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REVIEW ARTICLE

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Diet and Non-Communicable Diseases: Part I Cardiovascular Diseases, Respiratory Diseases, Obesity, Depression, Liver Diseases

Shashi K. Agarwal, MD *

[1]2227 US Highway 1, #309 North
Brunswick, NJ 08902, USA

Abstract

Diet is involved in the development and progression of several chronic diseases. These include diseases that are responsible for a major health burden globally, such as cancer, cardiovascular diseases, obesity, diabetes mellitus, and depression. The scientific world is replete with studies on the impact of dietary factors and common diets on these ailments. Prudent dietary habits sever both preventive and therapeutic roles in several non-communicable diseases. Healthy diets are primarily plant-based, and low in red and processed meats and sugar-sweetened beverages.

This manuscript discusses our understanding of the modulation of diet in order to mitigate cardiovascular diseases, respiratory diseases, obesity, depression, and liver diseases.

Keywords: diet, non-communicable diseases, cardiovascular diseases, respiratory diseases, obesity, depression, liver diseases

1 | INTRODUCTION

It is estimated that almost 10% of the global burden of disease is related to poor diet[1]. The influence of diet has been noted with several ailments, including cardiovascular diseases[2,3], diabetes mellitus[4,5], cancer[6,7], lung diseases[8,9], gastrointestinal diseases[10–12], kidney diseases[13,14], neurological diseases[15,16], mental disorders[17–19], and arthritis[20,21], and many others[22–25]. A poor diet reduces the quality of life[26]. It is also one of the leading causes of accelerated aging[27], disability[28], and excess mortality[29]. The seven countries study, reevaluated in 2017, highlighted the substantial influence of diet on health[30]. Dietary interventions have become a core aspect of primary and secondary prevention of the most common non-communicable diseases (NCDs)[31]. Besides caloric restriction to avoid overweight and obesity (a body mass index below 25 kg/m2)[32], a healthy diet is well balanced and consists of high consumption of non-starchy vegetables, fruits, whole grains, and legumes, a lim-

ited to moderate consumption of nuts, seafood lean meats, low-fat dairy products, and vegetable oil rich in mono and polyunsaturated fats, and limitation or elimination of trans-fats, saturated fats, fried foods, sodium, red meat, refined carbohydrates, and sugar-sweetened beverages[33−35].

Several diets have become popular for their beneficial health effects[36−38]. The most common ones are the Mediterranean[39], Dietary Approaches to Stop Hypertension (DASH)[40], and vegetarian[41] diets. The Mediterranean diet is commonly followed in the olive-growing areas of the Mediterranean region. These residents have a high intake of vegetables, whole grains, legumes, fresh fruit, non-refined cereals, nuts, and extra virgin olive oil. They have a moderate consumption of fish, poultry, and dairy, and a low intake of red meats (usually reserved for special occasions only) and sweets. Their intake of alcohol is moderate and usually limited to red wine consumed during their main meals[36,39]. Meta-analysis of cohort studies on this diet revealed a 10% reduction in cardiovascular events and 8% reduction in mortality[39]. The DASH diet is low in sodium (< 2300 mg/day) and has been promoted by the National Institutes of Health to treat hypertension. It also encourages consumption of fruits and vegetables of different colors, fat-free or low-fat dairy products, whole grains, and various protein sources (e.g., seafood, lean meats, eggs, legumes, nuts, seeds, and soya) while limiting added sugars (< 10% of calories per day), saturated fats (< 10% of calories per day), and alcohol (≤ 1 drink per day for women and ≤ 2 drinks per day for men). Besides effects on blood pressure, it also helps in improving other risk factors for CVD and diabetes mellitus[37,40]. A vegetarian diet is a plant-based diet, rich in whole grains, cereals, legumes, fruits, leafy ground vegetables, nuts, seeds, and sea vegetables[38,41]. The term semi-vegetarians is sometimes used to describe individuals who consume meat up to or less than once a week. Lacto-vegetarians eat dairy products, ovo-vegetarians eat eggs, lacto-ovo vegetarians eat both dairy products and eggs, while a pesco-vegetarian eats fish, in addition to the plants[42]. A vegan usually consumes no food from animal sources[43]. The nature of vegetarianism often varies between different cultures and regions[44−46]. Most European and North American vegetarians eat dairy products and eggs and are therefore lacto-ovo-vegetarians[44]. Asian Indian vegetarians are mainly lacto-vegetarians[45]. Dairy intake is much less in Chinese vegetarians when compared to Western vegetarians[46]. Vegetarian diets are specifically linked to a lower risk of coronary artery disease and type 2 diabetes[43,47], while vegan diets, in addition, also help in losing weight[43].

