



The Effectiveness of Nutritional Interventions on Hypertension Control: A Meta-Analysis

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Abstract

This study aims to evaluate the effectiveness of nutritional interventions in addressing hypertension, considering aspects such as food consumption, dietary patterns, and other nutritional interventions. Through meta-analysis, the research seeks to consolidate findings from various previous studies to provide a stronger conclusion regarding the effectiveness of nutritional interventions on hypertension and to establish a foundation for the development of more effective nutritional intervention programs for the prevention and control of hypertension. The research methodology employs a meta-analysis approach and literature research to evaluate relevant journal articles on the topics of "Hypertension," "Blood Pressure," and "Nutrition." Article selection criteria include publication years from 2015 to 2023, written in Indonesian or English, and document types "article research" and "review literature," resulting in a final selection of 10 articles for the meta-analysis study. The study findings indicate that nutritional interventions, such as reducing salt intake and adopting the DASH diet, are effective in lowering blood pressure, especially in individuals at high risk of hypertension. Dietary fiber supplements and early-life interventions also prove to significantly benefit blood pressure management. Holistically, emphasis on healthy eating patterns, active lifestyles, and the use of technologies like mHealth can help address hypertension issues among at-risk populations.

Introduction

Hypertension stands as a substantial global health challenge, characterized by a relentless upward trend in prevalence (Jabani & Kusnan, 2021). Within Indonesia, an estimated 26.7% of the adult population is afflicted with hypertension, with projections indicating a continued rise in this figure (Roza, 2016). The burgeoning prevalence of hypertension poses a formidable obstacle, heightening the susceptibility to a spectrum of chronic maladies, including cardiovascular ailments, stroke, and chronic kidney disease (Sihombing, 2017). Within this introductory discourse, the imperative of nutritional interventions as a strategic recourse for hypertension mitigation is underscored. Various nutritional modalities, such as the Dietary Approaches to Stop Hypertension (DASH) or Mediterranean diet regimens, alongside micronutrient supplementation, have emerged as efficacious measures in ameliorating hypertension (Wickman et al., 2021). Nonetheless, the heterogeneous outcomes observed across antecedent studies necessitate a comprehensive meta-analysis to amalgamate findings and engender robust conclusions regarding the efficacy of nutritional interventions.

Through delineation of the research objective namely, the evaluation of nutritional intervention efficacy across diverse dimensions encompassing dietary patterns, consumption metrics, and

ancillary nutritional strategies this study endeavors to furnish a significant contribution to our understanding of hypertension management vis-à-vis nutritional paradigms. Moreover, accentuation of the anticipated ramifications of research findings on stakeholders ranging from policy architects and healthcare practitioners to the broader populace underscores the salience and pragmatic import of this endeavor. The envisioned outcomes hold the promise of serving as a cornerstone for the formulation of more efficacious nutritional intervention schemes aimed at both prevention and control of hypertension. Thus, this introductory exposition adeptly furnishes a comprehensive overview, elucidates the significance of the research endeavor, and charts a course toward addressing this exigent health quandary.

Theoretical Framework

Hypertension

Hypertension, commonly known as high blood pressure, represents not only a medical condition but also a significant risk factor for severe cardiovascular disorders such as stroke, myocardial infarction, and heart failure (Saiz et al., 2022). Clinically, it manifests as systolic blood pressure levels of ≥ 140 mmHg and/or diastolic blood pressure levels of ≥ 90 mmHg (Tiara, 2020). Classifications of hypertension based on its etiology include: (1) Primary Hypertension: This form constitutes the predominant presentation, accounting for 90-95% of cases. Though precise causative factors remain elusive, identifiable risk elements encompass age, familial predisposition, obesity, unhealthy dietary practices, sedentary lifestyle, smoking, and excessive alcohol consumption; (2) Secondary Hypertension: Arising from underlying medical conditions or concomitant diseases, secondary hypertension includes causative factors such as renal diseases, adrenal artery disorders, sleep apnea, and adverse effects of pharmacotherapy (Cormick, 2021).

The pathophysiology of hypertension entails augmented systemic vascular resistance, culminating in elevated blood pressure. Contributing factors encompass enhanced blood volume due to sodium excess, fluid retention, or cardiac insufficiency, amplified cardiac output stemming from heightened cardiac contractility or rate, and escalated systemic vascular resistance prompted by vasoconstriction, atherogenesis, or heightened sympathetic nervous system activity.

