Proceedings of ICBSPH 2026 Symposium: Beyond Calories: Food and Nutrition for Sustainable Health
DOI: 10.54254/2753-8818/2026.NL33534

The Improved Dietary Approaches to Stop Hypertension (DASH) Assisting in the Treatment of Hypertension

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Abstract. As one of the common chronic non-communicable diseases, hypertension also serves as one of the major risk factors for cardiovascular and cerebrovascular diseases, which can lead to the loss of more than 235 million years of healthy life every year. Although certain achievements have been made in the field of hypertension treatment and control, the control and treatment of hypertension still face significant challenges in developing countries and require effective treatment plans and policy guidance. In this thesis, the DASH and the research on the improved DASH assisting in the treatment of hypertension were analyzed and integrated. According to the analysis, improvements to the DASH diet, such as sodium restriction and integration of local dietary habits, can enhance therapeutic effects, improve the quality of life of patients, and increase patient compliance. Although it provides a reference for future research and the formulation of prevention policies, the mechanism for various nutrients in the improved DASH lower blood pressure remains unclear, there is also a lack of guidelines for the formulation of dietary recipes for different populations, and the optimal content ratio of nutrients in the improved DASH diet still requires further exploration.

Keywords: Dietary approaches to stop hypertension, cardiovascular and cerebrovascular disease, diet therapy

1. Introduction

As one of the most concerned chronic non-communicable diseases in the world, hypertension has been proven to be one of the major risk factors for cardiovascular and cerebrovascular diseases. According to the data from the World Health Organization (WHO) in 2023, the number of global hypertension patients has exceeded 1.3 billion, but only 42% of them are receiving systematic treatment, among which only 21% are effectively controlled [1]. In the context of the development of the social economy and the acceleration of the aging population process, the incidence of hypertension has been increasing year by year, posing a huge challenge to public health and medical resources. The treatment of hypertension mainly consists of two aspects: drug treatment and non-drug treatment, both of which require long-term adherence to achieve the desired results. In multiple hypertension prevention and control guidelines, it is emphasized that in addition to drug treatment, dietary intervention methods should also be applied, which can achieve better control of blood

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pressure. It is advocated by WHO that non-drug treatment should be given priority as the preferred approach to conduct management for hypertension clinical treatment.

Dietary Approaches to Stop Hypertension (DASH) is an effective eating pattern for the reduction of blood pressure recommended by American Heart Association and Guide to the Prevention and Treatment of Hypertension in China, which focuses on consume more fruits, vegetables, whole grains, and low-fat dairy products, and less salt and oil [2]. The mechanisms for DASH to lower blood pressure include perfecting the supply of nitric oxide, helping urination, lowering oxidative levels, and making the intestinal barrier work normally, etc. [3]. According to research findings, whether the DASH is adopted alone to assist, intervene or control hypertension, or is combined with approaches such as sodium restriction and aerobic exercise, it has all demonstrated excellent effects in controlling blood pressure and reducing the relative risk of cardiovascular diseases [4]. Although DASH is an effective dietary treatment strategy, its effectiveness has not be demonstrated in China due to cultural differences and variations in dietary habits. The improved DASH combines local Chinese foods and the dietary habits of Chinese people, and achieves better compliance while maintaining a favorable blood pressure-lowering effect by strictly limiting sodium intake, increasing the variety and adjusting the amount of fruits and vegetables, optimizing fat types, improving the ratio of red meat and poultry to fish, and restricting the intake of special foods from Chinese culture.

In this thesis, the evidence-based evidence on the improved DASH diet for the treatment of hypertension was systematically organized, and the efficacy of the DASH diet assisting in the treatment of hypertension was further analyzed, expecting to propose a scientific improved plan, which is of great significance for the standardized management and interventional treatment of hypertension.

2. Hypertension and diet

Being a dangerous factor for various diseases, hypertension poses significant harm to coronary heart disease, stroke, chronic renal insufficiency, peripheral arterial disease and other cardiovascular and cerebrovascular diseases and kidney diseases, which is one of the public health issues that receive particular attention both in China and abroad. The "China Cardiovascular Health and Disease Report 2024" has showed that the China's Monitoring Project on Cardiovascular Diseases and Their Risk Factors conducted in 31 provinces of China (including autonomous regions and municipalities) from 2020 to 2023, a total of 298,348 valid samples were included, among which the prevalence rate of hypertension among residents aged 18 and above was 31.6%, the prevalence rate of hypertension among men (36.8%) was higher than that among women (26.3%), and the prevalence rate in rural areas (33.7%) was higher than that in urban areas (29.1%); these data showed a significant increase compared to the existing survey data [5]. What can not be ignored is that the prevalence rate of hypertension in children and adolescents fluctuated greatly with age. The 2019 Chinese Student Physical Fitness and Health Survey (n = 190,000, aged 7-17, Han Chinese) showed that the prevalence rate of hypertension among children and adolescents was 13.0%, the prevalence rate of hypertension among girls (13.2%) was higher than that among boys (12.7%), and the prevalence of hypertension in rural areas (14.1%) was higher than that in urban areas (11.9%); there was generally a trend of increasing with age ($P < 0.001$) [5]. According to another research, in 2020, the overall prevalence rate of hypertension among children and adolescents aged 6 to 18 in China was 3.11%, with approximately 6.8 million patients, the prevalence rate of hypertension among young people (aged 18 to 34) was 5.2%, and the prevalence rate of hypertension among residents aged 75 and above was 59.8%, and the number of adults aged 18 and above with hypertension was 245 million

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[6]. It follows that the control of hypertension remains a challenge and effective solutions are urgently needed.