The impact of diet on common chronic medical conditions is discussed in this two-part manuscript. Part I discusses the relationship between diet and cardiovascular diseases (CVD), chronic obstructive pulmonary disease (COPD), obesity, depression, and liver diseases. Part II discusses its impact on cancer, diabetes mellitus (DM), kidney diseases, Alzheimer's disease, and arthritis.

2 | DISCUSSION

CDC defines chronic diseases as "conditions that last 1 year or more and require ongoing medical attention or limit activities of daily living or both"[48] Most chronic diseases are NCDs, and their incidence and prevalence is growing all over the world[49]. Diet is an important modifiable risk factor for chronic diseases development and progression[50−52]. Cardiovascular diseases (CVDs) are a heterogeneous group of diseases of the heart and the circulatory system[53]. CVDs are associated with extremely high morbidity and continue to be the leading cause of premature mortality worldwide[54]. It is estimated that by the year 2030, 23.6 million people will die of CVDs per year[55]. The underlying cause is usually atherosclerosis[56]. Chronic respiratory diseases are common non-communicable diseases[57] and include chronic obstructive pulmonary disease (COPD),

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Corresponding Author: *Shashi K. Agarwal, MD*
Shashi K. Agarwal, MD 2227 US Highway 1, #309
North Brunswick, NJ 08902,USA
Email: usacardiologist@gmail.com

asthma, interstitial lung diseases, pulmonary sarcoidosis, and pneumoconiosis such as silicosis and asbestosis[58]. It is estimated that 545 million people in the world suffered from chronic respiratory diseases in 2017[59]. They remain a leading cause of death and disability worldwide[60]. They caused more than 3.8 million deaths in 2017, which accounted for 7% of all global deaths and 9% of all NCD deaths[61]. Obesity is an increasing public health problem worldwide[62]. Besides its epidemic influence in adults, it is increasingly affecting children and adolescents[63]. Obesity leads to a wide array of illnesses such as type 2 diabetes mellitus (DM)64, hepatic steatosis65, gallbladder diseases[66], osteoarthritis[67], and several cancers (such as those of the endometrium, breast, ovary, prostate, liver, gallbladder, kidney, and colon)[68], in addition to the diseases discussed in this manuscript. Even modest weight loss—5% decrease in body weight—has been shown to lower the risk of chronic disease[69,70]. Its etiology is multifactorial, but diet plays an important role[71]. Obesity increases mortality[72]. Depressive disorders are the leading cause of global disability[73]. It is usually associated with a low mood, sadness, lack of energy, and an inability to enjoy life[74]. It also affects physical health[75]. Overall, depression leads to a considerable reduction in the quality of life, medical comorbidity, and mortality[76,77]. Chronic liver diseases have become a major international public health concern[78–80]. It is estimated that nonalcoholic fatty liver disease (NAFLD) has a prevalence of around 25% of the general population[81]. Diet also plays a major role in alcoholic liver disease (ALD)[82] **. Diet also is associated with** liver cancer[83]. Chronic liver diseases cause more than 2 million deaths per year[57]. These diseases and their relationship with diet are discussed below.

2.1 | CARDIOVASCULAR DISEASES

Poor eating habits are a major modifiable risk factor for cardiovascular diseases (CVD)[84–86]. A plethora of scientific studies indicates that red and processed meat[87], fried foods[88], sugar-sweetened beverages[89], excess alcohol intake[90] and obesity[91] have detrimental effects on CVDs, while fruits and vegetables[92,93], whole grains[94], fiber[95], tree nuts[96], chocolate[97], and coffee[98] are cardioprotective.

