Review Article

A SYSTEMATIC REVIEW ON DIETARY APPROACHES TO STOP HYPERTENSION (DASH) TO CONTROL RAISED BLOOD PRESSURE AMONG HYPERTENSIVE PATIENTS

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Abstract

Introduction: Hypertension is a widely recognized public health problem worldwide. Its further complications lead to cardiovascular diseases, stroke, retinal and renal diseases. DASH diet has been recommended to control raised blood pressure among hypertensive patients. However; limited evidence exists for it in Asian countries. This study aimed to review published research articles on DASH diet for hypertension control.
Methods: Studies on hypertension and DASH diet (N=54) were searched using PubMed Central from 2012 to 2019 including all countries. The search strategy consisted of keywords "hypertension OR raised blood pressure OR blood pressure" and "Dietary Approaches to Stop Hypertension OR DASH diet". Whereas; no limitation was used for searching the literature and further references of the relevant studies were also analyzed. Full text articles of 31 researches were retrieved and analyzed for this review article.
Results: Findings of this review suggests that DASH diet is significantly effective in lowering the blood pressure as well as for prevention of cardiovascular diseases (CVDs). In addition, a low-sodium diet is beneficial for individuals and hypertensive patients in reducing CVD related events. However; evidence suggests that adherence to DASH diet for a longer duration is effective along with lifestyle modifications in the population.
Conclusion: Consuming a DASH diet as recommended can be a useful preventive measure to reduce blood pressure. Country-specific dietary recommendations are thus required. DASH diet along with pharmacological therapy and lifestyle modifications are proven to be effective. Further, longitudinal studies establishing temporal associations between consumption of DASH diet and its effect on blood pressure will be essential for clinical and public health practice.
Keywords: DASH diet, hypertension, blood pressure, DASH dietary pattern.

Introduction

According to World Health Organization (WHO) persistently raised blood pressure is termed as hypertension which is a significant risk factor mainly for heart diseases as well as stroke(1,2).

Worldwide around 1.13 million people suffer from hypertension(1) and in Pakistan approximately 18.9-33% of adults are hypertensive(3,4). Hypertension is a serious condition that eventually results in global deaths from cardiovascular diseases. The Non-Communicable Diseases (NCDs) global targets include reducing prevalence of raised blood pressure to 25% by 2025(5). Cost-effective measures include pharmacological and non-pharmacological therapies to prevent onset of cardiovascular diseases and their complications. Recent guidelines by Joint National Committee (JNC) defines high blood pressure as 140/90 mmHg but unlike JNC guidelines 7, it does not focuses on defining hypertension and pre-hypertension rather it defines goals of pharmacological treatment and selection of antihypertensive drugs(2). Non-pharmacological measures may include counseling, life style modification, weight reduction, regular exercise, reduction in salt intake and dietary changes which can all help to lower the raised blood pressure and reduce related complications among hypertensive patients.

In about 70% of cases, blood pressure tends to be uncontrolled despite of pharmacological treatment among hypertensive patients. Therefore, non-pharmacological measures can be employed in combination or alone with the treatment(6). Although beneficial effects of dietary measures are still unclear, though healthcare professional recommend a "Traditional Mediterranean Diet" or a vegetarian diet to prevent and manage hypertension(7). A Traditional Mediterranean Diet focuses on individuals who consume an increased amount of fruits and vegetables, mono & polyunsaturated fatty acids whereas; a less use of red meat and alcohol in their regular diet(6). Evidence suggests that people consuming a traditional or Mediterranean diet are less likely to show symptoms of cardiovascular diseases and eventually are less prone to develop CVD events(8). Among the dietary recommendations, DASH diet elaborated as "Dietary Approaches to Stop Hypertension" is a gold standard non-pharmaclogical intervention as recommended by the American Society of Hypertension(2,8,9).

The DASH diet is however similar to a typical American diet which is an effective strategy that is based on reduced intake of salt and increased potassium(8). It was designed, recommended and considered as a choice of non-pharmacological measure by American Heart Association and National Institutes of Health (United States) for managing hypertension and protecting the health of individuals(10). However; it was originally developed through research on treating hypertension without pharmacological intervention. This research was funded by US National Institute of Health (NIH) which recommended using fruits, vegetables, nuts & legumes, whole grains and low-fat dairy products. But it restricts excessive use of red meat, cholesterol, sugar, sweets and extra carbs whether in form of beverages in the diet. Further, the diet is mainly aimed to contain calcium, magnesium, potassium which has clinically demonstrated a significant effect on lowering the blood pressure and also on low-density lipoprotein cholesterol (LDL-C)(11,12).