Paradoxically, hypertension frequently presents as a "silent" malady devoid of overt symptoms during its incipient stages. However, as the condition progresses, symptomatic manifestations may manifest, including cephalalgia, vertigo, lethargy, dyspnea, anginal chest discomfort, and visual disturbances (Syvolap et al., 2017).

Diagnosis conventionally relies on routine blood pressure assessments, particularly among individuals harboring hypertension predisposing factors. Therapeutic endeavors pivot on attenuating blood pressure to normotensive thresholds and forestalling attendant complications. Standard therapeutic modalities encompass lifestyle modifications, embracing prudent dietary habits, weight reduction, regular exercise regimens, smoking cessation, and moderation of alcohol intake, alongside pharmacotherapy incorporating diuretics, beta-adrenergic blockers, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, and calcium channel blockers.

Hypertension represents a chronic malady mandating sustained management efforts. The amalgamation of pharmacological interventions and lifestyle adjustments facilitates complication mitigation and ameliorates overall quality of life. Vigilant blood pressure surveillance and collaborative engagement between patients and healthcare practitioners are pivotal in the efficacious management of this prevalent condition.

Nutritional Intervention

Nutrition, as a scientific discipline, occupies a pivotal role in comprehending the intricate processes by which the human body harnesses nutrients from food to sustain life, foster growth, and facilitate development (Gharibzahedi & Jafari, 2017). Beyond mere sustenance, the realm of nutritional science delves into a profound understanding of the complex interplay between dietary constituents and human health, along with the pivotal role of nutrition in both the prevention and treatment of diseases. Within this domain, several foundational theories underpin further exploration and knowledge advancement (Raubenheimer & Simpson, 2019).

Energy Balance Theory: This theoretical framework underscores the paramount importance of maintaining equilibrium between caloric intake derived from food sources and energy expenditure through physical activity. The preservation of an optimal energy balance is imperative in mitigating health maladies associated with either obesity or energy insufficiency.

Nutrient Requirements Theory: Central to this theory is the identification of the specific types and quantities of essential nutrients requisite for sustaining optimal health. The classification of nutrients into macronutrients (comprising carbohydrates, proteins, and fats) and micronutrients (encompassing vitamins and minerals) facilitates the formulation of well-rounded dietary regimens.

Metabolism Theory: This theoretical construct encapsulates a comprehensive understanding of the intricate processes governing the digestion, absorption, and metabolic utilization of ingested nutrients within the physiological milieu. Profound insights into metabolic pathways underpin the rational design of dietary patterns aimed at bolstering bodily functions in an efficient manner.

Nutritional Status Theory: This theoretical paradigm delves into the profound implications of an individual's nutritional status—be it characterized by adequacy or deficiency—on overall health outcomes. A nuanced comprehension of nutritional status serves as a linchpin in identifying susceptibility to nutrition-related disorders and devising tailored interventions accordingly.

The benefits of Nutrition are outlined as follows: (1) **Understanding Body Processes:** Nutrition facilitates a deeper comprehension of how the body metabolizes food to sustain health; (2) **Selection of Appropriate Foods:** It serves as a guiding principle for individuals in making informed choices regarding dietary selections that align with their body's nutritional requirements; (3) **Disease Prevention and Treatment:** Nutrition furnishes the groundwork for formulating dietary regimens conducive to averting and managing nutrition-related illnesses; (4) **Enhancement of Quality of Life:** Through the adoption of wholesome dietary practices, individuals can ameliorate their overall quality of life and well-being.

The ongoing advancement of nutritional theory, coupled with novel scientific research, fortifies the groundwork for nutrition experts to proffer precise guidance and recommendations. Furthermore, it underpins communal endeavors aimed at attaining and sustaining optimal health through the cultivation of balanced dietary habits.

Methods

The methodological approach adopted in this study is referred to as meta-analysis. Literature research, alternatively known as literature review, involves a meticulous examination and critical analysis of knowledge, ideas, or findings embedded within academic literature. It aims to formulate theoretical and methodological contributions pertinent to a specific subject matter. The selection criteria for journals under scrutiny encompassed accessible, peer-reviewed scientific literature available in PDF format, pertaining to the themes of "Hypertension," "Blood Pressure," and "Nutrition." The chosen timeframe for publication spanned from 2015

to 2023. Pre-existing scholarly articles were sought through reputable online platforms such as Google, ScienceDirect, and Emerald.