The most effective dietary intervention is probably salt restriction[99]. This leads to blood pressure (BP) reduction, which is associated with a substantial reduction in morbidity and mortality from CVDs[100]. According to major US cardiology associations, a reduction of salt intake to <1500 mg/d[101] should bring the BP down by about -5/6 mm Hg systolic and -2/3 mm Hg diastolic[102]. Obesity is closely related to hypertension (HTN)[103], and weight reduction in obese individuals, via calorie restriction, or other dietary changes, is also associated with BP reduction[104]. The AHA estimates that every 1 Kg (2.2 lbs) weight reduction is associated with about a 1 mm Hg reduction in systolic BP[105]. A change in the quality of diet also helps[105,106]. A diet rich in fruits, vegetables, whole grains, low-fat dairy products and with a reduction in saturated and total fat has also been estimated to reduce systolic BP by -11 mm Hg and diastolic BP by – 3mm Hg[105]. Both the DASH diet[107] and the Mediterranean diet[108], help reduce BP in patients with HTN. Controlling HTN helps reduce several CVDs, including stroke[109], heart failure[110], and cardiac arrhythmias[111]. The major beneficial impact of a drop in BP is, however, on coronary artery disease[112,113]. In a recent longitudinal study of 153,082 US veterans, the DASH diet was inversely associated with the incidence of coronary artery disease (CAD)[114]. Another study, a meta-analysis of cohort studies determined that adherence to the DASH diet resulted in a 21% reduced risk of CAD[115]. The Lyon Diet Heart Study, which evaluated the impact of the Mediterranean diet on CAD, found a reduction in coronary mortality of 65% after 46 months[116]. Benefits of a healthy diet have also been recorded with stroke[117], heart failure[118], peripheral arterial disease[119], and vasculogenic erectile dysfunction[120]. A high-fat diet has also been linked to an increase in cardiac arrhythmias[121], and SCD[122]. A cardiovascular healthy diet also helps reduce hypercholesterolemia[123], DM[124], and chronic kidney disease[125] – all major risk factors for CVDs.

2.2 | RESPIRATORY DISEASES

The adverse association between obesity and COPD is well known[126,127]. Obesity risks increase with the

consumption of an energy-dense, high fat, and low-fiber diet, resulting in excess caloric intake[128]. The quality of diet also appears to influence COPD[129,130]. Several diets appear to reduce the development of COPD from 25% to 54%[131−133]. The most important beneficial component of these diets appears to be a higher intake of fruits and vegetables[134]. consumption of fish[135], and a lower intake of processed meats[136]. A diet rich in a higher intake of meat and potatoes, and a lower intake of soy and cereal has been associated with lower forced expiratory volume in one second (FEV1) and an increased prevalence of COPD[137]. In patients with diagnosed COPD, patients on a diet with high consumption of fruits and vegetables demonstrated an annual increase in their FEV1 while those on a usual diet showed a decrease in FEVI during 3 years of followup[138]. Several recent studies have confirmed the beneficial effects of fruits and vegetables in retarding the development and progression of COPD[139−141]. Several micronutrients are present in high amounts in fruits and vegetables, are associated with better lung parameters and their presence may explain their beneficial effect in patients with COPD[142,143]. These include vitamin C[142], alpha-tocopherol[140], and beta-carotene[143]. Their benefits have been attributed to a reduction in inflammation and oxidative stress[144]. Fish oils are anti-inflammatory and are protective against the development of COPD[145]. Micronutrients like calcium, phosphorus, iron, potassium, and selenium also appear to be beneficial in these patients[146]. Vitamin D supplementation, especially in those with severe deficiency, also helps in reducing the number of COPD exacerbations[147]. Diet also influences COPD-related mortality[148]. Walda et al noted an inverse trend for 20-year COPD mortality, and a 100 g increase in fruit intake at baseline resulted in a 24% lower COPD mortality risk[149].

Obesity, which is usually associated with an energy-dense, low fiber, and high-fat diet, is common in asthma patients[150] with harmful effects[151,152]. Excess body weight is associated with reduced lung volumes, poorer asthma control and outcomes, and poorer quality of life[151,152]. Excess adipose tissue induces immunometabolism disarray, increased oxidative stress, and decreased bioavailability of nitric oxide, producing or aggravating airway disease[153]. Reduction in weight helps, as has been demonstrated by bariatric surgery studies that have resulted in dramatic improvements in asthma control and lung function[154]. A weight-reducing diet is therefore beneficial in asthma patients[155]. Asthma is an inflammatory disease[156], and the latter can be beneficially modulated with a judicious diet[157]. In adults with severe asthma, higher fat and lower fiber intake have been associated with increased eosinophilic airway inflammation[158]. Reduction of dietary saturated fat intake reduces this inflammation[159]. In contrast, fruits, vegetables, and their antioxidants help lower airway inflammation[160,161]. A study from Mexico demonstrated that fruit and vegetable intake was inversely associated with IL-8 protein in nasal lavage of asthmatic children, indicating reduced inflammation[162]. In asthmatic adults, intake of tomato juice, which is abundant in the antioxidant lycopene, reduced airway neutrophil influx and sputum neutrophil elastase activity after just seven days of supplementation[157]. On the other hand, a diet characterized by highly processed foods, with high intakes of refined grains, processed and red meats, desserts and sweets, fried foods, and high-fat dairy products, with low intake of fruits and vegetables has harmful effects on asthma in children[163−165].

