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Research Article

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Blood pressure impact of dietary practices using the DASH method: a systematic review and meta-analysis

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Abbreviations
BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; DASH, Dietary Approach to Stop Hypertension; DBP, diastolic blood pressure; HDA, Healthy Dietary Advice; HDL, high-density lipoprotein; JBI, Joanna Briggs Institute; MeSH, Medical Subject Headings; MIM,

ABSTRACT

Background: In order to ascertain the impact of the Dietary Approach to Stop Hypertension (DASH) diet on blood pressure (BP), a systematic review and meta-analysis of randomized controlled trials were carried out. DASH is advised for lowering BP.
Methods: Scopus databases were searched from the beginning of 2024. A total of 579 articles from 2019 to 2023 from PubMed: 15, Scopus: 164 and Crossref: 400. There were 8 articles included in the meta-analysis.
Results: Systolic BP (1.29 mmHg to 4.6 mmHg, 95% CI, −2.17, −0.41; $P < 0.005$) and diastolic BP (0.76 mmHg to 1.1 mmHg, 95% CI, −1.39, −0.13; $P < 0.005$) were found to be significantly reduced by the DASH diet, while total cholesterol concentrations (5.2 mmol/L; $P < 0.005$), low-density lipoprotein (8.2 mmol/L; $P = 0.03$), and high-density lipoprotein increased by 8.2% ($P < 0.005$) were lowered by 0.9 points.
Conclusions: When followed consistently, the DASH diet can reduce BP's systolic and diastolic readings.

Trial Registration: PROSPERO Identifier: CRD42023494005

Keywords: Dietary behavior; Reduced; Blood pressure

BACKGROUND

Although cardiovascular disease (CVD) has seen significant advancements in recent years, it remains one of the world's top causes of mortality [1-3]. In both industrialized and developing nations, CVD morbidity and mortality are still high [4]. The development and advancement of atherosclerosis are linked to hemodynamic (high blood pressure [BP]) and metabolic (hyperlipidemia and hyperglycemia) stresses, which are significant cardiovascular risk factors [5,6].

Models have been constructed to estimate the risk of cardiovascular events and death by combining risk factors as age, BP, diabetes, smoking status, gender, total cholesterol, and

mindfulness in motion; LDL, low-density lipoprotein; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT, randomized controlled trial; SBP, systolic blood pressure; SE, size effect.

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Competing interest
The authors declare that they have no competing interests.

Availability of data and materials
All data generated or analyzed during this study are included in this published article.

Ethics approval and consent to participate
No ethical approval was required for this study.

Consent for publication
Not applicable.

Authors' contributions
Conceptualization: Isnaini N, Dewi FST; Data curation: Supriyadi; Formal analysis: Supriyadi; Investigation: Supriyadi, Madyaningrum E; Writing - original draft: Isnaini N, Dewi FST; Writing - review & editing: Isnaini N, Supriyadi.

high-density lipoprotein (HDL) cholesterol concentrations [7]. One major behavioral strategy to lower cardiovascular risk is to modify one's diet and lifestyle. The Dietary Approach to Stop Hypertension (DASH) is a dietary pattern that encourages the consumption of whole grains, poultry, fish, nuts, and low-fat fruits, vegetables, and dairy products. It also aims to minimize consumption of red meat, sweets, sugary drinks, total fat, saturated fat, and cholesterol [8].

Individuals with cardiovascular risk, such as those with hypertension, need to modify their lifestyle [5], as lifestyle has a significant role in the management of hypertension. Altering one's lifestyle can improve BP, boost the effectiveness of antihypertensive medications, improve metabolism, and improve blood vessel health [4,7,9].

Reducing body weight by calorie restriction, limiting sodium intake to 2,300 mg per day, boosting fruit and vegetable consumption, and increasing physical activity are all components of lifestyle therapy [10]. When diagnosed with hypertension, those with diabetes and stress who have minimal blood elevation (systolic 120 mmHg or diastolic 80 mmHg) must begin pharmaceutical therapy concurrently [10].

