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REVIEW ARTICLE

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DIET AND NON-COMMUNICABLE DISEASES: PART II Cancer, Diabetes Mellitus, Kidney Diseases, Alzheimer's Disease, Arthritis

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Abstract

Several global studies have shown that diet plays an important role as a modifiable lifestyle factor in the development and progression of non-communicable diseases. A proper diet with a balanced percentage of macronutrients, viz. carbohydrates, proteins, and fats. It is also selective in the choice of macronutrients, preferring those that are plant-based, and avoiding refined carbohydrates, animal-based proteins, and saturated fats and trans-fats. It is also rich in needed micronutrients viz. vitamins and minerals, and adequate intake of water. This manuscript deals with the important role of a prudent diet in five major non-communicable diseases.

Keywords: diet, non-communicable diseases, cancer, diabetes mellitus, kidney diseases, Alzheimer's disease, arthritis

1 | INTRODUCTION

Homo sapiens are natural omnivores[1]. Our guts resemble those of gorillas and chimpanzees and are accustomed to handling a mostly plant-based diet with occasional meat intake[2]. In humans, the amount of caloric intake is important[3]. Since overweight and obesity have a significant negative impact on chronic diseases, proper weight is an extremely important health issue[4]. An ideal body mass index (BMI) is calculated as the weight in kilograms divided by the height in meters squared and should be between 18.5 to 24.9 kg/m2[5]. Many other anthropometric measurements are often used, primarily because visceral or central obesity appears to be more hazardous than measurement of BMI alone[6]. These include waist circumference, waist to hip ratio, and waist to height ratio[7]. Besides excess body weight, the quality of diet is also important for good health[8–10]. A healthy diet should provide appropriate proportions of macronutrients (carbohydrates, proteins, and fats) for the energy and physiologic needs[8], sufficient micronutrients (vitamins and minerals) for normal growth, development, metabolism, and physiologic functioning[9], and adequate water for hydration[10]. Carbohydrates are

abundant in grains, fruits, vegetables, and legumes[11]. Whole grains have a higher amount of fiber and micronutrients than processed grains and are therefore healthier[12,13]. Legumes and nuts are also healthy[14,15] – except that nuts are energy-dense and may increase body weight if not consumed judiciously[16]. Fresh fruits and vegetables are good sources of phytochemicals (polyphenols, phytosterols, carotenoids), and dietary fiber – all healthy[17–19]. Dietary proteins may be of animal origin (meat, dairy, fish, and eggs) or plant origin (legumes, soy products, grains, nuts, and seeds)[20]. Proteins are good sources of energy and help maintain lean body mass[21,22]. Animal-based sources of protein contain saturated fatty acids, which are unhealthy[23,24]. Fats (or lipids), besides providing energy, also help make up the cellular membranes[25]. Dietary fats may be monounsaturated fats, polyunsaturated fats, saturated fats, and trans fats[26]. Unsaturated fats are found in a variety of foods, including fish, many plant-derived oils, nuts, and seeds, and are healthy[27]. Monounsaturated fats (MUFA) include oleic acid, canola oil, and olive oil and are heart healthy[28]. Polyunsaturated fats (PUFA) include omega 3 fatty acids (Eicosapentaenoic acid or EPA and docosahexaenoic acid or DHA) and have positive health effects[29–31]. EPA and DHA are found primarily in oily fish[32], whereas animal products (and some plant-derived oils) are rich in saturated fats and should be only consumed infrequently[33–35]. Processed meats are carcinogenic (they are also low in micronutrients) and should be avoided[36,37]. Trans fats found in foods are predominantly the result of processing vegetable oils but are also present in small quantities in animal products - they are health harmful and should not be consumed[32,38]. Micronutrients are required in trace amounts and include vitamins, sodium, potassium, magnesium, zinc, selenium, copper, and calcium[39,40]. These are low in processed and refined foods[41]. Water is also a principal component of the body[42]. Besides hydration, water also provides several micronutrients, including trace elements and electrolytes[43,44]. Sugar-sweetened beverages, although water-based, are harmful, especially due to the high fructose content, and should be avoided[45]. Coffee[46], tea[47], chocolate[48], and olive oil[49] are all plant-based and healthy. Diabetics should watch their egg intake but in general, one egg a day14 and low dairy foods are safe[50]. Dietary patterns and dietary ingredients strongly affect chronic noncommunicable diseases[51].

