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*LITERATURE REVIEW*

# SMOKING, PHYSICAL INACTIVITY AND DIETARY WITH HYPERTENSION IN THE ELDERLY: A SYSTEMATIC REVIEW AND META-ANALYSIS

***Merokok, Aktivitas Fisik, dan Pola Diet dengan Hipertensi pada Lansia: Sistematik Review dan Meta Analisis***

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**ABSTRACT**

**Background:** The condition of the elderly can affect blood pressure because they may struggle to balance both psychologically and physiologically. Lifestyle can affect risk factors for hypertension. **Purpose:** To examine lifestyle risk factors for the incidence of hypertension in the elderly with a systematic review and meta-analysis. **Methods:** Eight electronic databases, including PubMed, Science PubMed, ScienceDirect, NCBI, ProQuest, and EBSCO Journals Online, were searched for studies published in English from 2017 to December 2023. Quality was assessed using the Joanna Briggs Institute (JBI) for cross-sectional and case-control studies. We further categorized the outcomes into smoking, physical activity, Diet, and hypertension in the elderly. We analyzed them using the Review Manager 5.3 application with both fixed-effect and random-effect models. **Results:** Eight studies and 30,821 subjects were included, with fair to excellent quality. Based on the meta-analysis, not dieting (AOR = 1.37; 95% CI = 1.17-1.61; p < 0.001) was a statistically significant risk factor for hypertension in the elderly. **Conclusion:** Not dieting is are risk factor for hypertension in the elderly.



***ABSTRAK***

***Latar Belakang:*** *Kondisi lansia dapat mempengaruhi tekanan darah karena tidak mampu menyeimbangkan secara psikologis dan fisiologis. Gaya hidup dapat mempengaruhi faktor risiko hipertensi. Tujuan: Untuk mengkaji faktor risiko gaya hidup terhadap kejadian hipertensi pada*

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*lansia dengan telaah sistematis dan metaanalisis.* ***Metode:*** *Delapan basis data elektronik, yaitu: PubMed, Science PubMed, Science Direct, NCBI, ProQuest, dan EBSCO Journals Online, ditelusuri untuk studi yang diterbitkan dalam bahasa Inggris dari tahun 2017 hingga Desember 2023. Joanna Briggs Institute (JBI), Meta-Analysis of Statistics Assessment dan instrumen tinjauan untuk ekstraksi data, penilaian kualitas. Merokok, aktivitas fisik, diet dengan hipertensi pada lansia dan dianalisis menggunakan aplikasi Review Manager 5.3. Dari total 3411 artikel, 8 disertakan dan dianalisis.* ***Hasil:*** *Kami mengidentifikasi 8 artikel, dan hasilnya secara statistik aktivitas fisik yang signifikan (AOR= 1,04; 95% CI= 0,70 hingga 1,54; p= 0,860) dan tidak melakukan diet (AOR= 1,37; 95% CI= 1,17 -1,61; p<0,001) merupakan faktor risiko hipertensi pada lansia.* ***Simpulan:*** *Aktivitas fisik dan tidak melakukan diet merupakan faktor risiko hipertensi pada lansia.*



## INTRODUCTION

The older population is rising, and a majority with hypertension is elderly (1). Hypertension (high blood pressure) is indeed a complex and multifactorial condition that involves a disruption in the hemodynamic balance of the cardiovascular system. It cannot be attributed to a single cause but rather results from the interplay of several risk factors, both modifiable and non-modifiable, that influence blood pressure (2). Growing issue involves improving awareness, regular screening, and promoting healthier lifestyles, especially in older populations. Blood pressure control, achieved through medication and lifestyle changes (e.g., reducing salt intake, exercising, and managing stress), is crucial in preventing complications related to hypertension (2,3). Aging hypertension involves a comprehensive approach that includes frequent monitoring, good lifestyle choices, and close interaction with healthcare providers to customize a treatment plan. Older persons can lower their risk of serious medical conditions like heart disease, stroke, and kidney damage by managing their blood pressure (3). In the world, the estimation of the prevalence of hypertension in the elderly is increasing by 29% to 32% in 2025 (2). There are deaths from hypertension in Southeast Asia, around 1.5 million people (4).

The increase in hypertension prevalence in Indonesia from 25.80% in 2013 to 34.10% in 2018 highlights a concerning public health trend (5). Promoting healthy lifestyle choices for the elderly is essential in managing and preventing hypertension. By focusing on Diet, physical activity, weight management, and other key factors, we can improve the quality of life for older adults while reducing the strain on healthcare systems (6–8). However, there is no significant lifestyle associated with the risk of hypertension in the elderly. Physical inactivity, smoking, and Diet are risk factors for hypertension in the elderly (9–13). However, physical inactivity and smoking were less likely to cause hypertension in the elderly (14).

