke exposure are related to an elevated probability of atherosclerosis, thrombosis, dysfunction with the endothelial cell, and myocardial damage. One of the most effective therapies for decreasing the chance of CVD includes refraining from smoking, as indicated by the quick improvements in cardiovascular outcomes that follow. Additionally, smoking cessation is correlated by a considerable lessen in the amount of peripheral vascular condition, CAD, and ischemic stroke along with a minimize in consequence and cardiovascular-related death. Moreover, there is a significant progress by the public health community in improving cardiovascular health and reducing smoking prevalence through tobacco control initiatives such as regulating tobacco products, introducing smoke-free policies, and implementing smoking cessation programs. (Bashir, 2024).

Chapter 6: Conclusion

Modifications in lifestyles have a significant effect on cardiovascular health. A balanced diet, regular exercise, quitting smoking, reducing stress, and ensuring sufficient sleep are just a few of the healthy behaviors that can dramatically lower the possibility of CVDs and enhance overall cardiovascular health. There are also some health conditions which is directly connected to the CVD for instance hypertension, diabetes, blood sugar, high cholesterol, obesity etc. To avoid unexpected consequences of cardiovascular health it is very essential to focus on these conditions. Besides different types of diet patterns have a great impact on cardiovascular health. This review basically highlights how important it is to address lifestyle changes from every perspective. Multiple beneficial lifestyle choices collectively have a progressive effect on cardiovascular health. To get maximum benefit from these lifestyle changes, adoption should be maintained over time. Even though the evidence in this study is strong, it is important to recognize that individual characteristics can affect how effective lifestyle changes are for improving cardiovascular health. These factors include genetics and previous medical conditions. Consequently, customized approaches that are based on the particular circumstances of each person are required.

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