In several researches, DASH diet has been found effective in reducing mortality owing to CVDs, diabetes and preventing progression to heart failure among individuals(13-16). The results of these studies also demonstrated DASH diet to be effective in improving cardiac function, functional capacity and arterial compliance. Proper management of hypertension is thus essential to prevent its complications and to improve quality of life among hypertensive patients(6). We therefore aimed to review published studies to assess the evidence of DASH diet as cardio-protective specifically for hypertension, its management and prevention.

Methodology

For this review, studies on hypertension and DASH diet were systematically searched using PubMed Central from 2012 to 2019. The search strategy consisted of keywords "hypertension OR raised blood pressure OR blood pressure" and "Dietary Approaches to Stop Hypertension OR DASH diet". Whereas; no limitation was used for searching the literature and further references of the relevant studies were also analyzed. Almost fifty four relevant studies were screened and full text articles of 31 researches were retrieved and included in this review (Figure 1). Only two published studies were included from Pakistan that reported consumption of DASH diet in management of hypertension. Inclusion criteria for literature search consisted of published research articles, review article, clinical trial, meta-analysis and systematic reviews. All eligible studies were then exported to Mendeley software version 1.19.4 where repeated studies and duplicate files were removed. Studies were selected on the basis of pre-defined criteria. All articles were screened for their title and abstracts after which full text of the articles were assessed for their relevance. Data analysis was then performed by selecting the study on basis of its relevance to our objective. Finally, reported evidence was synthesized, accumulated and then thematic analysis was conducted to document findings from the selected studies. Identified themes interrelated to DASH diet and hypertension were coded and hence outcomes of interest are reported in this paper.

Results

Effect of DASH diet on blood pressure

A randomized controlled trial (LIFECARE) was carried out among two different cohorts in Malaysian and Philippines populations for one year approximately. Cross-sectional association was examined between the blood pressure and consumption of DASH dietary pattern. Consumption of a DASH diet and its effect on the blood pressure among cohorts was calculated by DASH score which is based on consuming sodium and specific food items. Findings of the trial yielded a significant reduction in the systolic and diastolic blood pressure i.e. SBP (MD= -5.20 mm Hg and DBP (MD = -2.60 mmHg)(12). This study explicated a clinically useful decrease in blood pressure achieved through DASH diet which showed an evident reduction in the SBP. In another study, a higher SBP alone is ascribed to deaths due to stroke (10%) and coronoary heart diseases or other causes (7%) among men and women both(10). Although, the results are inconclusive for diastolic blood pressure for which future RCTs are recommended to assess risk estimates(10). Furthermore, findings of a prospective cohort (over 12 years) has clearly demonstrated a reduced risk of 11% in all-cause mortality among individuals who had a stable diet quality and had better quality score of DASH diet. Also, a 9% of risk was sustained among consumers of high quality DASH diet which shows that better compliance can result in a decrease in CVDs. As hypertension is also an implicated risk factor for diabetes, consuming a DASH diet can result in contributing a beneficial effect on diabetes as well by lowering blood pressure(17). In addition, earlier studies indicate that diet comprising of fruits, vegetables, whole grains, nuts & legumesand dietary fiber help to cause a reduction in HbA1c(18,19).

Similarly; a trial named Exercise and Nutrition Interventions for Cardiovascular Health (ENCORE) revealed that reduction in uncontrolled blood pressure among adults can be achieved by consuming DASH diet and a low sodium intake(20). This study also showed that DASH dietary intervention lowers the blood pressure within two weeks of its initiation(21). Whereas; another study compared the effects of DASH diet among individuals with pre-hypertension or those who are not currently on antihypertensive medications. The findings of this study reported combined effects of consuming a low sodium-DASH diet compared to a high sodium-control diet on systolic blood pressure which showed a significant reduction in the SBP from the baseline was recorded as -5.3, -7.5, -9.7, & -20.8 mmHg ($p<0.001$), respectively(22).