Based on the literature study conducted, various research results were found, which served as a valuable research reference. Elderly individuals with hypertension can significantly reduce their risk of serious complications such as stroke, heart disease, and kidney damage, ultimately improving their quality of life and longevity. The research aims to analyze and review articles on risk factors for hypertension, specifically lifestyle factors such as smoking, physical activity, and Diet, in relation to the incidence of hypertension in the elderly, using a systematic review method and meta-analysis.

## METHODS

We are searching for research articles published in PubMed, ScienceDirect, NCBI, ProQuest, and EBSCO from January 2017 to December 2023. The following search terms are used in the database: MeSH (Medical Subject Headings) and Boolean usage (hypertension or high blood pressure) AND (aged or elderly) AND (smoking or smoking) AND (diet or eating patterns) AND (physical activity).

This study is a systematic review of the PRISMA method. A systematic review begins with the presentation of research according to the research topic, specifically through the stages of screening, feasibility, and inclusion, to answer the research questions (15). Articles considered for inclusion were cross-sectional or case-control studies, articles with full text accessibility, research

articles that examined independent lifestyle variables (such as smoking, physical activity, and Diet), and research articles on hypertension in the elderly written in English.

This systematic review was conducted and reported in adherence to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Assessment of data quality using the tools of the Joanna Briggs Institute Critical Appraisal (JBI) with numbers that aim to determine the value of validity, the importance of the Journal, and the results of the contents of articles (15). The data collection stage involved several key steps, including data search, data filtering, overall data assessment, data search results, and data extraction. We demonstrate a meta-analysis to estimate the effect of at least studies extracted from the computational analysis using the Review Manager 5.3 application. In all included studies, effect estimates were reported as 95% Adjusted Odds Ratios (AORs) with 95% Confidence Intervals (95% CI).

## RESULTS

A total of 36,575 articles were found. The results of the analysis using the prism method are shown in Table 2. A total of 33,164 scientific articles were excluded because they met the exclusion criteria, namely, research articles in the form of abstracts, research articles in the form of proceedings, research articles in publication manuscripts, and duplicate research articles. Articles obtained eight scientific articles were obtained (Figure 1).

### Smoking

There is a significant relationship between smoking and the incidence of hypertension in the elderly (16,17). Smoking is a critical factor in cardiovascular health at any age, and quitting smoking is strongly recommended for long-term health benefits, particularly for older individuals who may have multiple health issues.

The number of articles combined to analyze the relationship between smoking and hypertension was seven, comprising a cross-sectional descriptive analysis study design. The following is the result of a meta-analysis of the relationship between smoking and hypertension in the elderly.

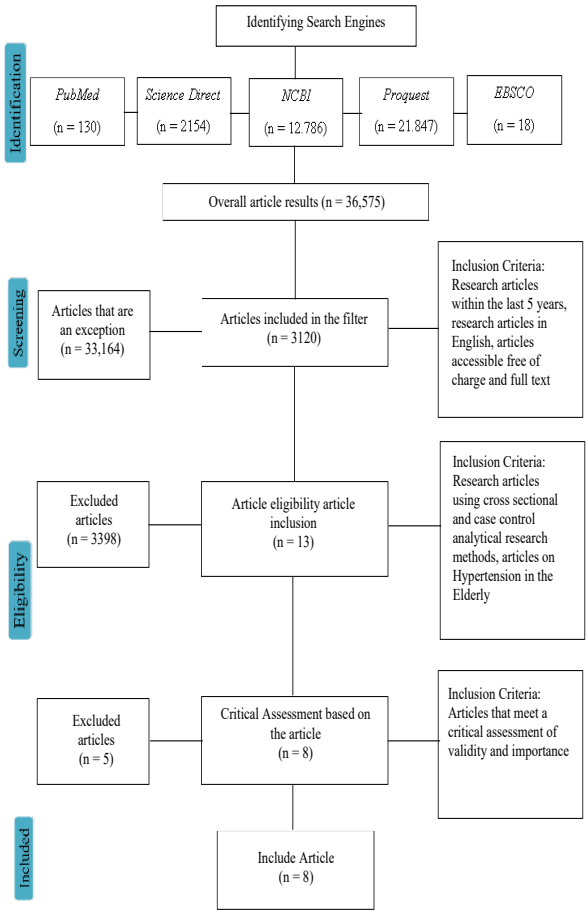


**Figure 1.** PRISMA Flowchart

### Smoking and Hypertension in the Elderly

Figure 2 shows that smoking is a protective factor for hypertension in the elderly. Elderly smokers had the possibility (likely) to experience hypertension 0.85 times compared to elderly who do not smoke, and this result is not statistically significant (AOR= 0.85; 95% CI= 0.66 to 1.09; p= 0.190). The heterogeneity of research data is indicated by I2 = 95%, which suggests that the effect estimates between primary studies in this meta-analysis vary significantly. Thus, the calculation of the average effect estimate is performed using the random effects model approach.