Approach the suggested lifestyle as the initial stage of treatment. Consume a diet rich in fruits, vegetables, and low-fat dairy products, as well as foods low in fat, sugar, and sodium, to lower BP, including the DASH pattern and its promotional measures [11]. The DASH diet significantly reduced BP systolic and diastolic when compared to a typical Western diet or simply eating a lot of fruits and vegetables, according to randomized controlled trials (RCTs) and research on persons with hypertension [12].

Consuming more salt raises the risk of CVD and death, and it is associated with hypertension. The World Health Organization advises consuming less than 5 g of salt and less than 2,000 mg of sodium per day [10]. Diets that restrict salt intake and DASH diets are known to reduce BP and lipid profiles [13,14]. The DASH diet is a well-known diet for patients with hypertension in industrialized nations [15]. Vegetables and up to 30 g of fruit-containing fiber-rich foods are consumed daily, and some minerals including calcium, magnesium, and potassium also limit salt intake [12].

For people with hypertension to be able to control their condition on their own, the proper kind, quantity, and timing of DASH diet foods must be followed. It is anticipated that a plan for BP management will involve appropriate and simple innovation and technology [16]. Among them are appealing commercials and pictures that have an impact on their well-being [17]. Even though a lot of important research has been done to explain how food choices can affect BP, it is challenging to find a statistically significant and systematic relationship between dietary behavior and stress blood in patients with hypertension because there is currently no article that explains what diet is, only that it can affect BP and BP. This research is to determine systematically whether dietary practices that incorporate DASH can help people with hypertension lower their BP.

METHODS

Design

We registered the title and protocol on PROSPERO (CRD42023494005) and carried out a systematic review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [18].

Review questions

What effect does the DASH dietary intervention have on BP?

Inclusion criteria

We include article language English with design peer-reviewed RCT research fulfilling colleagues' criteria following criteria: 1) Population: adults and elderly age with or without hypertension who live in the community, are given a focused health program, for any dietary arrangements, for any purpose, for lower pressure blood and delivered (self or together); 2) Intervention: we don't enter specific intervention focus on nutrition; 3) Comparator: no there is training or maintenance normal; 4) Result: our main thing is pressure blood, or other variables besides from pressure blood. We exclude article systematic research reviews, scoping reviews, opinion letters, conference proceedings, dissertations, and non-human studies.

Search strategy

The Medical Subject Headings (MeSH) terms, and keywords for "DASH diet" and "blood pressure" and cardiovascular risk factors were used to develop our search strategy from the month of January 2019 until the month of December 2023 from the PubMed database as many as 15, Scopus as many as 164 and Crossref as many as 400 for a total of 579 (**Fig. 1**).

Assessment of risk of bias

We use tools from the Joanna Briggs Institute (JBI) for RCTs with 13 questions filled in with Y = Yes, N = No, U = Unclear, and we review and critically evaluate the papers to determine their quality. The evaluation's summary was Low 1–4, Moderate 5–7, and High > 7 [19]. The fourth reviewer (SU) determines any gaps that remain after the 4 authors (NI, FST, EM) independently assess article scores and discuss scores regardless of any discrepancies. Eight articles have good quality results because their scores are greater than 7.