Several case–control studies indicate that a diet rich in vegetables and fruits, may exert some protective effect against lung cancer[166,167]. Cruciferous vegetables, such as broccoli, are rich in isothiocyanates, and these have cancer-preventive activity[166]. A high intake of total or saturated fat does not appear to increase the risk of lung cancer, as a pooled analysis of eight cohort studies showed[168]. However, high levels of nitrosamines (formed during cooking) in fried or well-done red meat, appear to increase lung cancer risk[169,170].

2.3 | OBESITY

Excess caloric intake without corresponding energy burn results in weight gain[171]. An imbalance between energy intake and expenditure, results in an increase in the number (hyperplasia) and size (hypertrophy) of adipocytes[172,173]. In other words, individuals consuming more calories than the recommended daily allowance according to the METs expended, are

likely to become overweight or obese[171]. Excess calories are easier to consume with food rich is fats and sugars, and low in fiber[174]. Ultra-processed foods are typical examples - they are highly processed foods high in total energy, free sugars, saturated fats, sodium, and additives, and low in fiber, protein, phytochemicals, and micronutrients – with additives primarily to increase their shelf life without increasing their cost[175]. The foods include chips, carbonated soft drinks, sweet or savory snacks, confectionary, mass-produced packaged bread, buns, pastries, cakes, biscuits and desserts, prepacked breakfast cereals, preprepared meals, including pies, pasta and pizza dishes, reconstituted meat and meat products, 'instant' soup, and noodle dishes[175]. Ultra-processed foods account for about 50–60 % of the energy content in the usual diet of the average US, Canadian, or British consumer[176−178].

Several epidemiological studies have examined differences in body weight based on dietary patterns. Findings from AHS, EPIC and the Swedish Mammography Cohort studies found that omnivores had the highest prevalence of overweight and obesity compared to individuals eating less meat, such as plant-based diets[179]. The EPIC-PANACEA study showed that an increase in 250 g/day of meat led to a 2 kg weight gain after 5 years[180]. In a study examining a cohort of 49,098 Taiwanese adults, the percentage of participants with a BMI $\geq$ 27 kg/m2 was significantly lower among those following a vegetarian diet (10.9%) as compared to those following a non-vegetarian diet (15.4%)[181]. The Adventist Health Study also demonstrated that BMI increases as the number of animal foods in the diet increased[182]. In this study, vegans had the lowest BMI, followed by vegetarians, pesco-vegetarians, semi-vegetarians, and omnivores[182]. The European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford) study found that vegans gain significantly less weight as they age compared to omnivores[183]. Plant-based diets also help in weight loss[184,185], Huang et al in a meta-analytic study found significant weight loss with plant based diets[184], while Barnard et al reported in another meta-analysis that plant-based diets were associated with a mean weight loss of −3.4 kg to 4.6 kg[185]. Several subsequent clinical trials, including the New DIETs study[186], HER Health Study[187], and the VA BEACH Diet Study[188], have also confirmed the weight loss benefit associated with plant-based diets. A prudent diet – plant based or restricted in calories, should ideally include 60% carbohydrate intake, 25% protein intake, and 15% fat intake[189]. Weight loss in these patients is enhanced by combining exercise[190] - regular moderate-intensity aerobic exercise for at least 150 min per week or more than 300 min per week. Resistance exercises at moderate intensity two times per week with 10 to 15 resistance exercise repetitions should also be part of this exercise regimen.

2.4 | DEPRESSION

Diet is a well-known factor associated with depression[191−194]. As mentioned before, a calorie-rich diet may result in obesity[128]. Obesity is harmful to depression[195]. The prevalence of depression in obese individuals is twice as high as in those of normal weight[196,197]. An improvement in the diet, especially with calorie restriction resulting in weight loss may help with an improvement in depression symptoms[198,199]. Depression can also lead to obesity, indicating that there is a bidirectional causality[200−202]. The quality of diet also has a major impact on depression[203]. Lassale et al. in a review and analysis of 20 longitudinal and 21 cross-sectional studies, concluded that an inverse association between healthy diet and depression[204]. A recent meta-analysis confirmed that 'healthy' dietary patterns (regardless of the type) may contribute to the prevention of depressive symptoms[205] . and this appears to be related in a linear dose-response fashion[198]. Diets low in fruit and vegetables[206], fish[207], or legumes[208], are associated with an increase in depression. Diets rich in sugar, sodium, saturated fat[209,210], meat, and eggs[211,212] are associated with more depression. A diet with lower intakes of low-calorie foods is similarly harmful[213]. An unhealthy diet is often poor in several micronutrients, including tryptophan, inositol, magnesium, fiber, folate, and omega-3 fatty acids which are important for proper mental wellbeing[214]. However, dietary supplements do not appear to be very effective in reducing depression[215]. Improper diet and obesity result

in HPA axis dysregulation[216]. They also increase inflammation, oxidative stress, and other endocrine dysfunctions[217].