The narrative method was employed to synthesize the findings of this literature review, organizing extracted data into coherent groupings aligned with measured outcomes, thereby facilitating the attainment of research objectives. This systematic approach was pivotal in addressing the research inquiries comprehensively. Rigorous examination and scrutiny of both abstracts and full-text articles were conducted to ensure a comprehensive understanding of the content therein. Upon completion of the journal review phase, meticulous scrutiny of the information presented in the research ensued.

Result and Discussion

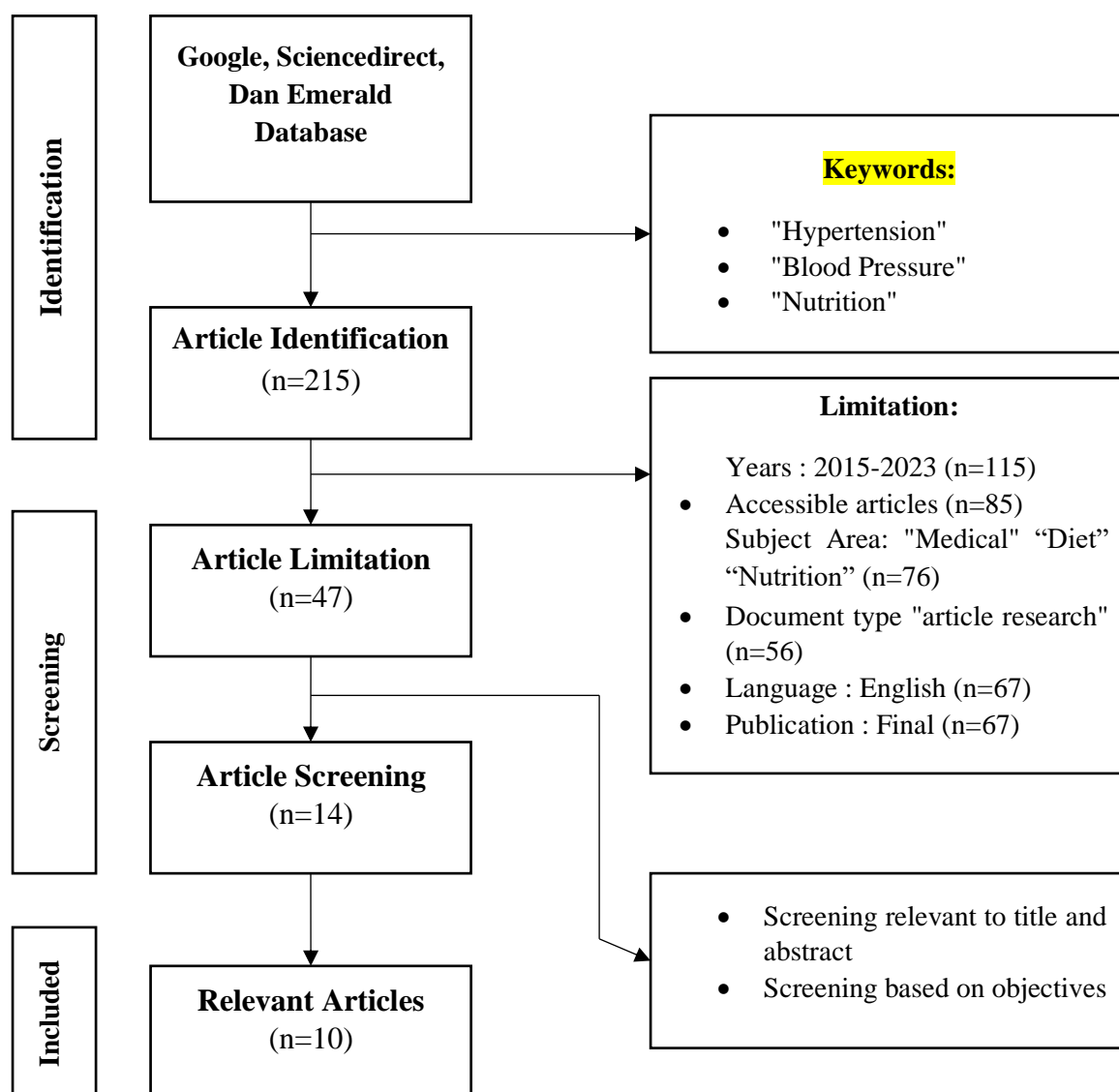


Figure 1. The PRISMA Flowchart for the Research Data Process.