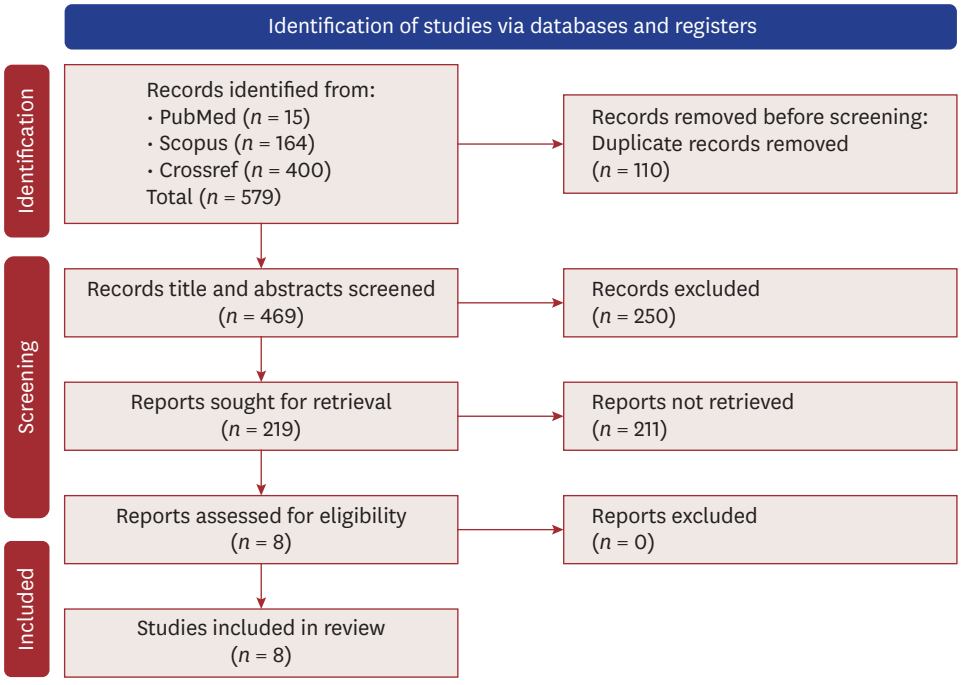

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study selection.

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Data extraction, analysis, and synthesis

Via the web rayyan.ai delete article duplication and commit screening levels 1 and 2. Two authors (NI and SU) co-independent filter title and abstract (level 1) and exclude quotes that don't fulfill criteria inclusion; for example study with a population of patients different in age and no there is intervention diet management. Reviewers third and fourth (EM and FST) decide all gaps that have not been resolved. We repeat this process fully filtering text (level 2), and note-taking reason exception only at this level. We sent an email to the writer to ask if we had any questions.

Data extraction is carried out based on author, year, country, amount of respondents, age of respondents, programs carried out, length of program, and results from the program (**Table 1**).

RESULTS

Study characteristics

Eight studies out of the 579 that we analyzed were in English, and they came from countries such as Peru [20], India [21], America [22], Thailand [21], Spain [23], England [12], Australia [24], and Egypt [25]. The study's respondents varied in age from youth over the age of 18 to senior people living in the community and having a nurse or energy health visit them at home. The largest number of respondents (2,376) were on research [20].

Intervention characteristics and outcomes

Giving intervention uses the method of stare face and combines it with media modules as well as leaflets. The amount of meetings done is at least one month and takes the longest to do 4 months. Size sample from 38 to 2,376 people aged adults and the elderly. Monitor pressure blood, body mass index, measurements laboratory form HDL- and low-density lipoprotein (LDL)-cholesterol, measurement sample 24-hour urine for know rate urea creatinine and measure cognitive-affective as well as the perception of stress due to. There is one article that provides intervention with education pattern eating and also mental health in patients hypertension. Intervention and outcome models are explained in **Table 1**.

Description of interventions

Interventions included a campaign to replace common salt in food preparation with salt that is low in sodium and high in potassium [20,21], mindfulness motion and dietary intake with the DASH diet during 8 Sundays [22], and other articles that explain how respondents manage their diet by consuming less oily and floury foods and by copying vegetables and fruits [26].

According to another studies, adopting a Mediterranean lifestyle and eating a Mediterranean diet for 24 hours will help you save time. Socializing, getting enough sleep, maintaining an active lifestyle, eating fruits and vegetables, and avoiding sugar and salt are all important [27]. Other studies show that people with hypertension do alter their lifestyles after receiving a diagnosis by cutting back on salt and eating more fruits and vegetables [12].

