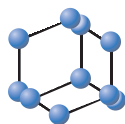


REVIEW ARTICLE

BENTHAM
SCIENCE

DASH Dietary Pattern: A Treatment for Non-communicable Diseases



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ARTICLE HISTORY

Received: June 14, 2019
Revised: August 23, 2019
Accepted: August 26, 2019

DOI:
10.2174/1573402115666191007144608



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Abstract: Non-communicable diseases are the major inducer of mortality and morbidity in the Western world. In terms of nutrition, a diet high in fat (particularly saturated fat), salt and sugars have shown to be associated with innumerable incidence of diet-associated health diseases. Dietary modification is a central part of any treatment strategy. The Dietary Approach to Stop Hypertension (DASH) diet is one among such healthy dietary patterns, which emphasizes on the consumption of fruits, vegetables and low-fat dairy foods, including whole grains, poultry, fish, and small quantities of red meat, sweets and drinks containing sugar. This study provides certain practical evidence that prolonged adoption of DASH diet which can be a useful treatment for numerous non-communicable diseases with a sustained effect on the health that involves both accessibility and proximity to healthy eating choices. Long-term studies are required to assess whether these effects are maintained over time.

Keywords: DASH diet, non-communicable diseases, treatment, dietary modification, hypertension, health.

1. INTRODUCTION

Cardiovascular diseases (CVDs) have become one of the leading causes of deaths worldwide especially among low-income countries like India where CVDs have reported to account approximately 52 percent of the total death annually as compared with the people of European ancestry [1]. CVDs are a diverse class of diseases that include coronary heart diseases, hypertension, Ischemic Heart Disease (IHD), stroke and heart failure *etc.*, which is the leading cause of mortality among Iranian population dominated by IHD and stroke [2]. The major risk factors associated with CVDs are dyslipidemia, inflammation, oxidative stress and tobacco [1, 2]. Sedentary lifestyle and changing food habits have resulted in low consumption of fruits and vegetables and is regarded as a significant factor for widespread prevalence of CVDs and is contrary to the fact of vegetarian food habits among different population. The reason thus quoted is that the population with low socioeconomic strata is more susceptible to get affected by CVDs as such people are unable to incorporate fruits and vegetables in their daily diet due to its high cost. Moreover, due to traditional cooking methods usually the food is overcooked which causes the loss of essential micronutrients. Further, overconsumption of energy

dense foods *i.e.*, fried food, sausages, sweets and drinking soda on regular basis can significantly increase the recommended intake levels of many dietary substances, which further aggravates the problem [3]. Hypertension increases the risk of a variety of cardiovascular diseases that can lead to several other health problems, such as congestive heart failure, kidney disorder, blindness, and increased blood pressure ($\geq 140/90$ mmHg) which in normal range as systolic and diastolic blood pressure should be less than 120 and 80 mmHg, respectively [4]. This condition of elevated blood pressure is referred to as hypertension [5] and nearly 25-30% of urban and 10-20% rural population in India have been reported to suffer from hypertension and a large proportion of deaths and disability have been reported worldwide [6].

The major risk factors associated with the occurrence of CVDs include tobacco use, diabetes, abnormal cholesterol levels, obesity as well as physical inactivity or sedentary lifestyle. Hypertension can be controlled or prevented by managing all these parameters and also by following a healthy diet plan or the DASH (Dietary approach to stop hypertension) diet [5, 7]. The DASH diet is a specially proposed dietary pattern promoted by the U.S. based National Heart, Lung, and Blood Institute (part of the National Institutes of Health (NIH), United States Department of Health and Human Services) in order to prevent/control hypertension [8]. The diet consists of a lot of fruits and vegetables combined with low fat dairy products with diminished satu-

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rated and total fat content and low level of cholesterol with a fair amount of whole grains, nuts, poultry and fish [9]. Usually, red meat, sweets and sugar-containing beverages are exempted from DASH diet and are enriched with potassium, magnesium, calcium and fiber with excess of antioxidants. Such diets have been reported to reduce systolic B.P. by 5.5 mmHg and diastolic B.P. by 3mmHg [2]. DASH diet with minor modification in daily food items not only meets the daily nutritional requirements of an individual but also assist in various regulatory processes with some functional benefits like weight loss [5].