Essentially, hypertension is a lifestyle-related disease, involving the risk factors such as genetic factors, age, lifestyle, etc. Multiple randomized controlled studies have shown that patients with hypertension can lower their blood pressure and reduce the risk of complications by adjusting their dietary structure [7]. According to the studies, excessive intake of carbohydrates in daily diet leads to an excess of energy provided to the body, and the excess carbohydrates will be converted into fat and accumulate in the body, causing the blood pressure to increase [8]. The traditional Chinese dietary patterns have led to a generally high salt intake (9 - 13 grams / day) among people. According to the studies, diastolic pressure and systolic pressure will rise by 2.11 mmHg and 0.78 mmHg respectively for every 1g increase in per capita salt intake [9]. High-fat and high-sugar diets and other unhealthy dietary habits can cause gastrointestinal dysfunction such as intestinal bacilli illness, metabolic endotoxemia, and disordered secretion of gut hormones, while gastrointestinal dysfunction has a crucial effect in the onset of hypertension [10]. Studies have revealed that blood pressure rises as the alcohol drinking capacity increases, and long-term alcohol consumption can lead to an increase in the content of catecholamines and corticosteroids in the body, as well as an enhancement in the activity of renin angiotensin, vasopressin, and aldosterone, thus resulting in disordered potassium-sodium pump activity, abnormal ion transport, increased intracellular Ca2+ concentration, intensified vascular contraction response, increased peripheral resistance, and ultimately an increase in blood pressure [10].

3. Improved DASH diet

In 1994, the National Heart Lung & Blood Institute discovered a dietary combination that have better effects on controlling blood pressure while studying the impact of dietary patterns on the treatment of hypertension, and named this dietary combination the DASH. In this pattern, patients with hypertension are required to consume an adequate amount of fruits, vegetables, and low-fat milk, consume foods rich in potassium, calcium and magnesium, and reduce the intake of oils.

Further in-depth research on dietary management for hypertension has led to the further development of DASH diets, that is, the recipes are more diverse and can better adapt to the dietary habits of residents in different regions. The improved DASH has the following core features: low sodium, low fat, and rich in calcium, potassium and magnesium. The National Heart Lung & Blood Institute usually provides the participants with an adequate supply of fruits, vegetables and cereal foods, while reducing the intake of red meat, fat and carbohydrates, and controlling sodium intake. In the experiments, cereals are usually coarse food grains such as brown rice, oat and whole-wheat breads; meats are usually fish and poultry, which contain abundant protein and have very few saturated fatty acids, and are cooked in low-oil methods such as steaming, boiling and blanching; the cooking oil is usually olive oil or flaxseed oil, avoids using animal fats; dairy products are usually dairy products that are light-fat or defatted, ensuring calcium intake while reducing fat absorption; the dessert after meals is replaced by fruits, and eating with the peels is beneficial for increasing the intake of fiber. DASH diet can effectively lower blood sugar, triglycerides, and LDL-C level in the body, as well as improve insulin resistance, which is an adjuvant treatment approach for various metabolic syndromes. DASH diet can regulate blood pressure levels by reducing sodium and increasing potassium intake. Compensatory hyperinsulinemia is accompanied by insulin resistance, leading to vascular oxidative stress and aggravates hypertension. Potassium plays a role in increasing urinary sodium excretion, reducing insulin resistance, and alleviating oxidative damage, and is also of vital significance for the treatment of patients with with salt-sensitive hypertension.

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Another function of potassium is to lower blood pressure by reducing the contraction of vascular smooth muscle. In addition to improving the intestinal barrier function of hypertensives, DASH diets can also reduce the level of Zonulin in their blood. The way the DASH diet lowers blood pressure is to improve and increase the bioavailability of nitric oxide, promote the diuresis in the early stage and reduce the level of oxidative stress [3]. The phenolic-rich beans in the DASH diets inhibit angiotensin converting enzyme activity while promoting blood vessel dilation [7].