Effect of DASH diet on cardiovascular risk factors & related diseases

Various other studies have also reported useful effect of DASH diet on hypertension as well as on CVD risk factors. An umbrella review of 15 cohort studies which assessed more than 30,000 cardiovascular events, including more than 23,000 events of diabetes and 4413 events of stroke documents significant evidence from trials synthesized from systematic reviews and meta-analyses. The primary outcome of these controlled trials report significant reduction in blood pressure (SBP=-5.2 mmHg) and (DBP=-2.6 mmHg) whereas; a decrease in HbA1c to less than 0.53% was also reported in this study(10). In the Philippines cohort, a significant association between DASH score and CVD risk factors were found(10). DASH score is based on eight components which include high intake of fruits, vegetables, nuts and legumes, whole grains and low intake of sodium/ salt, low-fat dairy products, red meat, sweeteners, beverages and drinks. Unlike research studies, review of available literature elucidates beneficial effect of DASH dietary pattern on cardiovascular health but the estimates remain uncertain(12). In a nationally representative British birth cohort study, results indicated that adherence to DASH diet or similar in adulthood if used on a long term basis can sustain a favorable cardiovascular risk

profile. In addition, long-term adherence to DASH diet can also help to improve vascular functions among hypertensive patients. However; no association was found between cardiovascular risk factors and DASH diet among individuals of 60-64 age group(23).

Dietary factors

DASH diet is known to be effective in the prevention of CVDs and in lowering blood pressure(13,24). Multi-factorial factors may play their significant role in achieving CVD benefits. This may compose of biologically effective key nutrients that result from consuming foods containing magnesium, potassium and phytochemicals found abundantly in the DASH diet as recommended. It has been found beneficial as it contains anti-inflammatory and anti-oxidative properties that causes a decrease in angiogenesis and therefore reduces progression to cardiovascular complications(10). Although, result findings of systematic reviews suggest beneficial effect of consuming DASH diet in lowering blood pressure whereas; it also narrated possible benefits against heart failure (HF) and in preventing secondary HF. Foods containing high levels of magnesium, potassium, calcium and low in sodium are recommended as being more beneficial(25).

Salt/Sodium Restriction & Potassium and Magnesium Supplementation

To lower the blood pressure, the most recommended measure is reducing sodium in diet. An increase of sodium intake in the diet raises the blood pressure and contributes to the progression of hypertension and its further complications. An intake of up to 2.3g (5.75g) is recommended in a standard DASH diet while sodium up to 1.5g is allowed in the restrictive diet. According to a meta-analysis, salt restriction among normotensive tends to decrease blood pressure by 1% while a 3.5% decrease among hypertensive patients(2). Findings from DASH-Sodium trial implicated that a greater decrease in blood pressure is attained when sodium is restricted in the diet for four months as compared to one month dietary intervention of sodium. Reduction of 5 mm Hg in blood pressure was achieved from baseline SBP of ?150 mm Hg as compared to SBP of less than 140 mm of Hg. Results of the trial also elucidated that effects can be seen at one month of sodium restriction. However; secondary analysis of DASH-sodium trial showed that association of sodium with blood pressure was found to be strongly associated at a lower energy intake(26). A meta-analyses of RCTs presented that DASH diet is effective in reducing systolic SBP by 6·74mmHg (95% CI ?8·25, ?5·23) and diastolic DBP by 3·54mmHg (95% CI, ?4·29, ?2·79). Hypertensive patients who received interventions designed to restrict the energy intake were found to have greater effect of intervention such as patients consuming DASH diet having low sodium intake showed to have blood pressure lowering effect(27).

In a similar study, DASH-sodium randomized crossover trial was conducted that intended DASH diet combined with low sodium for lowering the blood pressure. Low baseline blood pressure cannot be assumed to have mass reduction due to floor effect in which body tends to resist to hypotension. The findings of this study replicated that an increase of 5 mm Hg in SBP is associated with the risk of vascular mortality. However; clinical impact of DASH-sodium diet in the pre-hypertension phase is particularly important(28,29). Still, safety of low sodium diet intake is indecisive but evidence indicates beneficial effects can emerge even with a small reduction in salt intake(20,29). However, an association of blood pressure to sodium-potassium ratio was explored in a multi-country study in which relationship of blood pressure to 24 hour urinary sodium-potassium (Na/K) ratio was ascertained. The findings revealed statistically significant relation of Na/K to blood pressure however; in the analysis systolic and diastolic blood pressure both remained higher with or without controlling for BMI(30).