Haghighatdoost *et al.* [2] reported DASH diet has the ability to provide the feeling of satiety and being healthy, it can be adopted for the whole life. They further reported that it is an effective way to improve and manage various factors in metabolic syndrome (B.P., lipid levels and insulin resistance) due to its rich nutritional profile *i.e.*, high calcium, magnesium and fiber with a relatively very low amount of saturated fat and balanced with the right amount of protein. The effect imparted by the modification of traditional food consumption pattern by DASH diet on our body is the same as what expensive prescription medicines does. The interventions in the study included changes in the intake level of oil (which should not exceed 16ml per capita), sugar (should not exceed 10% of the daily calorie intake) and salt (less than 5 g of salt/day) [10] as recommended by the WHO [4]. Even if the reduction in the mean per capita intake of these food items is inadequate, this reduction is sufficient to improve many conditions linked to risk factors for hypertension, such as dyslipidemia and glucose intolerance [10].

Despite having numerous known health benefits, the diet of the majority of individuals doesn't confirm the incorporation of all these natural food ingredients in their food due to various barriers. The reasons behind the non-adherence to DASH diet include cultural preferences of people, limited availability, lack of time for preparing DASH meals and higher cost of DASH food ingredients, which cannot be afforded by under-resourced population [11]. The reversal of risk factors leading to the progression of CVDs, effective implementation of evidence-based policies, providing optimal therapy to low socioeconomic groups and reinforcement of health systems would surely help to counteract this epidemic [1]. Different researchers have made appreciable efforts to document the different components of DASH diets and their health benefits. However, the acceptability of these diets is very low because of certain disadvantages /limitations/ barriers, and thus lacks its identity in the health food industry. Therefore, the need of the present era is to educate the consumers and readers about the DASH diet and its relation to our health. To fulfill this research gap, the present review has been aimed to attract the researchers and consumers.

2. METHODOLOGY

The main aim of the literature searching strategy was to explore the recent trend of the research, undergoing in the field of the DASH diets, used as treatment/prevention strategy for non-communicable diseases. A wide variety of the relevant publications were identified by searching over the

electronic databases (Science direct, PubMed, SciELO, Google scholar, Link springer and Research gate) on the basis of different descriptors *i.e.* DASH diet, non-communicable diseases, treatment, dietary modifications. Furthermore, cross-references to the selected manuscript were also taken into consideration through electronic search engines. Manual literature search was done through books, thesis, *etc.* to collect the desired information. Throughout the research process, documents that focus beyond the desired keywords from the title of this manuscript were excluded by evaluating the abstract and the body of the manuscript. After searching the relevant literature, 68 research and review papers were studied which provided the glimpse of the different descriptors under study. Information regarding the proved clinical benefits of DASH diet is tabulated in Table 1 to provide the overview to the readers. Main barriers in the implementation of DASH diet have been tabulated in Table 2. The data presented in the tables, as well as the text, have been verified and reviewed by all the authors to maintain the accuracy in terms of citations and language. The review collected was expressed in the following titles and subtitles.

3. DASH DIET AND NON-COMMUNICABLE DISEASES/ DISORDERS

DASH diet has witnessed the cure or prevention of numerous diseases. These proven health benefits include lowering the blood pressure, plasma triglyceride and VLDL concentrations, type 1 diabetes and type 2 diabetes, as well as improvement of bone mineral status *etc.* A brief detail of the DASH diet in relation to non-communicable diseases/ disorders is presented in Table 1.

3.1. DASH Diet and Bone Health

With a longer life span and a rising elderly population, the prevalence of osteoporosis has increased, significantly contributing to public health problems. DASH diet can be easily manipulated for calcium enrichment with lower acid load owing to the incorporation of fruits, vegetables, and low fat dairy products [16] which ultimately leads to a reduction in bone remodeling [22]. Further, DASH may lead to a reduction in bone turnover and can maintain bone health due to its rich nutritional profile [23]. Moreover, it has been observed that the consumption of numerous phytochemicals influences bone metabolism [24]. A positive correlation between fruit/vegetable intake and Bone Mineral Density (BMD) [25] and negative for bone loss [26] may be partially explained by the calcium-sparing effect of potassium. The high consumption of fruit and vegetables is often correlated to potassium intake and in one of the studies on elderly women with highest urinary potassium excretion, BMD was found to be highest in those cases, which had increased intake of fruits and vegetables [27].