Test transformation

Test transformation is performed before meta-analysis to get the size effect from each correlation test article with the t-test. Through the process, z scores are created z variation for calculate effect size. Transformation data from 8 articles is seen in **Table 2**.

Table 1. Characteristics articles and descriptions of intervention

No.	Author	Country	No. of subjects	Design	Respondents	Duration of intervention	Intervention description	Results	Variables measured
1	Seangpraw et al., 2019 [26]	Thailand	175	RCT	Elderly with hypertension	2 mon	Weekly 45-min group education meetings, 25-min group activity training sessions, and 15-min individual checklists	Statistically significant difference after 3 mon follow-up BP decreased	BP
2	Bernabe-Ortiz et al., 2020 [20]	Peru	2,376	RCT	Adults aged 18 yr and over	4 mon and BP measurement at 5 mon	Replace household salt with high potassium salt	Systolic decrease 1.29 mmHg, diastolic decrease 0.76 mmHg	BP, BMI
3	Margerison et al., 2020 [24]	Australia	251	RCT	Average 55 yr	1 mon	Conducting observations on eating patterns and there were 3 eating patterns identified and only one eating pattern was related to BP, namely vegetable juice, vegetables, and high-fiber bread	The dietary patterns in the group that regularly consumed vegetable juice, vegetables, and high-fiber bread experienced significant differences in BP compared to BP in the group that consumed high amounts of low-fiber bread, pasta, noodles and rice, meat dishes, poultry and egg dishes, mixed cereal dishes, salted nuts and low consumption of milk and yogurt	BP, BMI
4	Said et al., 2020 [25]	Mesir	92	Cohort prospective	> 40 yr	12 wk	Comparing 2 groups on the DASH diet with the HDA diet for 12 wk and comparing BP, BMI and Cholesterol laboratory results	BMI decreased by 6.5% versus 2.5%, systolic BP decreased by 6.9% and 4.1%, fasting blood sugar decreased by 5.5% and 3.1%, total cholesterol decreased by 5.2% and 3.1%, LDL decreased by 8.2%, and 3.1%, and HDL increased by 8.2% and 2.4%, respectively, in the DASH and HDA groups. Conclusions: both the DASH and HDA diets were associated with improvements in CVD risk factors	BP, BMI, blood sugar, HDL- and LDL-cholesterol
5	Yu et al., 2021 [21]	India	502	RCT	Age > 61 yr	3 mon	Replace household salt with table salt (100% sodium chloride) or salt substitute (70% sodium chloride/30% potassium chloride mixture), and it is recommended to replace all household salt	Significantly decreased SBP by 4.6 mmHg and DBP by 1.1 mmHg. Significant increase in 24-hr urinary potassium excretion in the salt replacement group by 0.24 g/day and decrease in urinary sodium and potassium ratio by 0.71	BP, 24-hr urine, urinary sodium and potassium levels
6	Wright et al., 2021 [22]	American	38	RCT	Elderly people over 60 yr old diagnosed with hypertension	3 mon	Two-hour group sessions lasting 8 weeks were used to provide the MIM DASH and mindfulness-only treatments Guided meditation, breathing techniques, and mindful chair/stand movements were all part of MIM Critical thinking techniques were applied in the DASH component to self-efficacy, goal-setting, problem-solving, and reflection After the study was over, a DASH booklet was given to the control group	The MIM DASH group's BP dropped by 7.2 mmHg, whereas the attention-only group's BP dropped by 7	BP, knowledge, affective and stress perception
7	Talavera-Rodríguez et al., 2023 [23]	Spain	2,184	RCT	Elderly 60 yr and above	1 mon	Health workers measure sociodemographics, lifestyle, health status, morbidity, and health service utilization throughout three consecutive stages of visits	Older people are more compliant with a healthy lifestyle and this is significantly related to BP	BP
8	Blumenthal et al., 2024 [12]	Inggris	164	RCT	The average elderly is 63 yr and above	4 mon	Intensive lifestyle modification program including dietary counseling, weight management behaviors, and exercise; or a single counseling session providing standard education and physician advice	Diet and exercise can lower BP in patients	BP