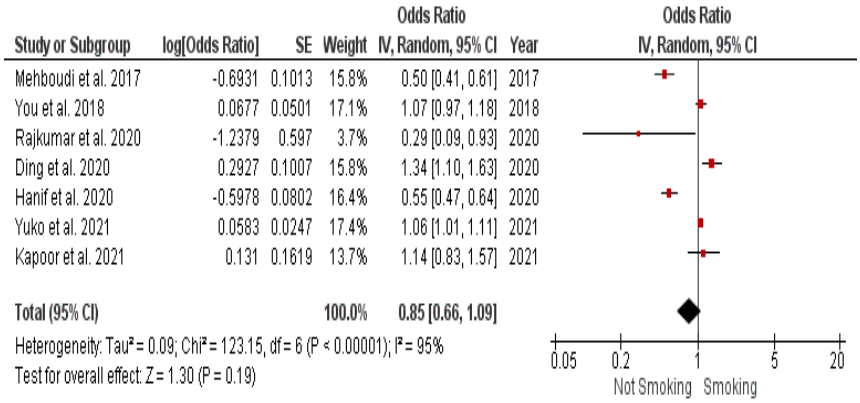


**Figure 2.** Forest Plot of The Effect of Depression on Hypertension

**Physical Activity**

Physical activity plays a crucial role in the prevention and management of hypertension (high blood pressure), but it is only one part of a larger condition. Regular exercise is beneficial, but addressing other lifestyle factors is also essential for optimal health in the elderly. The number of articles combined to analyze the relationship between physical activity and hypertension was five, all of which employed a cross-sectional study design. According to a meta-analysis, physical activity is correlated with hypertension in the elderly (Figure 3).

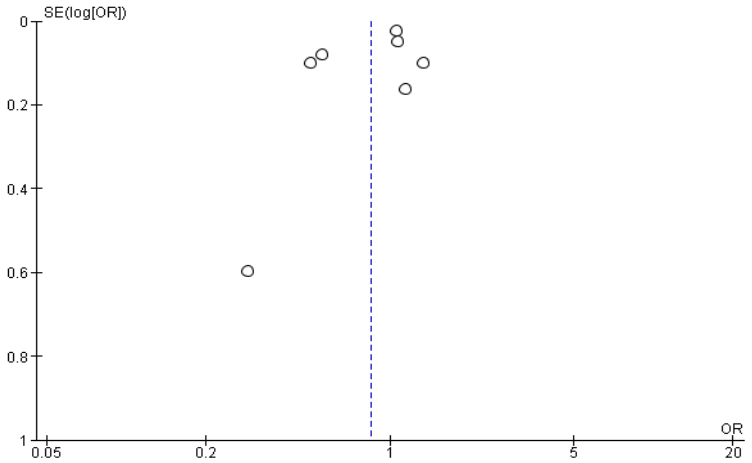


**Figure 3.** Funnel Plot of The Effect of Therapy on Hypertension

**Physical Activity and Hypertension in The Elderly**

Figure 4 illustrates that not engaging in physical activity increases the incidence of hypertension in the elderly. The elderly who do not engage in physical activity have a 1.04 times higher risk of experiencing hypertension compared to the elderly who engage in physical activity, but this result is not statistically significant (AOR = 1.04; 95% CI = 0.70 to 1.54; p = 0.860). The heterogeneity of the research data was evident, with an I2 value of 93%, indicating that the effect estimates between primary studies in this meta-analysis varied significantly. Thus, based on the analysis of the average effect estimate is carried out using the random effect model approach.

Figure 5 shows that the distribution of effect estimates from the primary study meta-analysis is symmetrically located to the right and left of the vertical line representing the mean estimate, indicating the absence of publication bias.