Adherence to DASH diet

In the developed countries, cohorts and randomized controlled trials have been conducted on adherence to DASH dietary pattern(16). A similar study demonstrated that patients who were found adhered to DASH and Mediterranean diets showed to be consuming increased intake of fruits, nuts, fish, vegetables and whole grains and a lesser inclusion of alcohol, sweetened beverage and processed red meat in meals. Among individuals with greater adherence to DASH diet, lesser than 20% reduction in all-cause mortality was found(16,31). According to the findings of a prospective cohort study that aimed to determine adherence to a healthy diet such as DASH diet explicated a positive association for higher DASH scores which is known to be related to lower risk of cardiovascular diseases and stroke. Adherence to a healthy diet such as consuming DASH diet is not implied as a practical tool to assess CVD risk in the general population. But evidence specifies consuming DASH diet or alike can help to reduce blood pressure in the general population. It can also act as a significant mediator to reduce CVD risk. Moreover, a significant reduction owing to adherence to DASH diet elucidated that DASH diet as a significant component in addition to other factors can favor to avert obesity, CVD, stroke and kidney diseases among adults and middle-aged population(32,33).

Discussion

Hypertension is the commonest chronic disease that causes substantial morbidity and mortality owing to several cardiac diseases as well as renal, vascular and retinal ailments(29). With an steeping prevalence of hypertension, effective strategies are needed to control the prevailing burden of hypertension which are available, cost-effective and sustainable in order to prevent the incidence of hypertension among individuals. The current review article aims to describe DASH dietary pattern and its consumption by hypertensive individuals and its effects on the blood pressure, specifically. Findings of analogous studies have shown beneficial results of DASH diet on reducing and controlling blood pressure, hence decreasing the risk of CVDs among populations(24,34-36). No evident findings exist in literature on use of DASH diets in Asian countries(37). Because the diet pattern followed in Asia is heterogeneous in nutrition by culture and ethnicity which renders the need of further research to study the effects of DASH diet among different Asian populations(10). Whereas; evidence suggests that association of DASH dietary pattern with blood pressure and other cardio-metabolic risk factors varies across countries(10). However, a RCT conducted in two different cities of Pakistan showed that restrictive use of salt and an increased intake of fruits, vegetables, low-fat dairy products along with lifestyle modifications can effectively help to manage hypertension(2).

Cardiac health can be improved by using combination of foods as recommended in the DASH dietary pattern or in combination with lifestyle modifications or alone(2,10,29). A significant reduction in raised blood pressure can be achieved due to the consumption of DASH diet as demonstrated in prospective cohort and controlled trials(2,10,20). Evidence implies that DASH diet is attributed with a decrease in cardiovascular related incidence and mortality among individuals(38). However; previous researches aimed to ascertain association of consuming a DASH diet with lower incidence of cardio-metabolic disorder vary by country. Hence, country specific dietary interventions suggesting estimates for acceptable reductions in blood pressure are needed. More longitudinal studies for establishing temporal associations between consumption of DASH diet and blood pressure will be essential for clinical and public health practice(10,29).

A similar DASH-JUMP diet composed of green-yellow vegetables, meat, milk and low volume of meat, eggs, oil, fruits, shellfish and pickle was introduced in a single-arm cohort study conducted among Japanese participants. The findings of this intervention also supported significant reduction in SBP and DBP after 4 months and concluded it as a new lifestyle medication among the Japanese participants'(39). However; in comparison, dietary interventions imply significant results such as demonstrated by DASH-sodium trial and ENCORE trial for primary prevention of cardiovascular diseases. Studies have shown significant effects of consuming DASH diet and reducing salt intake among individuals, hypertensive and patients with uncontrolled blood pressure. However; it is implicated that adherence to DASH diet for a longer time period can actually reduce the magnitude of hypertension. It can be recommended alone or in combination with low sodium, and additive nutrients as a pharmacological monotherapy demonstrated by trials conducted earlier(10,20).

Further, cost-effective dietary modifications are needed to ascertain their applicability, sustainability and scalabilty among masses for blood pressure reduction. Reducing sodium/salt intake in the diet should be a national and international priority which can help to resolve the global hypertension incidence(20). Moreover; public health policies can play an important role particularly related to nutrient content of processed foods, and sustaining such nutritional programs to promote healthy diet in combination with lifestyle modifications to prevent and manage hypertension among individuals and patients(29).