RCT, randomized controlled trial; BP, blood pressure; BMI, body mass index; HDA, Healthy Dietary Advice; HDL, high-density lipoprotein; LDL, low-density lipoprotein; DASH, Dietary Approaches to Stop Hypertension; CVD, cardiovascular disease; SBP, systolic blood pressure; DBP, diastolic blood pressure; MIM, mindfulness in motion.

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Table 2. Test transformation to get SE value

No.	Author	*r*	*n*	z	vz	Vz	SE
1	Seangpraw et al., 2019 [26]	0.01	90	0.00502542	−0.33444816	0.33444816	0.578314932
2	Bernabe-Ortiz et al., 2020 [20]	1.23	2,376	−1.743481708	−0.56497175	0.56497175	0.751646028
3	Margerison et al., 2020 [24]	1.88	51	−0.601017213	−0.89285714	0.89285714	0.944911183
4	Said et al., 2020 [25]	0.01	94	0.00502542	−0.33444816	0.33444816	0.578314932
5	Yu et al., 2021 [21]	4.6	502	−0.239273139	0.625	0.625	0.790569415
6	Wright et al., 2021 [22]	7.2	13	−0.169688238	0.238095238	0.23809524	0.487950036
7	Talavera-Rodríguez et al., 2023 [23]	7.2	3,273	−0.169688238	0.238095238	0.23809524	0.487950036
8	Blumenthal et al., 2024 [12]	12.5	140	−0.113160421	0.105263158	0.10526316	0.324442842

SE, size effect.

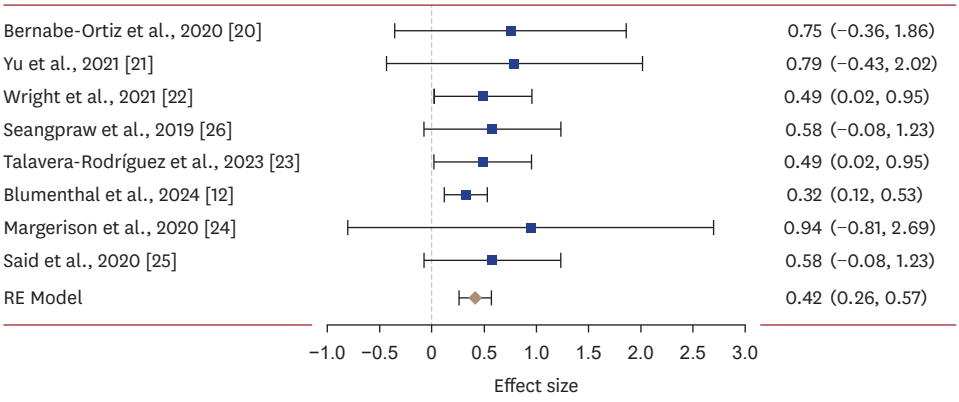

Fig. 2. Forest plot of relationships between diet patterns with blood pressure.

According to a meta-analysis of 8 publications, Wright et al.'s and Talavera-Rodríguez et al.'s studies [22,23] is the most often used method for predicting the relationship between BP and the DASH diet. Because the 2 studies' statistics fall between zero and zero, the 2 articles demonstrate that following the DASH diet has a 1-fold chance of not raising BP.

Six further research are still significant. For BP that is lower as may be shown in **Fig. 2**, the confidence interval passes negative [12,20,21,24-26] according to statistics. Look research by Wright et al. [22] and Talavera-Rodríguez et al. [23] appears at the top of the funnel plot picture, indicating that 2 studies had the strongest correlation between BP and the DASH diet. The image of the funnel plot indicates that the effect of increasing size spread and exceeded the influence of no. The image is displayed in **Fig. 3**.