3.2. DASH Diet and Cardiovascular Diseases

Current guidelines on the prevention and treatment of hypertension in addition to drug therapy prominently emphasize on the lifestyle changes [28]. Further, different dietary programs have recommended DASH dietary approaches and low sodium intake to reduce/prevent hypertension [29]. Studies have shown that DASH diet significantly reduced

Table 1. Proved clinical benefits of DASH diet.

S. No.	Country/ University	Total No. of Participants	Significant Findings	Refs.
1.	USA	36	High fat-DASH diet helped in lowering the blood pressure also plasma triglyceride and VLDL concentrations reduced significantly without increasing overall LDL cholesterol.	[12]
2.	USA	797	Increased consumption of DASH diet significantly decreased HbA1c levels among youth having type 1 diabetes and systolic blood pressure among youth with type 2 diabetes was also reduced.	[13]
3.	USA	144	Among overweight or obese patients possessing higher BP, DASH diet when combined with balanced diet and exercise resulted in even larger BP reductions, improvements in vascular and autonomic function, and decreased left ventricular mass.	[14]
4.	USA	53	Greater improvements in Cognitive Representations of the DASH Diet (CRDDs) scores was observed among the population and were significantly more compliant with the diet.	[15]
5.	England	186	The DASH diet was helpful in reducing bone turnover and when sustained may improve bone mineral status. Monitored sodium intake reduced calcium excretion which supported that DASH diet and reduced sodium intake may have complementary, beneficial effects on bone health.	[16]
7.	England	88,517	Longer adherence to the DASH-style diet was helpful in lowering the risk of (coronary heart disease) and stroke among middle aged women during 24 years of follow-up.	[17]
8.	Europe	74,404	Findings indicated that high adherence DASH diet along with regular physical activity reduced the risk for ischemic stroke.	[18]
9.	Iran	1291	DASH diet is helpful in achieving a significant greater weight loss compared with the individuals assigned to control group particularly among the individuals those adhered for the longer period of time.	[19]
10.	England	412	Studies suggest that overall effect of reduced sodium intake (to levels below the current recommendation of 100 mmol per day) and the DASH diet in combination gave better result rather than altering them singly on blood pressure.	[20]
11.	USA	44444	Among 1731 confirmed cases of gout with 26 years of follow-up, DASH diet adherence documented the greater reduction in such rate.	[21]

systolic and diastolic blood pressure [30] with favorable changes in total cholesterol and LDL and minimum changes in triglycerides with reduced HDL cholesterol *i.e.* reduction in total (-0.35 mmol/L, or -13.7 mg/dL), LDL- (-0.28 mmol/L, or -10.7 mg/dL) and HDL- (-0.09 mmol/L, or -3.7 mg/dL) cholesterol concentrations (all $p < 0.0001$), without significant effects on triacylglycerol [31]. Excess of saturated fatty acids and glucose mediates the association between diet and heart failure, reduces the mechanical performance of heart, with increased myocardial triglyceride content, cardiac hypertrophy and fibrosis and altered mitochondrial function [32, 33]. In addition, several potential physiological effects of DASH diet including estrogenic effects of phytochemicals and the reduction of oxidative stress [34] have also been reported in the literature and often correlated to the reduced risk of cardiovascular disease. A better improvement for DASH plus weight management compared with DASH alone was witnessed in another clinical study where a significant reduction in BP was observed by 16.1/9.9 mm Hg (DASH plus weight management); 11.2/7.5 mm (DASH alone) [35]. There has been increasing evidence in recent years that supports the role of nutrition in Alzheimer's Disease (AD) [36]. Reducing the oxidative stress is considered to play a key role in dealing with AD [37]. The number of diseases is projected to reach 106.8 million by 2050 [36]. Smith *et al.*, [38] carried out a study as a randomized controlled trial among 124

participants with elevated blood pressure and concluded that DASH diet when combined with aerobic exercise and caloric restriction improves neurocognitive functions.

