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Review Article
Vegetarian Diet: Health Implications and Nutrients' Adequacy

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Abstract

Vegetarian diets that exclude meat, fish and poultry and/or egg and dairy products, are based on grains, fruits, vegetables, legumes and seeds. Vegetarian diets are often varied in composition, involving a wide range of dietary practices and individual dietary restrictions. Vegetarian dietary patterns have been reported to be associated with several favorable health outcomes in epidemiological studies. There is good evidence for the protective effects of a vegetarian diet on lipid profile, blood pressure, fasting blood sugar, blood insulin and C-reactive protein (CRP). Vegetarian diets typically contain large amounts of antioxidant micronutrients (such as vitamins C and E, phytochemicals and fiber) which may improve inflammatory processes and decrease circulatory levels of inflammatory biomarkers, thereby reduce the risk of chronic diseases. Few comprehensive reviews have addressed the effect of a vegetarian diet on preventing diet-related diseases and its nutrients adequacy for all life stages. Therefore, this review aimed to explore the impact of a vegetarian diet on health outcomes. Additionally, the adequacy of the nutrients of these vegetarian diets (energy, protein, ω-3 fatty acids, iron, zinc, calcium, vitamin D and vitamin B_{12}) in different stages of the life-cycle was also discussed.

Key words: Vegetarian diets, nutritional status, biochemical markers, chronic disease, health implications

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INTRODUCTION

DEFINITIONS AND TYPES OF VEGETARIAN DIETS

There are numerous variations of a plant-based diet; vegetarian diets are completely devoid of red or white meat[1]. Some vegetarian diets are restricted to plant products (plant-based) only such as a vegan diet that omits all animal products from the diet; fruitarian that includes processed or cooked foods but in minimum quantity and raw vegan which includes vegetables, fruit, nuts, seeds, legumes and sprouted grains[1]. Other vegetarian diets include eggs and/or dairy products or both are classified as ovo vegetarian who does not eat meat or dairy products but eats eggs[2], lacto-vegetarian who does not eat eggs but eats dairy products[2], while lacto-ovo vegetarian diet excludes all meat but includes eggs and dairy products. Lacto-ovo-vegetarian diet includes dairy and egg products, it is a less restrictive diet with more food choices than a vegan diet and more calorie-dense, so it is considered as the best diet for optimal child growth[3].

Macrobiotic diet excludes all meat, poultry, dairy products and eggs but at initial levels may include fish[1]. Pescetarian diet excludes red meat and poultry but includes fish (although factory-farmed fish are usually avoided)[1]. "Flexitarian" or "Semi-vegetarian" is a newly introduced term for those who mostly eat a vegetarian diet but occasionally eat meat; they have given up red meat due to health problems and only eat free-range or organic animals and animal products[1].

REASONS FOR FOLLOWING VEGETARIAN DIETS

A vegetarian diet may be adopted for various reasons such as distaste of eating flesh[4], food beliefs and peer and/or family influences[5]. Some vegetarians avoid meat to derive certain health benefits or to lose weight[6,7], while some vegetarians do not eat meat for ethical reasons, they believe that it is morally wrong to kill animals for food[8]. Environmental and ecological impacts are other reasons for avoiding meat and animal products[9] and some people are allergic to both dairy products and lactose[10].

Abstinence from the consumption of meat and animal products is one of some religious practices including Buddhism and Seventh Day Adventism[11]. In many cultures, diet is perceived as essential to good health and longevity, while poor diet is associated with lower levels of health and even specific diseases[4]. People who followed a vegetarian diet and healthy lifestyle claim that a plant-based diet is a cheap, healthy and safe approach for the prevention and possible management of modern lifestyle diseases[12].

PREVALENCE OF VEGETARIANISM

Vegetarianism and veganism are increasingly acquiring popularity in the western world[13]. The prevalence of vegetarianism varies widely around the world[14]. India has the highest proportion of vegetarians as compared to other countries with about 30% of the population adopting a vegetarian diet[14]. About 4.3 to 10% of the population in Germany is estimated to be vegetarians, whereas the number of vegans is estimated at 1.6%[13]. Switzerland, Italy, Austria and the United Kingdom show a similar number of vegetarians as Germany at 9-11%[13]. About 3% of American adults are vegetarians or vegans according to a nationwide poll[15].