DISCUSSION

DASH diet statistics show that eating a diet high in fruits, vegetables, and low-fat dairy products, along with lowering saturated and total fat, will lower BP and blood sugar levels. Food's calcium, potassium, magnesium, protein, and fiber content helps reduce consumption of salt and saturated fat [28]. The strongest correlation between the DASH diet and BP was found in a meta-analysis study by Wright et al. [22] and Talavera-Rodríguez et al. [23], while 6 other studies also found a relationship. Hypertensive patients greatly need to learn more about the DASH diet through training or education [29].

Limiting sodium has been linked to a decrease in BP and a diminished renin-angiotensin system action inhibitor. In order to minimize the drop in BP, it is crucial to consider the

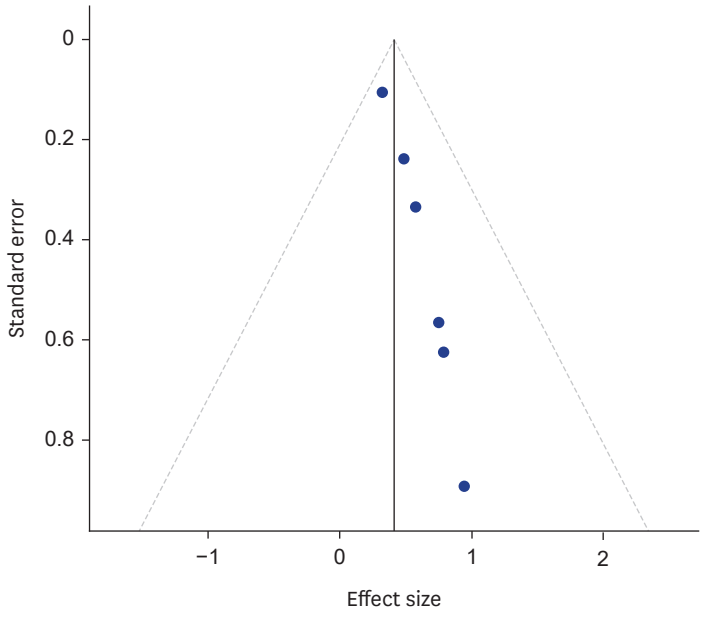

Fig. 3. Funnel plots.

pattern change associated with increased potassium availability in cereals, fruits, vegetables, and nuts [30]. The consumption of potassium, calcium, magnesium, and vegetables is increased with a DASH diet. For people with hypertension, low-sodium diets and the DASH diet are advised. Hypertension can be summed up as a diet that lowers sodium and raises potassium, or a diet that lowers the ratio of sodium to potassium. One could conclude that the ratio of sodium to potassium may be more significant in a certain circumstance. Actually, in contrast to the separate effects of potassium or sodium, which were in line with base theory We have already covered sodium reabsorption [31].

The DASH diet is one practical method. Results of a study that split 40 patients into 2 groups showed that, while diastolic BP did not significantly differ between the DASH diet group and the control group, the DASH diet group had a significant decrease in systolic BP. Sodium and potassium from diet appear to have a stronger effect on the systolic pressure BP than the diastolic pressure BP. In addition to the DASH diet and the use of hypertension medication, decline pressure diastolic is more advised [32].

The DASH diet causes natriuretic and diuretic effects, increases the amount of physiological inhibitory effects of the angiotensin converter enzyme, and interacts with the renin-angiotensin-aldosterone system. Depending on BP, the DASH diet may cause an increase in salt production and act as a diuretic. The DASH diet has a natriuretic effect because it contains a lot of potassium and calcium, which are found in fruits, vegetables, and low-fat dairy products. Potassium is involved in the arrangement of action and pressure natriuretics. The DASH diet's high calcium or potassium content counteracts the debilitating effects of low sodium intake [33,34].