4. The effect of the improved DASH diets in assisting the control of hypertension

By increasing the intake of potassium, calcium and magnesium and avoiding excessive fat and calories, the improved DASH diet exerts the blood pressure-lowering mechanism of potassium ions, inhibits the reabsorption of sodium ions by the mucosal cells of the proximal convoluted tubules of the renal glomerulus, increases the activity inhibition of the renin-angiotensin system, antagonizes angiotensin II, relaxes and dilates the smooth muscle of the arteriole, reduces total peripheral resistance, thus lowering blood pressure. It has been revealed in Yuan Qin's research that after 12 months of intervention for the patients (except for the dietary pattern, no differences with statistical significance showed in other variables such as age and occupation), the systolic and diastolic blood pressures of the patients in the intervention group decreased significantly compared to before the intervention (t systolic blood pressure = 6.74, $P < 0.01$; t diastolic blood pressure = 10.90, $P < 0.01$), the systolic and diastolic pressures of patients in the intervention group showed significant improvements compared to those in the control group (t systolic blood pressure = 10.27, $P < 0.01$; t diastolic blood pressure = 8.83, $P < 0.01$) [11]. It has been revealed in the research of Zhong Fanghong, et al. that after a 6-month intervention with the improved DASH diet for patients with hypertension, the systolic blood pressure of the study group was (124.37 ± 5.50) mmHg and the diastolic blood pressure was (77.26 ± 4.68) mmHg, both of which were inferior to those of the control group [(135.26 ± 5.41) mmHg and (83.36 ± 4.79) mmHg], and the differences were statistically significant ($P < 0.05$) [12]. The improved DASH diet can also reduce the systolic pressure (12.5 mm Hg) for 24 hours, the diastolic pressure (7 mm Hg) for 24-hour, the systolic pressure (15 mm Hg) during the day time, and the diastolic pressure (9 mm Hg) during the day time.

According to the study findings [11,12], the scores of physical function, role function, cognitive function, emotional function, and social function of the patients in both groups all increased by an average of 10 points compared to their average scores before treatment in this group; the scores of the functions in body, role, cognition, emotion and society for the subjects in the study group were all higher than those in the conventional group, and there was statistical significance in terms of difference ($P < 0.05$). The improved DASH diets not only have a good effect in assisting the control of hypertension, but also enable patients to live a better life.

It was found that patients who were intervened with the improved DASH diet (strictly limiting sodium intake) showed more significant improvement in reducing systolic pressure than the control group adopting DASH, but the estimated central systolic and diastolic blood pressures were inferior to those of the control group, and there was no statistical significance in terms of difference ($p = 0.06$). The improved DASH diet with strict sodium intake restriction was superior to the control group in terms of improving arterial elasticity index and reducing heart rate response in patients [13]. The DASH diets under this improved model effectively reduced oxidative stress in patients and improved vascular endothelial function.

It was revealed that the DASH combined with aerobic exercise showed significant improvements in EMFL (executive function-memory-learning) score (ES: 0.21; Cohen's D=0.02; p=0.008) and blood pressure reduction compared to before the intervention, and was superior to the conventional

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care group; in terms of psychomotor speed, the DASH combined with aerobic exercise (ES: 0.18; Cohen's D=0.480; p=0.023) and the simple DASH intervention (ES: 0.15; Cohen's D=0.440; p=0.036) showed more significant improvement than that of the conventional care group [14].

In the context of an increasingly severe aging population, the intervention of dietary patterns to assist in the control of hypertension has become a research hotspot. As the advantages of DASH in assisting the control of hypertension gradually become apparent, DASH is expected to play a significant role in formulating new expert consensus on hypertension prevention and treatment in the future, and also to have an important position in the nutritional dietary guidelines. The DASH fully exploits the blood pressure-lowering mechanism of potassium ions through strict and reasonable dietary restrictions, enabling the body's blood pressure to maintain a stable state. DASH shows promising prospects in the control of hypertension, but its molecular mechanism still requires further research. In the future, more randomized controlled clinical trials with large scale are needed to verify the effectiveness and safety of the DASH to prevent and treat hypertension. It is necessary to develop an individualized DASH treatment plan based on traditional Chinese dietary habits and in combination with the specific circumstances of the patients, such as their economic conditions, age and lifestyle, to enhance the treatment effect. Meanwhile, it is is necessary to combine the research results of multiple disciplines such as nutrition to explore the application of the DASH in the comprehensive treatment of hypertension and develop new treatment strategies.

5. Conclusion

Promoting the improved DASH has significant positive implications for controlling hypertension in different countries and regions. The development of society and changes in age structure will lead to more people paying attention to the impact of a healthy and safe dietary patterns on physical and mental health. Moreover, conducting a therapeutic effect analysis on the improved DASH can provide an effective nutritional treatment plan for the subsequent development of the "general practitioner +" medical community model, and also offer ideas for subsequent research on the combination of the improved DASH with different exercise patterns to serve people with different diseases or special groups. However, in this thesis, there are still deviations in the improvement of the DASH and intervention methods, individual factors of the subjects, measurement personnel and measurement instruments, and there are still limitations in clinical trials, such as the lack of rigor in applying mathematical methods like random sequences and blinding, which have affected the effectiveness of the improved DASH in treating hypertension. Therefore, rigorous and large-scale cohort studies or clinical research can be carried out in the future. In terms of the random method, the random number table method can be used to generate random sequences, reducing the interference of subjective factors and further ensuring the authenticity of the research results; moreover, mechanism research can be conducted to provide a theoretical basis for formulating a scientific and effective DASH diet recipe.

To sum up, the improved DASH has significant advantages in controlling blood pressure and improving quality of life scores when assisting in the treatment of hypertension, and is superior to conventional drug treatment solutions.

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