The search for articles from the literature databases Google, ScienceDirect, and Emerald using the keywords "Hypertension," "Blood Pressure," and "Nutrition" yielded a total of 115 articles published between 2015 and 2023. These articles comprised: (1) 85 accessible articles; (2) 76 articles aligned with the subject areas of "Medical," "Diet," "Nutrition," "Microbiology," and "Laboratory."; (3) 6 articles categorized as "research articles" and "literature reviews."; (4) 14 articles written in both Indonesian and English; (5) 10 articles in both Indonesian and English that were published and selected for further screening.

The article screening process involved a thorough examination of the entire text to ensure alignment with the research subject. From the initially selected 14 articles, 10 were deemed relevant and subsequently utilized for the research. Thus, based on the research methodology, out of the 115 identified research articles, 10 relevant articles were utilized for the meta-analysis study, as illustrated in the following flowchart.

Here is a summary of research related to nutritional interventions for hypertension control.

Table 1. Previous Studies

No.	Researchers (Years)	Research Objectives	Nutritional Intervention	Findings
1	Lee et al. (2018)	Evaluating the effectiveness of home-based lifestyle modification interventions in managing blood pressure.	The control group, Dietary Approaches to Stop Hypertension (DASH) diet education group, and DASH group with home-based exercise.	There was no significant difference observed in blood pressure alterations among the intervention groups; however, the DASH diet and exercise group exhibited a tendency towards reduced blood pressure.
2	Schwingshackl et al. (2019)	Evaluating the comparative impact of different dietary approaches on blood pressure.	Conducting a network meta-analysis of 13 dietary interventions in individuals with hypertension and prehypertension.	Dietary strategies including the DASH, Mediterranean, low-carbohydrate, Paleolithic, high-protein, low-glycemic index, low-sodium, and low-fat diets were found to be significantly more effective in reducing blood pressure
3	Moreira-Rosário et al. (2023)	Contrasting two empowerment-based strategies for reducing blood pressure.	Salt reduction program versus a general healthy lifestyle program	While there was no notable distinction between the program groups, it was observed that the salt reduction program effectively lowered blood pressure, particularly among individuals with heightened hypertension risk.
4	Cicero et al. (2021)	Assessing the impact of the Mediterranean diet on blood pressure compared to the DASH diet.	Mediterranean diet vs. DASH diet.	The Mediterranean diet has a lesser effect on blood pressure compared to the DASH diet, but it may improve various health factors.
5	Gay et al. (2016)	Conducting a meta-analysis of the effects of various dietary patterns on blood pressure control..	The DASH dietary approach has the largest net effect on reducing blood pressure..	Dietary modifications are associated with clinically significant reductions in blood pressure, with the DASH diet having the most substantial effect..
6	Xu et al. (2020)	Evaluating the effects of a comprehensive intervention including nutritional education and physical activity on children's blood pressure.	Comprehensive intervention in children in China with monitoring over two semesters.	Moderate reduction in blood pressure was observed in the intervention group compared to the control group.
7	Filippou et al. (2021)	Assessing the effect of the Mediterranean diet on blood pressure compared to a regular diet or other dietary interventions.	Mediterranean diet vs. regular diet or other dietary interventions.	The Mediterranean diet reduces blood pressure compared to a regular diet or several other dietary interventions, particularly in

				subjects with high baseline blood pressure.
8	Xue et al. (2021)	Evaluating the effect of dietary fiber supplements on blood pressure and gut microbiota in hypertensive patients.	Oat bran fiber supplementation in hypertensive patients.	Fiber supplementation enhances blood pressure health and alters gut microbiota composition
9	Hosseinpour-Niazi et al. (2022)	Investigating the effects of legumes on blood pressure and urinary sodium-potassium in patients with type 2 diabetes.	Traditional DASH diet vs. legume-based DASH diet.	A more significant reduction in blood pressure and urinary sodium occurred in the legume-based DASH diet group.
10	de Paula (2017)	Investigating the effects of micronutrients on blood pressure in patients with type 2 diabetes.	Sodium, vitamin C, vitamin D, and magnesium supplementation in patients with type 2 diabetes.	Vitamin D and possibly vitamin C have beneficial effects on blood pressure in patients with type 2 diabetes.