HEALTH IMPLICATIONS OF VEGETARIAN DIETS

In the last 50 years, the health effects of vegetarian diets have been studied with a more scientific view[16]. Early studies often focused on examining vegetarians for possible nutrients deficiencies and the focus has been expanded to evaluate possible health benefits of these long-standing real-world dietary patterns[16].

Obesity and overweight: In observational studies, people who follow a plant-based diet show lower body weight compared to persons following other dietary patterns[17], suggesting that a plant-based diet may be useful for preventing or treating weight problems[17]. A healthy body weight is associated with improved cardiovascular function and insulin sensitivity[18], as well as reducing the risk of other chronic diseases[2]. Plant-based dietary patterns were found to be associated with lower BMI[2]. In the Adventist Health Study-2, average BMI was highest (28.8 $kg\ m^{-2}$) in non-vegetarians and lowest in those who avoided all animal products (23.6 $kg\ m^{-2}$)[19]. Research indicates that the therapeutic use of a vegetarian diet is effective for treating overweight and may perform better than an alternative non-vegetarian diet for the same purpose[2].

Non-communicable diet-related diseases: In developed and some developing countries such as middle-eastern countries, the epidemiologic transition is characterized by an increase in non-communicable diseases (NCD), such as cardiovascular diseases (CVD), diabetes mellitus and obesity. Vegetarians consume smaller amounts of total fat and saturated fat and larger amounts of unsaturated fats and fiber than non-vegetarians[10]. There is convincing evidence that vegetarians have lower rates of coronary heart disease (largely explained by low LDL cholesterol), hypertension and diabetes mellitus and lower prevalence of obesity[20]. Additionally, cancer rates among vegetarians appear to be moderately lower than others living in the same communities and life expectancy appears to be greater[20].

The consumption of a vegetarian diet is believed to decrease the risk of CVD[20]. In the Adventist Health Study-2 of 73,308 Seventh-day Adventists, researchers found that vegetarians had a 13 and 19% decreased risk for developing CVD and ischemic heart Disease[16]. A case-control study conducted in Jordan showed consumption of some fruit and vegetable could be considered as a protective factor against developing CVD[21]. Additionally, a vegetarian diet improves several modifiable heart disease risk factors, including abdominal obesity[22], blood pressure[23], serum lipid profile[24] and blood glucose[25]. A case-control study has been performed by Tayyem *et al.*[26] to detect the association between dietary patterns and metabolic syndrome. The authors reported a protective effect of the Mediterranean diet (which is loaded with fruits, vegetables and legumes) against the development of metabolic syndrome. Vegetarian diet also decreases markers of inflammation such as C-reactive protein, reduces oxidative stress and protects against atherosclerotic plaque formation[27]. Consequently, vegetarians have reduced the risk of developing and dying from ischemic heart disease[16,28].

Epidemiologic studies have consistently shown that a regular consumption of fruit, vegetables, legumes, or whole grains is associated with a reduced risk of certain cancers[2,29,30]. A vast array of phytochemicals, such as sulforaphane, ferulic acid, genistein, indole-3-carbinol, curcumin, epigallocatechin-3-gallate, diallyl disulfide, resveratrol, lycopene and quercetin found in vegetables, legumes, fruits, spices and whole grains may protect against cancer[31]. These phytochemicals are known to interfere with several cellular processes involved in the progression of cancer[32].

Vegetarian diet is associated with several factors that promote bone health, including high intakes of vegetables and fruits; an abundant supply of magnesium, potassium, vitamin K, vitamin C and a relatively low acid load[33]. Conversely, they can compromise bone health when their component is low in calcium, vitamin D, vitamin B_{12} and protein[33]. EPIC-Oxford reported a 30% increase in fractured risk of vegans as a group but no increase in fracture risk in lacto-ovo-vegetarians compared to non-vegetarians[33]. Inadequate intakes of vitamins D and B_{12} have been linked to low bone mineral density, increased fracture risk and developing osteoporosis[33]. To achieve and maintain excellent bone health, vegetarians and vegans are well-advised to meet the RDA of all nutrients, particularly calcium, vitamin D, vitamin B_{12} and protein and to consume generous servings of vegetables and fruits[33].

Fasting blood glucose and vegetarian diet: Vegetarian diets have been studied over the past few decades for their preventative and therapeutic effects on diabetes that might be more beneficial than medication for diabetes management[34]. Additionally, interventional studies have shown that following a vegetarian diet is an effective method in glycemic control and that this diet control plasma glucose to a greater level than do control diet, including diets traditionally recommended for patients with diabetes (e.g., diets based on carbohydrate counting)[35]. Studies indicate that a vegetarian diet can be universally used in type 2 diabetes prevention and as a way to improve blood glucose management[35].