2 | DISCUSSION

Chronic noncommunicable diseases (NCD) are common conditions affecting humans[52]. According to the World Health Organization, in 2020, the common cases of cancer were related to the breast, lung, colon and rectum, prostate, skin (non-melanoma), and stomach[53]. Cancer accounted for nearly 10 million deaths in 2020[53]. It is on its way to replace cardiovascular diseases (CVD) as the number one killer in the world[54]. Diabetes mellitus is approaching epidemic proportions worldwide[55]. According to the International Diabetes Federation, it affected 425 million people globally in 2017, and these numbers are expected to increase to 629 million by 2045[56]. Type 2 diabetes mellitus (T2DM) is responsible for 90% of all diabetes cases[57] and is caused by a combination of defective insulin secretion by pancreatic β-cells and/or the inability of insulin-sensitive tissues to respond to insulin[58]. T2DM results in considerable morbidity and mortality[59]. Diabetics live approximately six years less than non-diabetics[60]. It is an expensive disease, with the economic burden being approximately 12% of global health expenditure[61]. Chronic kidney disease (CKD) is defined as the presence of kidney damage or an estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73 mt2, persisting for 3 months or more, irrespective of the cause[62]. It affects an estimated 10% to 15% of people around the world[63]. It is a progressive disease, and sufferers ultimately need dialysis or

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kidney transplantation[64]. CKD patients experience considerable cardiovascular complications[65], poor cognitive function[66], and a lower quality of life[67]. They also face an early death[68]. Dementia is common globally[69]. A recent report estimated that 50 million people in the world are living with dementia, and this number is projected to increase to 82 million by 2030 and to 152 million by 2050[70]. The most common cause is Alzheimer's disease (AD)[71], which is characterized by amyloid plaques and neurofibrillary tangles in the brain[72]. Symptoms include cognitive impairment and functional decline, loss of independence, poor quality of life, and premature institutionalization[73,74]. There is no cure for AD, and treatment remains symptomatic[75]. AD is also a major cause of death[76]. The main types of arthritis encountered in clinical practice are osteoarthritis (OA), rheumatoid arthritis (RA), and gout[77]. OA is characterized by progressive cartilage degradation, synovitis, osteophyte formation, and subchondral bone sclerosis[78]. Treatment is largely symptom based[79−81], and many patients may end up needing total joint replacement[82]. It is the fastest-growing cause of disability worldwide[83]. Rheumatoid arthritis is an autoimmune disease and presents as a symmetrical polyarthritis often with systemic manifestations[84]. Gout is autoinflammatory joint arthritis and is associated with hyperuricemia[85]. It is induced by monosodium urate crystal deposition in joints and soft tissues[86].

2.1 | CANCER

A healthy diet is associated with lower cancer morbidity and mortality[87−93]. Steinmetz et al. reviewed of 206 human epidemiologic studies and 22 animal studies and found that consumption of fruits and vegetables was protective for cancers of the stomach, esophagus, lung, oral cavity and pharynx, endometrium, pancreas, and colon[94]. Islami et al reported that low fruit and vegetable consumption was associated with the development of 17.6% of oral cavity/pharyngeal cancers, 17.4% of laryngeal cancers, and 8.9% of lung cancers while low dietary fiber accounted for 10.3% of colorectal cancer cases[95]. Red meat and processed meat are cancer provoking[96,97]. Their consumption has been associated with an increased incidence of cancers of the breast, colon, stomach, and prostate[95,98]. A healthy diet improves cancer-related symptomology[99], the efficacy of treatment[100], and raises the quality of life[101]. Cancer patients decrease their risk of getting a second primary tumor[102] and improve their survival[103,104]. A healthy diet also helps mitigate against other chronic ailments like obesity, diabetes, osteoporosis, and cardiovascular disease, which are often present in cancer patients[105−109]. Processed and red meat increases the exposure to carcinogens such as N-nitroso compounds, polycyclic aromatic hydrocarbons, and heterocyclic amines[110−113]. Plant-based diets are rich in phytochemicals and fiber that diversify gut microbiomes, resulting in lower inflammation, decreased oxidative damage, better immunity, decreased tumorigenesis, and improved levels of circulating sex and growth hormones[114−116].