2.5 | LIVER DISEASES

Nonalcoholic fatty liver disease (NAFLD) is a progressive disease of the liver that ranges from hepatic steatosis (liver fat >5% of liver weight) to more severe steatohepatitis, (NASH, hepatocellular inflammation}, with progression to fibrosis and end-stage cirrhosis[218]. Weight loss via caloric restriction remains the most viable option in the treatment of NAFLD and fibrosis[219]. Reducing body weight by 7-10% with hypocaloric diets is the most efficacious in the treatment of NAFLD/NASH and fibrosis[220,221], with greater weight loss (≥10%) being associated with the highest rates of NAFLD/NASH resolution and fibrosis regression[222]. However, histological improvements are also observed with as little as 3-5% weight loss[223,224]. A healthy diet, besides a diet that prevents excess body weight, is also important. Several diets, including the Mediterranean Paleolithic, ketogenic, high-protein, plant-based, low-carbohydrate, and intermittent fasting approaches all have shown beneficial health outcomes in these patients[225]. Dietary ingredients that are beneficial include soluble and insoluble fiber, monounsaturated or polyunsaturated fatty acids, several micronutrients, vitamins E, C, and D, and several polyphenols (e.g., resveratrol, curcumin, caffeine, quercetin) are also helpful in NAFLD[226,227.] On the other hand, fructose and saturated fatty acids contribute to the pathogenesis of NAFLD[228]. Alcohol intake in excess induces hepatic damage resulting in alcohol liver disease, which includes liver steatosis, fibrosis, cirrhosis, and alcoholic hepatitis[229]. These can be prevented by alcohol abstinence and the damaged liver can be helped with nutritional support. Patients with ALD usually suffer from malnutrition[230], and this exacerbates the severity of the liver disease[231]. These patients may either have an intake of an unhealthy diet with too few essential nutrients or the alcohol may prevent the body from digesting and utilizing essential nutrients[232]. Many ALD patients suffer from protein-calorie malnutrition233 which increases complications. **Th**e American College of Gastroenterology and the American Association for the Study of Liver Diseases guidelines recommend 1.2 to 1.5 g/kg per day of protein intake and 35 to 40 kcal/kg per d of body weight for energy intake in patients with ALD[82] Besides these macronutrients, ALD patients need several micronutrients to protect liver toxicity and distant complications include zinc[234], magnesium[235], selenium[236], vitamins D[237], vitamin E[238], folate[239], niacin[240], and thiamine[241]. A proper nutritional support in patients with ALD helps reduce infectious complications and improves 1-year mortality in such patients[242,243]. There is a strong association between obesity and hepatocellular carcinoma[244,245] .The results show that diet plays an important role in HCC occurrence[246]. Several diets have been noted to lower the risk of hepatocellular carcinoma[247,248]. These diets are usually rich in foods such as vegetables[249,250], poultry[251], fish[252], wholegrains[253], nuts[254], tea[255], and caffeinated coffee[256,257]. Micronutrients such as vitamin E, vitamin B9, β-carotene, manganese, and potassium may help in reducing the development of HCC[258]. Some fats, including monounsaturated fats[259], may also have beneficial effects. However, data indicates that processed red meat consumption[260] high-fat dairy foods[261], and ingestion of sugar-sweetened beverages[262] may increase HCC risk. Heavy alcohol intake is also harmful[263,264].

3 | CONCLUSION

A healthy diet should provide adequate macro and micronutrients, and avoid harmful saturated fat, processed meats, sugar-sweetened drinks, excess salt, and excess alcohol. The beneficial effects of a prudent diet on several NCDs are strong. Water is also an important component of diet[265]. It comprises from 75% body weight in infants to 55% in the elderly. Besides providing adequate hydration, plain water intake is associated with a decrease in sugar-sweetened beverages, and a decrease in caloric intake. Water intake should not be forgotten as a beneficial component of a healthy diet.

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