Lipid profile and vegetarian diet: Plasma total cholesterol is lower in vegetarians as compared to non-vegetarians, primarily due to a reduction in LDL cholesterol, with little difference in HDL cholesterol[36]. This difference in plasma cholesterol is likely to be largely due to differences in animal fat intake since meat is a rich source of saturated fatty acid whereas some plant foods such as vegetable oils, nuts and seeds are rich sources of polyunsaturated fatty acid[37].

Serum vitamin B_{12} and vegetarian diet: Individuals who follow a vegetarian diet are at risk of developing vitamin B_{12} deficiency due to suboptimal intake of this vital vitamin[38]. Vitamin B_{12} is essential for the synthesis of nucleic acids, erythrocytes and in the maintenance of myelin[38]. De ciency may result in a variety of symptoms some of them may be severe while others may be irreversible[38]. Reduced consumption of cobalamin from food or impaired intestinal absorption leads to severe deficiency when tissue stores of the vitamin are depleted[39].

Early symptoms of a severe B_{12} deficiency are unusual fatigue, tingling in the fingers or toes, poor cognition, poor digestion and failure to thrive in small children[38]. Additionally, subclinical B_{12} deficiency may result in elevated homocysteine. If folic acid intake is high, hematological symptoms of vitamin B_{12} deficiency may be masked and go undetected until neurological symptoms are manifested[40]. Laboratory tests, that are used if there are concerns about vitamin B_{12} status, include serum methylmalonic acid, serum or plasma B_{12} and serum holo-transcobalamin (Holo-TC or Holo-TCII)[41].

Inflammatory biomarkers and vegetarian diet: The vegetarian diet contains different anti-inflammatory components. Lower serum concentrations of inflammatory biomarkers among vegetarians compared to non-vegetarians have been reported by Haghighatdoost *et al.*[42]. The authors declared that a vegetarian diet substantially can alter fecal ora which may play an important role in the inflammatory response[42].

Fruits and vegetables are known as dietary sources of salicylic acid which is considered an active ingredient of anti-inflammatory medications[42]. Further, fruits and vegetables may modulate gut microbiota via dietary fiber[42]. The ratio of the anti-inflammatory bacterium, *Faecalibacterium prausnitzii*, is higher in vegetarian diets[43]. The cytokines and C-reactive protein are biomarkers with pro-inflammatory or anti-inflammatory properties, or both[44]. Inflammatory biomarkers are influenced by genetic, environmental and/or lifestyle factors, among which diet is thought to be particularly influential[44].

A vegetarian diet generally contains higher amounts of foods that are thought to be anti-inflammatory such as those of plant origin and somewhat lower amounts of inflammation-related foods such as fried foods, white bread and meats which are abundant in Western diets[44]. The relationship between C-reactive protein (CRP) and vegetarian diet depends on the particular population and study design[45]. Most of the available evidence regarding vegetarianism and chronic inflammation comes from observational studies and their results are conflicting[42]. While Haghighatdoost *et al.*[42] reported lower levels of inflammation in vegetarians, Lee *et al.*[46] did not find any significant difference between groups and reported greater levels of inflammatory markers (e.g. IL-6 and hs-CRP) in vegetarians.

NUTRIENTS CONSIDERATIONS FOR VEGETARIANS

In the Dietary Guidelines for Americans (2015-2020), vegetarian diets are recommended as one of three healthful dietary patterns and meal plans are provided for those who follow lacto-ovo-vegetarian and vegan diets[47]. The nutrients of concern in the diet of vegetarians include vitamin B_{12}, vitamin D, ω-3 fatty acids, calcium, iron and zinc; although a vegetarian diet can meet current recommendations for all of these nutrients, the use of supplements and fortified foods provide a useful shield against nutrientdeficiency[3].

Energy intake: Previously various studies have indicated differences in nutrients intake in vegetarians and vegans as compared to non-vegetarians[48,49]. Nevertheless, total energy intake does not seem to differ significantly but the contribution of proteins (total energy intake) was lower in the non-meat-eating diet groups[48]. Total fat intake, expressed as a percentage of total energy, was lowest in vegans and highest in non-vegetarians[48].