2.2 | DIABETES MELLITUS

The obesity epidemic is giving rise to an increased number of diabetics worldwide[117]. Weight loss in individuals who are obese is effective in the prevention and management of T2DM[118]. A calorie restriction-induced weight loss of about 15 kg, can lead to remission of T2DM in about 80% of obese diabetics[119]. Certain dietary ingredients also impact T2DM[120−125]. Plant-based diets help reduce HbA1c more when compared to HbAIc in patients on a conventional diet[120,121]. High consumption of whole grains, low-fat dairy products, yogurt, olive oil, chocolate, fiber, magnesium, and flavonoid also significantly reduces the risk of T2DM[122−125]. Intake of olive oil[126] and coffee[127] lowers the risk of T2DM. Nut and legume intake does not appear to affect T2DM[122]. In contrast, a high consumption of red and processed meat, and sugar or sugar-sweetened beverages significantly increases the risk of T2DM[124,128,129]. No association has been noted between fish intake and T2DM130. Schwingshackl et al found that 1 serving/day of eggs (55 g/day) increases the risk of T2DM by threefold[122]. However, a recent review and meta-analysis of 82,750 women from the Nurses' Health Study, 89,636 women from the NHS II, and 41,412 men from the Health Professionals Follow-up Study found no overall associ-

ation between moderate egg consumption and risk of T2DM[131]. Schwingshackl et al calculated that risk-decreasing foods are associated with a 42% reduction, while consumption of risk-increasing foods resulted in a threefold increase in T2DM risk, compared to non-consumption[122]. The Mediterranean diet may result in a 30% relative risk reduction in type 2 diabetes over a 20-year period[132]. The DASH diet, along with the Alternate Mediterranean Diet Index, Healthy Eating Index 2010, and Alternate Healthy Eating Index 2010, has also shown an inverse association with T2DM[133]. A prudent diet is more effective in decreasing the risk of T2DM if it is combined with increased physical activity[134].

2.3 | KIDNEY DISEASES

Diet plays an important role in CKD[135]. A proper diet, primarily plant-based, leads to a higher eGFR and better serum albumin levels[136]. The prospective observational Northern Manhattan Study with 900 participants found that plant-based diets resulted in a 12% lower risk of eGFR decline when compared with meat-based diets[137]. A dietary pattern rich in whole grains, fruit, and low-fat dairy foods is associated with lower urinary albumin to creatinine ratio[138]. Plant-based diets also are associated with decreased mortality in adults with CKD[139]. Mortality is high is CKD, primarily from cardiovascular complications[140,141]. Individual dietary components influence blood pressure, lipid levels, oxidative stress, insulin sensitivity, systemic inflammatory responses, pro-fibrotic processes, thrombosis risk, and endothelial function in these patients and thereby modify CVD and clinical outcomes[142−144]. CKD patients may be advised to reduce their fluid and salt intake[145].**A low protein diet is CKD friendly[146]. It helps delay the progression of CKD[147].** A diet rich in animal protein is potentially harmful and results in deleterious outcomes[148]. Animal protein (red and processed meat), results in higher BP, vasodilation of afferent renal arterioles, glomerular hypertension, hyperfiltration, metabolic acidosis, mitochondrial oxidative stress, DNA damage, and increased accumulation of the end-products of protein catabolism – all harmful to the kidneys[149]. A diet high in fruits and vegetables results in a slower CKD progression and reduces complications and is associated with decreased mortality[146]. Patients adhering to a Mediterranean diet for six years showed a 50% lower risk of developing CKD[150]. An analysis of several large RCTs also showed that compliance with the Mediterranean diet reduced CVD in these patients[151]. DASH diet is also CKD protective[152−154]. A recent German study also found that the Dietary Approaches to Stop Hypertension diet **(DASH)**

adherence was associated with better eGFR numbers[152]. Poor adherence to the DASH diet results in a 16% higher risk of CKD (study of **15,000 Atherosclerosis Risk in Communities participants)[153]. An inverse association between the DASH diet and the risk of developing CKD can therefore be inferred[154].** Healthy dietary patterns (higher in fruit and vegetables, fish, legumes, cereals, whole grains, and fiber, and lower in red meat, salt, and refined sugars also **lead to better health quality of life in CKD patients[144].**