3.3. DASH Diet and Risk for Kidney Damage

Adherence to the DASH diet has been associated with a lower risk of kidney damage particularly the decline in glomerular filtration rate [39]. There is a clear evidence in humans [40] that salt loading increases renal vascular resistance, reduces renal plasma flow with subsequent increase in capillary glomerular pressure, which is indirectly controlled by increasing blood pressure while, the adverse effects of high salt concentrations have been observed much earlier. In general population, there is a correlation between albuminuria and salt intake [41]; and in young individuals, the saline load increases the Glomerular Filtration Rate (GFR) and Effective Renal Plasma Flow (ERPF) and the filtration fraction indicating efficient working of the kidney, even more in individuals with an index of body mass exceeding 25 kg/m [42, 43]. Also, in another study [44] the reduction in kidney stone risk in adherence to DASH diet was reported along with the effects on a number of urinary lithogenic factors including increased calcium content in urine, while a decrease in calcium content was associated with lower animal proteins and higher potassium-rich food consumption [45].

Further, incorporation of fruits and vegetables in DASH diet also increases the urinary citrate, an important inhibitor of calcium stones, with an increase in pH of urine and reduced risk of formation of uric acid crystals [46].

3.4. DASH Diet and Obesity

Obesity and obesity-related comorbidities have become an epidemic in the world (with their global [47] prevalence which have doubled between 1980 and 2008 [48] and it is estimated that by 2030 about 2.116 million adults worldwide will be overweight and 1.12 million will be obese [49]. DASH diet has a positive influence on weight management [50] and has been reported to decrease body weight and waist circumference in patients with metabolic syndrome. Low glycaemic index and low-calorie dense DASH diet (particularly high fiber content) positively stimulate satiety and thus decrease the food intake [51] in an attempt to treat/prevent hypertension. Miller *et al.*, [52] recommended sodium reduction, weight loss, Dietary Approach to Stop Hypertension (DASH) and regular aerobic exercise as a potential management strategy. For 9 weeks, the sample group received a hypocaloric DASH diet with 100 mmol/d sodium and reported a weight loss of about 4.9 kilograms.

3.5. DASH Diet and Diabetes

International diabetes federation estimated 382 million adults with diabetes in 2014 worldwide with a projection of about 592 million by 2035 [53]. Keeping these things in mind investments in prevention and effective management of diabetes has become necessary to combat this global epidemic. Rapid urbanization coupled with economic growth, have led to a shift in the dietary pattern of many countries with increased caloric intake, and decreased overall diet quality [54]. The DASH diet with a low glycemic index and a low energy diet with relatively larger amounts of dietary fiber [55] can be suggested for patients with high blood pressure [56] however, its effects on the metabolic profile of diabetic patients have recently been demonstrated. Improvements in insulin sensitivity have been documented with DASH diet, together with exercise and weight loss in overweight hypertensive patients [14]. A study carried out by Azadbakht *et al.* [57] targeting 31 people with type 2 diabetes following DASH diet for 8 weeks revealed that DASH diet with 2400 mg sodium/day had beneficial effects on glycaemic control, and CVD associated risk factors.

3.6. DASH Diet and Gout

Gout is the most common inflammatory arthritis caused due to high concentration of uric acid in the serum and its prevalence has increased over several decades among adults in the United Kingdom and the United States to 3.2% and 3.9%, respectively [58]. This problem is further complicated by a high level of cardiovascular metabolic co-morbidities [59]. Dietary advice has a great impact on long-term wellbeing of a patient with gout and DASH diet is one of the models associated with a reduction in serum uric acid concentration, while western diet on the other hand, is associated with an increase in uric acid as it contains a good amount of purine [21]. To study the effect of DASH diet on serum uric acid

(SUA) levels, Tang *et al.*, [60] conducted a study in which randomized controlled trial in prehypertensive or hypertensive adults ($n = 103$) was evaluated in 30, 60 and 90 days and demonstrated that DASH diet reduces SUA within 30 days, with a prolonged effect at 90 days.