Protein intake: A variety of plant foods supplies protein and essential amino acids and meet the energy and nutrients need[2].The consistent and regular use of legumes and soy products could ensure an adequate protein intake for the vegetarian, as well as providing other essential nutrients[2,49]. Protein needs at all ages, including those for athletes, can be well achieved by balanced vegetarian diets[2].

ω-3 fatty acids intake: Craig and Mangels[10] reported that n-6 fatty acids are high in vegetarian diets. However, ω-3 fatty acids are low in vegetarian diets. Diets that do not include fish, eggs, or generous amounts of algae are generally low in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), fatty acids are important for cardiovascular health as well as eye and brain development[10]. Intake of linolenic acid (ALA) is similar in vegetarians and non-vegetarians, dietary intakes of the long-chain ω-3 fatty acids, EPA and DHA are lower in vegetarians and typically absent in vegans compared with non-vegetarians[50]. Additionally, blood and tissue had lower levels of EPA and DHA[15]. The clinical relation of reduced EPA and DHA status among vegetarians and vegans is unknown[50].

Iron intake: Iron intake among vegetarians is often slightly higher than those of the non-vegetarians[2]. Despite having similar iron intakes, the iron stores among vegetarians are typically lower those of non-vegetarians[2]. Non-heme iron absorption depends on physiological needs and is regulated in part by iron stores. Its absorption varies greatly, depending on both the meal composition and the iron status of the individual. Bioavailability of non-heme iron is impacted by the ratio of inhibitors, such as phytates and polyphenolics and enhancers, such as vitamin C, citric acid and other organic acids[2]. Although vegetarian adults have lower iron stores than non-vegetarians, their serum ferritin levels are usually within the normal range[2].

Zinc intake: Because phytate binds zinc and animal protein enhance zinc absorption, total zinc bioavailability appears to be lower in vegetarian diets[2]. Compared with non-vegetarian control groups, Foster *et al.*[51] showed that adult vegetarians have similar or somewhat lower dietary zinc intakes and serum zinc concentrations that were lower but within the normal range. Food preparation techniques, such as soaking and sprouting beans, grains, nuts and seeds, as well as leavening bread, can reduce the binding of zinc by phytic acid and increase zinc bioavailability[52]. Acids, such as citric acid, also can enhance zinc absorption to some extent[52].

Calcium intake: Calcium intake for lacto-ovo vegetarians typically meet or exceed recommended value while calcium intakes of vegans vary widely and sometimes fall below the recommendations[2]. Bioavailability of calcium from plant foods, which is related to the oxalate content of foods and a lesser degree, phytate and fiber, is an important consideration[53]. Oxalates present in some foods can greatly reduce calcium absorption, so vegetables such as spinach, beet greens and Swiss chard that are very high in these compounds, are not good sources of usable calcium despite their high calcium content. Phytate may also inhibit calcium absorption. However, some foods with high contents of both phytate and oxalate, such as soy foods, still provide well-absorbed calcium[54].

Vitamin D intake: Vitamin D not only maintain the bone health but also plays an important role in immune function, the reduction of inflammation and reducing the risk of chronic diseases[40]. Many genes encoding proteins that regulate cell proliferation, differentiation and apoptosis are modulated in part by vitamin D[55]. Adequate vitamin D intake is essential since all tissues in the body have a vitamin D receptor and respond to its active form, (1,25-dihydroxyvitamin D_3)[55]. Vitamin D status depends on sunlight exposure and intake of vitamin D fortified foods or supplements[55]. The production of vitamin Dis dependent on several factors such as the time of day, season, latitude, air pollution, skin pigmentation, sunscreen use, amount of clothing covering the skin and age[33,55].

Low intake of vitamin D and plasma or serum 25-hydroxy vitamin D levels has been reported in some vegan vegetarians, especially when the blood was collected in the winter or spring and especially in those living at high latitudes[33]. Dietary and supplemental sources of vitamin D are commonly needed to meet the nutrient requirements[2]. Cow's milk, some non-dairy milks, fruit juices, breakfast cereals and margarines are fortified with vitamin D. Eggs also provide some vitamin D[33]. Both vitamin D_2 and vitamin D_3 are used in supplements and to fortify foods. Vitamin D_3 (cholecalciferol) may be of plant or animal origin, while vitamin D_2 (ergocalciferol) is produced from the ultraviolet irradiation of ergosterol from yeast[33]. At low doses, vitamin D_2 and vitamin D_3 appear to be equally effective but at higher doses, vitamin D_2 appears to be less effective than vitamin D_3[33]. If sun exposure and intake of fortified foods are insufficient, vitamin D supplements are recommended, especially for older adults[33,55].