The discourse underscores the pivotal significance of nutritional interventions in the management of hypertension, as elucidated by several conducted studies. Research conducted by Lu et al. (2019) highlights the significant impact of interventions facilitated through mobile health (mHealth) technology on blood pressure management, particularly among populations initially grappling with poorly controlled blood pressure. These findings advocate for the potential utility of interactive approaches via mHealth as effective tools to augment blood pressure control among adults, especially those initially contending with suboptimal blood pressure control. Correspondingly, a study by Moreira-Rosário et al. (2023) elucidates that programs aimed at curbing salt intake effectively reduce blood pressure, particularly among individuals at elevated risk of hypertension. This underscores the imperative of empowerment-based strategies in reducing blood pressure by bolstering health literacy, ultimately fostering adherence to the Mediterranean diet and promoting weight loss.

Conversely, investigations by Schwingshackl et al. (2019) and Gay et al. (2016) underscore the pivotal role of specific dietary patterns in mitigating blood pressure. The Dietary Approaches to Stop Hypertension (DASH), a meticulously crafted eating regimen aimed at ameliorating blood pressure, has emerged as a proven and effective dietary paradigm in blood pressure reduction. Studies indicate that this approach may yield the most pronounced benefits among various dietary interventions. Additionally, research by Xue et al. (2021) corroborates that adequate dietary fiber supplementation can also confer substantial benefits in lowering blood pressure and modulating gut microbiota composition.

The DASH regimen, as explicated by Murtaugh et al. (2018), predominantly entails dietary protocols entailing stringent limits on salt intake—up to 2,300 mg per day (or 1,500 mg per day for individuals with hypertension)—and underscores the importance of consuming potassium, magnesium, calcium, and fiber-rich fruits, vegetables, and whole grains. Furthermore, the diet mandates constraints on saturated fat intake, limiting it to 6% of total daily caloric intake, and on total fat intake, capping it at 27% of daily caloric intake. Empirically, DASH emerges as a formidable instrument for blood pressure management, as attested by a meta-analysis conducted by Hill (2022), encompassing 23 studies and 4,556 individuals, which elucidated that adherence to the DASH diet could elicit a reduction in average systolic blood pressure by 5.5 mmHg and diastolic blood pressure by 3.2 mmHg. Moreover, a study by Juraschek et al. (2017) involving 82 individuals with hypertension substantiated that the DASH regimen yielded a mean reduction in systolic blood pressure by 11.4 mmHg and diastolic blood pressure by 5.5 mmHg over an 8-week timeframe.

In a specified context, the study conducted by Lee et al. (2018) elucidates that lifestyle modifications encompassing dietary adjustments and home-based physical exercises prove efficacious in lowering blood pressure, particularly among cohorts exhibiting elevated baseline blood pressure levels. Likewise, research by Xu et al. (2020) accentuates the significance of early-life interventions in the prevention of hypertension, demonstrating that comprehensive interventions implemented within educational settings yield moderate effectiveness in averting hypertension incidence among juveniles. Collectively, the research outcomes underscore the paramount importance of comprehensive and diverse nutritional strategies in hypertension management. The Dietary Approaches to Stop Hypertension (DASH) diet, reduction in sodium consumption, dietary fiber supplementation, and early-life interventions all assume pivotal roles in blood pressure regulation. Moreover, empowerment-centric approaches and the integration of technologies such as mobile health (mHealth) emerge as efficacious modalities in bolstering blood pressure management within vulnerable demographics. Hence, emphasis on fostering healthy dietary patterns, promoting active lifestyles, and implementing early interventions is anticipated to contribute significantly to the holistic and enduring mitigation of hypertension challenges.

Conclusion

The conclusion of this meta-analysis asserts the significant role of nutritional interventions in controlling hypertension. Various approaches such as salt intake reduction programs, DASH dietary patterns, dietary fiber supplementation, and early-life interventions have proven effective in lowering blood pressure in individuals with hypertension or high hypertension risk. The implication is that a holistic and diverse approach to nutritional interventions needs to be emphasized in hypertension management, with an emphasis on individual empowerment and the utilization of technology to facilitate better interaction between healthcare providers and patients.

Further recommendations include enhancing public health education and literacy regarding the importance of healthy dietary patterns, salt reduction, and active lifestyles in hypertension control. Nutritional intervention programs also need to be expanded to various age groups, including children, with a focus on early interventions in school and community settings. The development of mHealth technology should also be further encouraged to facilitate continuous blood pressure monitoring and the delivery of personalized health information. Additionally, the integration of nutritional interventions into broader healthcare systems is also crucial to ensure accessibility and continuity of care for individuals with hypertension. Thus, collaborative efforts among individuals, communities, and healthcare providers can help address the issue of hypertension in a holistic and sustainable manner.

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