4. LIMITATIONS OF DASH DIET

Preparing foods with fruits and vegetables takes a little more effort. Moreover, following a diet like DASH can be a bit pricey as fresh fruits, veggies and whole-grain products tend to cost more than processed, fatty and sugary foods. In addition, portion sizes need to be carefully monitored and keeping to the daily sodium recommendation less than 1,500 mg per day for some people can be a challenge. Several features of a DASH-style diet may account for the impact on stone risk as the diet is rich in calcium and increased levels of dietary calcium is associated with an increased risk of kidney stone formation [46]. Oxalates are concentrated in excessive amounts in the DASH-style diet (because of higher intakes of fruits, vegetables, and nuts) that may increase the excretion of oxalates in the urine and may be responsible for calcium oxalate nephrolithiasis [39].

5. SOME BARRIERS IN THE ADOPTION OF DASH DIET

The evidence showing adoption of DASH diet by people with hypertension [61] or even by the general public is limited [62] and the perception that pharmaceutical treatment for hypertension is adequate may be one possible reason [63]. Further, ecological barriers, such as impeded access to supermarkets, availability of fresh commodities, increase in the number of fast-food restaurants and convenience stores [64]. Another important aspect is lack of practicality as DASH is not a commercial diet and is individual specific will not be available in a pre-packaged format to be delivered at the doorstep. Formulating DASH diet requires special considerations with respect to person's medical history, genetic makeup, and previous food habits. Further preparation of DASH diet is more time consuming than other diets [65] and requires a little more efforts. Another reason for its low adoption is its cost, as incorporation of fresh fruit, vegetables and whole products tends to cost more than the processed, fat and sweetened foods. In an attempt to confirm this hypothesis, Franco *et al.*, in 2008 [66] carried out a survey by assessing 226 food stores in Baltimore city, Maryland and found that lower-income communities had a lower availability of healthy foods depending on the affordability of the people residing in the area. Another study was conducted with 9,274 participants aged between 29 and 64 residing in Cambridge shire, in the United Kingdom, to find out the interaction between economic accessibility and proximity of supermarkets and the effect on the acceptability of DASH diet. The study revealed that people with poor economic status did not have access to supermarkets and were likely to render from DASH diet than people with greater economic access. This association was stronger than with geographical accessibility alone [11]. A brief overview of the main barriers, which affect the adoption of DASH diet, is tabulated in Table 2.

Table 2. Main barriers in implementation of DASH diet.

S. No.	Significant Findings	Description	Refs.
1.	Poor availability and quality of healthier food in stores	Subjects expressed a concern with the availability of fruits, vegetables and lean meats that was poor in their neighbourhoods.	[64]
2.	Limited options to eat healthier foods in restaurants	Mostly the restaurants were outlets of fast food chains.	[67]
3.	Cost of healthier foods	The potential cost of preparing the recipes is quite high while adopting DASH dietary pattern.	[65]
4.	Lack of familiarity with DASH menus	Study suggested that a single, generic brochure was not appropriate for all segments of the population as it varies with different body types and levels of physical activity.	[65]
5.	Tension with family members' food preferences	At the interpersonal level within families, adults have to adapt to culturally recognized foods to the idiosyncratic preferences of individuals which binds diverse individuals together into a social unit.	[68]

CONCLUSION

The DASH diet is a lifelong approach to healthy eating and is designed to treat or prevent hypertension by encouraging a reduction in sodium intake and incorporating a variety of fortified foods with nutrients, such as potassium, calcium, and magnesium into our diet. The diet emphasizes the low-fat food sources with a lot of vegetables, fruits and moderate amounts of whole grains, fish, poultry and nuts that meet dietary recommendations to prevent osteoporosis, cancer, heart disease, stroke and diabetes. The geographical considerations and economic status of the target population should be taken into account when considering approaches to promote adherence to healthy diets for the prevention of particular medical condition or management of healthy life by simply changing the food consumption pattern. On the basis of potential of DASH diet in the maintenance of our wellbeing it can be concluded that there is still a heap of opportunities for consideration of this diet in our regular meal plan so that most of the nutraceutical potentials can be used directly in the food. Further research is still required to increase the adoption pattern of DASH diet by the sufferers in particular and masses in general.

CONSENT FOR PUBLICATION

Not applicable.

FUNDING

Lovely Professional University provided the financial assistance to conduct the present study.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The authors are highly grateful to School of Agriculture, Lovely Professional University Phagwara, Punjab, India for providing financial assistance and infrastructure for the preparation of this review.

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