Vitamin B_{12} intake: Vitamin B_{12} is found naturally in meat and animal products[38]. It contains a corrin ring with mineral cobalt[38]. Physiologic functions of vitamin B_{12} include erythropoiesis, the synthesis and maintenance of the myelin sheath and the synthesis of nucleic acid (DNA)[38]. Lacto-ovo-vegetarians can obtain adequate amount of vitamin B_{12} from1 dairy foods, eggs, fortified foods and supplements if regularly consumed[10]. The vegans should eat foods high in vitamin B_{12}, such as fortified soy and rice beverages, some breakfast cereals and meat analogs, or Red Star Vegetarian Support Formula nutritional yeast; otherwise, a daily vitamin B_{12} supplement is needed[10]. Unfortified plant food doesn't contain significant amount of vitamin B_{12}[10]. Fermented soy products cannot be considered as a reliable source of active B_{12}[10].

B_{12} are absorbed via an active process that requires an intrinsic factor. Because the intrinsic factor becomes saturated at about half the RDA, B_{12} absorption requires 4-6 h[2]. Hence, One of the best ways to get enough vitamin B_{12} is to eat fortified foods at least twice a day[2]. A second absorption mechanism is a passive diffusion at a rate of 1%, allowing less frequent consumption of large supplemental doses[2].

Recommendations based on large doses have been made (eg, 500 to 1,000 mg cyanocobalamin several times per week)[2]. There are four forms of B_{12} (Adenosylcobalamin, Cyanocobalamin, Hydroxocobalamin and Methylcobalamin). Cyanocobalamin is the form of B_{12} that is the most commonly used in fortified foods and supplements because of its stability. Methylcobalamin and adenosylcobalamin are forms used in the body's enzymatic reactions; these are available in the form of supplements which are no more effective than cyanocobalamin and may require higher doses than the RDA. Hydroxocobalamin is used effectively in injections form[56]. Many individuals who adhere to vegetarian diets and do not use vitamin B_{12} supplements can develop vitamin B_{12} deficiency; regardless of the type of vegetarian diet, they consume[57].

VEGETARIAN DIETS THROUGHOUT LIFE CYCLE

Health professionals do not have complete and exhaustive knowledge about vegetarian diets and lack information on health outcomes and the adoption of a vegetarian diet throughout the different life cycles and nutrients[58]. Nutritional deficiencies may cause serious and irreversible health issues which creates difference of opinion about the appropriateness of vegetarian diets during all phases of an individual's life[59].

The American Dietetic Association and the Academy of Nutrition and Dietetics stated that well-planned vegetarian diets are nutritionally sufficient and meet the nutrients requirements and promote normal growth in all stages of the life cycle, including pregnancy and lactation, infancy, childhood, adolescence and older adulthood[60]. In contrast, the German Nutrition Society and the European Society for Pediatric Gastroenterology Hepatology and Nutrition advised that such dietary patterns could be catastrophic for child growth[61,62].

Pregnancy and lactation: Pregnancy is a delicate time in a woman's life. Appropriate maternal energy intake is important to prevent poor pregnancy outcomes and for physiological growth of the fetus. In recent years, this factor has been tied to birth weight, which is an indicator of the infant health status and predicts future health of infants[63].

During pregnancy, the woman should take all the required macronutrients and micronutrients to meet her energy needs and for fetal health[59]. Therefore, if the pregnant woman wants to adopt a plant-based diet, she must be aware of the possible risks of nutrientsdeficiencies[59]. There is increased risk of nutrients deficiency, such as iron, zinc, vitamin D, vitamin B_{12}, iodine, proteins and ω-3 fatty acids, if the pregnant mother consumes only vegetarian diet[58]. The vegetarian diet is not appropriately planned and balanced. This issue has been underlined by several scientific societies, particularly with regard to the promotion of children's neuropsychomotor development[59].