The severity and problems of hypertension in the elderly will be reduced by applying the DASH program's behavioral patterns with greater awareness [35]. This issue encourages older people to modify their behavior, such as cutting back on sodium when cooking, avoiding fat in food, exercising frequently, and abstaining from alcohol and tobacco. This issue

contributes to an increase in self-management, which lowers BP. As a result, this treatment has been successful in lowering BP, plasma triglycerides, and LDL concentrations without raising LDL [26,36].

Dietary practices have become crucial in the development and prevention of CVD, which is the leading cause of death globally [37]. High adherence to the eat healthy pattern leads to a considerable decline in CVD risk. Examine this indicates a statistically significant improvement in the outcomes of both groups that underwent managed eating before and after the intervention [25]. A diet high in fiber, such as the DASH diet, lowers cardiovascular risk and suggests consuming foods high in fiber to break the pattern of unhealthy eating. This issue can be explained by the DASH diet's recommendation of nuts and seeds, which are high in fiber and an excellent way to lower LDL [25].

Reducing salt intake on the DASH diet is linked to lower BP since higher BP is caused by higher sodium intake. Due to the fact that increased sodium consumption might result in increased extracellular osmotic fluid pressure and intracellular osmoreceptor cell phenomena [38]. Only fluid rose extracellularly when sodium was eaten; sodium concentration remained unchanged. This indicates that mean sodium consumption increased extracellular fluid. Conversely, a decrease in mean sodium intake results in a decrease in extracellular fluid [10].

Within the human body, liquid extracellular fluid is divided into 2 compartments: fluid intravascular, or plasma volume, which contains approximately 1/4 liquid extracellular, and fluid interstitial, which contains approximately 3/4 liquid extracellular. Extracellular fluids circulate exactly once every 3 hours, and during the exchange process This amounts to around 180 L of filtration kidney every day [39]. About 65% of the sodium that enters the nephron and is absorbed returns from the tubule kidney to the interstitial fluid and then to the systemic circulation via the peritubular capillaries [34].

The space between ascending and descending extremities becomes hypertonic as a result of the ascending branch loop of Henle actively secreting sodium into the interstitial space while remaining tight to water. Hypertonicity as a result, the fluid inside the descending extremities and the space interstitial create an osmotic gradient that raises the tonicity of the liquid inside and drains water from the descending extremities. Due to the waterproofing of the ascending extremities, salt is continuously pushed out in an active manner [40].

Therefore, kidneys that are differentiated according to their location can regulate sodium and water by differentiating their sodium concentrations based on their location [41]. In the tubule lumen nephron, the ratio of the rates of glomerular filtration, tubular sodium reabsorption, and secretion fluids containing sodium determines the rate of natriuresis [42]. Intravascular volume and fluid volume rise proportionately with an increase in sodium intake. The next factor contributing to elevated BP is an increase in the mass of the heart. Physiological mechanism Whereas the kidney's arteries' elevated BP results in improvement pressure natriuresis is the term used to describe the excretion of water and salt [43].

CONCLUSIONS

Findings from the study, this serves as a solid basis for recommending the appropriate diet for older adults and mature individuals with normal circumstances or high BP due to

the fact that meta-analysis findings indicate a strong correlation between the DASH diet and decreased BP [22]. Dietary control because the necessary knowledge for managing hypertension becomes an integral part of the process, the DASH diet does not eliminate the education and training that patients require [29]. Support from friends and family is crucial because it can impact the elderly's efforts to modify their behavior. This will improve their health and promote their well-being, which will benefit both the old and individuals with high BP [35].

The implementation of the right type, amount, and schedule of DASH diet food is needed for patients so that those with hypertension can manage themselves independently. Appropriate and easy innovation and technology are expected to be a strategy for managing BP [16], one of which is like attractive advertisements and images that affect their health [17].

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