2.4 | ALZHEIMER'S DISEASE

There appears to be no strong connection between diet and the risk or progression of dementia[155]. There is some suggestion that plant-based diets, especially rich in green leafy vegetables may reduce cognitive decline and dementia[156]. Several studies have demonstrated that the Mediterranean diet may have a weak protective effect on cognition[157−161]. A slightly modified DASH diet also appears to prevent cognitive decline[162]. The benefits may derive from the beneficial effects of healthy diets on the cardiovascular system[163]. Some studies have noted that the intake of folate, B vitamins, vitamin C, D, E, and selenium, may beneficially modify cognitive impairment and dementia[164−169]. The Lipididiet trial found that multi-nutrient supplementation slowed the decline of cognitive, functional, and structural aspects of dementia, and slowed disease progression, after a period of 36 months[170]. In this study, the authors did not find any difference between groups on the cumulative incidence of dementia nor the mean time to dementia diagnosis1[70]. The World Health Organization does not recommend dietary supplements for the management of dementia[171].

2.5 | ARTHRITIS

A weight losing diet resulting in weight loss shows a benefit on OA[172−175]. Obesity increases strain on weight-bearing joints and aggravates OA[172−176]. An association of higher BMI with the development of hand OA has also been noted[177]. Hyperglycemia affects the subchondral bone and is also a predictor of OA[178−179]. Cholesterol has been found to accumulate in human OA cartilage[180]. Higher intakes of total and saturated fat are associated with increased knee joint space-width loss, whereas higher intakes of monounsaturated fatty acids (MUFAs) and PUFAs are associated with reduced radiographic progression[181]. These can be modulated with dietary interventions. Low levels of vitamin D and vitamin K have also been implicated in OA[182], although benefit via supplemental remains unclear[183,184]. Several diets have been studied in RA for their inflammation-reducing effects, including fasting[185], the Mediterranean diet[186], the Cretan Mediterranean diet[187], vegetarian diet[188,189], and an anti-inflammatory diet[190]. Fasting followed by a period of the Mediterranean diet, the Cretan Mediterranean diet, a vegetarian diet or an anti-inflammatory diet have been shown to have a beneficial effect on RA[191]. A vegan diet is also useful[192]. Several foods are pro-inflammatory, including highly refined flours, gluten, trans- and saturated fatty acids, dairy products, and red meat[193−196.] These may aggravate RA. Some vegetables may worsen RA and include tomatoes, eggplants, and potatoes[197]. Some micronutrients are anti-inflammatory and include long chain omega-3 polyunsaturated fatty acids monounsaturated fatty acids, antioxidants, phytochemicals, flavonoids, vitamin D, fruits with enzymatic proteins such as papain and bromelain, ginger, turmeric, black pepper, green tea, and legumes[198−217]. However, it is not clear if supplementation with these ingredients helps[218−223]. Gout is related to hyperuricemia and dietary factors that increase the latter are harmful[224]. Uric acid-raising foods like alcohol, fructose (fruit juices), meats, organ meats, and seafood, and sugar intake (including sugar-sweetened beverages) should be reduced[225−227]. Beneficial products in diet are low-fat dairy products, soy, and vitamin C[228]. Coffee consumption may decrease the risk of gout[229]. Both the DASH diet[230] and the Mediterranean diet[231] may help prevent gout or reduce gout attacks.

3 | CONCLUSION

A healthy diet is rich in plant-based foods, including fresh fruits and vegetables, whole grains, legumes, seeds, and nuts, and lower in animal-based foods, particularly saturated fat-laden red meat, and processed meats. Sugar-sweetened beverages are health harmful. Coffee, tea, and olive oil are plant-based and healthy. Alcohol is a double-edged sword and is harmful if consumed in more than moderate amounts. Dietary and other lifestyle modifications are expected to reduce NCD-related morality by 25% by the year 2025[232].

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