Vitamin B_{12} deficiency can lead to anemia and neurological disorders. Vitamin B_{12} deficiency have been reported in infants of vegan mothers who strictly adopt vegetarian diet and/or with limited access to foods of animal origin[59]. A previous study showed that where food access is adequate, pregnancy outcomes of vegetarian mothers, such as birth weight and pregnancy duration, were similar to those in non-vegetarian pregnant mothers[64]. Melina *et al.*[2] reported that the use of a vegetarian diet in the first trimester resulted in a lower risk of excessive gestational weight gain. A maternal diet high in plant-derived foods may decrease the risk of pregnancy complications, such as gestational diabetes[65]. The American Dietetic Association[60] stated that appropriately planned vegan, lacto-vegetarian and lacto-ovo-vegetarian diets may result in positive maternal and infant health outcomes. However, in practice, balancing of diet without necessary experience or nutritional knowledge is very difficult. The main difference in the composition of vegetarian mothers' milk compared to non-vegetarians' is the lower content of docosahexaenoic acid and higher content of Linoleic and α-Linolenic acid[66].

Infancy and childhood: The European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) recommends a careful evaluation of potential B_{12} deficiency. The lack of adequate nutritional intake or supplement of B_{12} is found to be associated with severe neurological consequences[62]. Many vegetarians are young parents who decide to share their dietary patterns with their children[58]. People are not adequately educated and they do not know the negative effects of inappropriate diets and thus they follow a diet because of fashion or ethical issues related to animal welfare[58].

Health professionals who look after pregnant women, newborns and children should provide the proper nutritional education to their patients to avoid nutritional imbalances[67]. A previous study reported that vitamin B_{12} deficient mothers gave birth to an infant with neurological defect[68]. Vitamin B_{12} deficiency has also been linked to long-term neurological disturbances such as an increased risk of adulthood depression in babies born to vegan or vegetarian mothers[69]. These outcomes show the significant nexus between maternal nutrition during pregnancy and fetal programming[69]. Exclusive breastfeeding is recommended for the first 6 months[70]. If breastfeeding is not possible, commercial infant formula milk should be used as the primary beverage for the first year[2]. Complementary foods should be rich in energy, protein, iron and zinc and may include hummus, tofu, well-cooked legumes and mashed avocado[2]. Full-fat, fortified soy milk or dairy milk can be started as early as one year of age for toddlers who are growing normally and eating a variety of foods[71].

Average protein intake of children who consume vegetarian diet generally may meet or exceed its recommended level[2]. Need of protein for vegan children may be slightly higher than those of non-vegan children because of differences in protein digestibility and amino acid composition[2].

Elderly: The nutritional profiles of older adults consuming vegetarian diets is reviewed and specific recommendations are made for their diets[72]. Generally, the results of following vegetarian diet in older adults go in track of those in younger vegetarians. Though, following the vegetarian diet presents many favorable nutritional characteristics, concerns regarding the potential weaknesses in certain vegetarian diets still remain, especially vitamin B_{12}, calcium, protein and zinc[72].

Caloric needs generally decrease while some nutrients need increase with age; thus, all older people must choose nutrient-dense diets[72].

Protein is used less efficiently in older adults and need to increase its intake to maintain muscle mass and strength and bone health[72]. Older adult vegetarians and vegans need to include protein-rich foods such as legumes and soy foods in their diets. Meat analogs contained a good supply of protein[2]. Older people synthesize vitamin D less efficiently and are recommended to consume its supplements. Older adults can meet their nutritional requirements more easily from fortified foods such as fortified plant-milks and cereals[2]. Also, the requirement for vitamin B-6 increases with aging and may be higher than the current RDAs for older people[2]. Atrophic gastritis is common among older adults and can result in decreased absorption of vitamin B_{12} from animal products. Therefore, older people require vitamin B_{12} supplements[2].

CONCLUSION

Vegetarian diets are usually low in fat, particularly saturated fat and high in fiber. They are also likely to include more legumes, whole grains, nuts and fruits and vegetables and lack of most types of meat, which may provide many benefits for the prevention and treatment of obesity and chronic health problems, including diabetes and cardiovascular disease. Although a well-planned vegetarian diet can meet all the nutritional needs of an individual. Additionally, the vegetarian diet and plant-based eating pattern exert a beneficial effect on lipid profile, blood glucose and other biochemical parameters.

SUGGESTIONS FOR FUTURE RESEARCH

A cohort study is warranted to investigate the effect of a vegetarian diet on health in the long-term among the developing countries. Cultural and socioeconomic differences among vegetarian populations should be studied to assess nutrients adequacy and their effects in reducing the risk of developing chronic diseases related to diet.

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