Conflict of Interest

All authors declare no conflict of interest.

Conclusion

Findings of this review article elucidated the effectiveness of consuming DASH diet for the prevention and management of hypertension and cardiovascular diseases (CVDs). The findings calrify role of DASH diet in reducing blood pressure, CVD related morbidity and mortality. Hence, country-specific dietary recommendations are required for specific nutrients such as sodium, potassium, calcium and type of foods consumed among population. DASH diet along with pharmacological therapy and lifestyle modifications are proven to be effective. Further, longitudinal studies establishing temporal associations between consumption of DASH diet and its effect on blood pressure will be essential for clinical and public health practice.

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Table 1: Effect of a DASH diet on hypertension as demonstrated by research studies (2012-2019)

Sr. #	Investigator	Study Design	Overall BP Reduction (mmHg)	Assumption / Objective	Conclusion
1.	Naseem et. al (2016)	RCT	SBP 126.33±3.35, p<0.05	Change is SBP & DBP in the post-interventional phase through consumption of a controlled diet	A diet which is restricted in salt, rich in fruits, vegetables, and low-fat dairy foods and reduced saturated and total fat can substantially lower blood pressure. Such a diet offers an additional nutritional approach to the prevention and treatment of hypertension.
2.	Mahmood et. al (2019)	Narrative Review	To emphasize the significance of non-pharmacological interventions for hypertension control and to provide the most recent research evidence on the success of these interventions in effective management of hypertension.	The non-pharmacological interventions can be utilized alone before starting the pharmacological therapy or in combination after. The lifestyle modifications can help reduce the use of medications.	This study proved that lifestyle directly affects the level of blood pressure. These lifestyle changes include increased physical activity, better diet, healthy weight, avoiding smoking, and limiting alcohol consumption.
3.	Chiavaroli et. al (2019)	Umbrella Review	-5.2 mmHg, 95% CI, -7.0 to -3.4	To summarize the available evidence for the update of the European Association of the Study of Diabetes (EASD) guidelines using GRADE approach of the relation of the DASH dietary pattern with cardiovascular disease and other cardiometabolic outcomes.	The DASH dietary pattern was associated with decreased incident cardiovascular disease and improves blood pressure.
4.	Tiong et. al (2018)	Systematic Review	DASH Score: 20.19 +/-3.71 & 19.85+/3.80	This study, therefore, examined the crosssectional association between a DASH dietary pattern and blood pressure, fasting lipid profile and fasting glucose level in the Malaysia and Philippines cohorts from the	Differential associations of DASH diet and dietary components with cardiometabolic risk factors by country suggest the need for country specific tailoring of dietary interventions to improve cardio-metabolic risk profiles.
5.	Maddock et. al (2018)	Cohort Study	SBP to be 4·83mmHg (95% ---- ---- --	To examine whether long-term adherence to a DASH-type diet is associated with: conventional CV-risk factors; two markers of vascular function: cIMT and PWV.	Greater adherence to a DASH diet over the life course is associated with conventional CV-risk factors and independently associated with cIMT and PWV.
6.	Murtaugh et. al (2018)	Randomized Crossover Trial	SBP: 1.3 mm Hg, DBP: 1.3 mm Hg	To determine if the strength of the relationship of sodium intake with blood pressure varied with energy intake	The relationship of sodium intake with BP varied by energy intake; the strength of the relationship was stronger among individuals with lower energy intake than among those with higher energy intake.
7.	Juraschek et. al (2017)	RCT	SBP: -3.20 mm Hg and -0.88 mm Hg	To compared the effects of low versus high sodium, DASH versus control, and both (low sodium-DASH versus high sodium-control diets) on systolic BP (SBP) by baseline BP.	In adults with pre-hypertension, stage I hypertension and baseline systolic blood ------ --- ------ ------ ------
8.	Padwal et. al (2016)	Systematic Review	--	The effect of treating hypertension with dietary modifications compared with placebo, normal diet, or other treatment options	It was concluded that efficacy for five interventions based on information about the effectiveness and safety of calcium supplements, a low-salt diet (including the DASH diet), magnesium supplements, a Mediterranean diet, and potassium supplements.