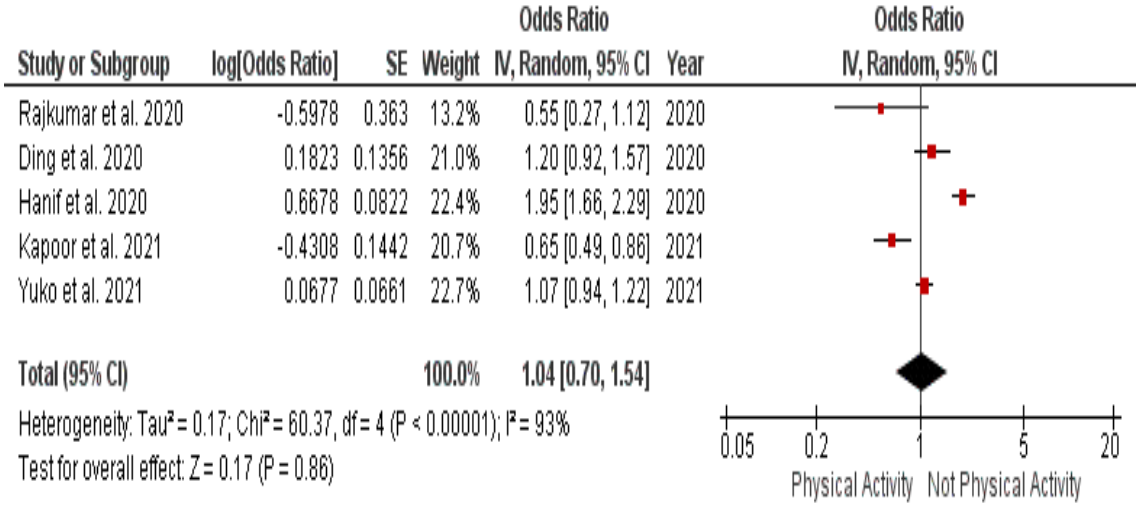


**Figure 4.** Forest Plot of Not Physical Activity for Hypertension

**Diet**

According to Table 2, dietary salt intake and hypertension are particularly significant among the elderly. Furthermore, individuals who are salt-sensitive should reduce their salt intake, as it is an effective strategy for managing hypertension in this age group. Dietary factors may not be at risk of hypertension compared to respondents who do not have hypertension. In accordance with the theory that not dieting is a risk factor that can increase high blood pressure or hypertension. Currently, dietary factors are the main cause of hypertension. Doing a diet can prevent hypertension. However, in other studies, the results showed that there was no significant relationship between Diet and hypertension (8,10). This difference is attributed to the adoption of a healthy lifestyle from a young age, which involves maintaining a balanced diet and consuming a variety of fruits and vegetables (10).

The number of articles combined to analyze the relationship between Diet and hypertension was three, with a cross-sectional study design. Based on the results of a meta-analysis related to Dietary among hypertension in the elderly.

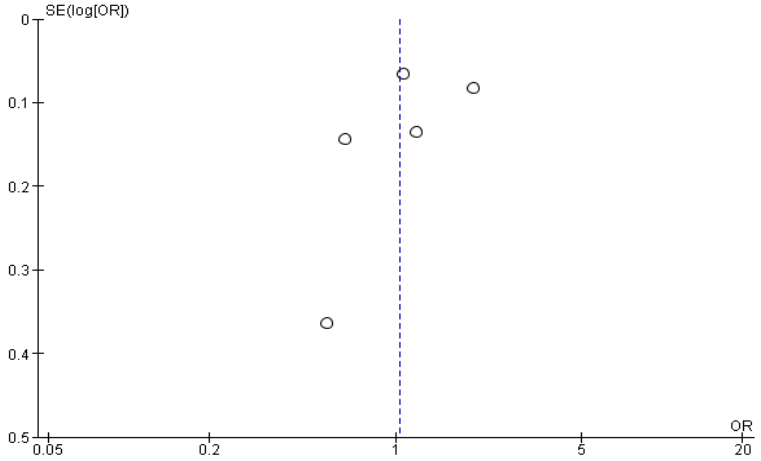


**Figure 5.** Funnel Plot of Not Physical Activity for Hypertension

**Diet and Hypertension in the Elderly**

Figure 6, a forest plot, shows that Diet does not increase the incidence of hypertension in the elderly. The elderly who did not follow a Diet had a 1.37 times higher risk of developing hypertension compared to the elderly who followed a Diet, and this result was statistically significant (AOR = 1.37; 95% CI = 1.17 to 1.61; p<0.001). The heterogeneity of research data is indicated by I2 = 0%, which suggests that the effect estimates between primary studies in this meta-analysis are homogeneous. Thus, the calculation of the average effect estimate is performed using the fixed effects model approach.

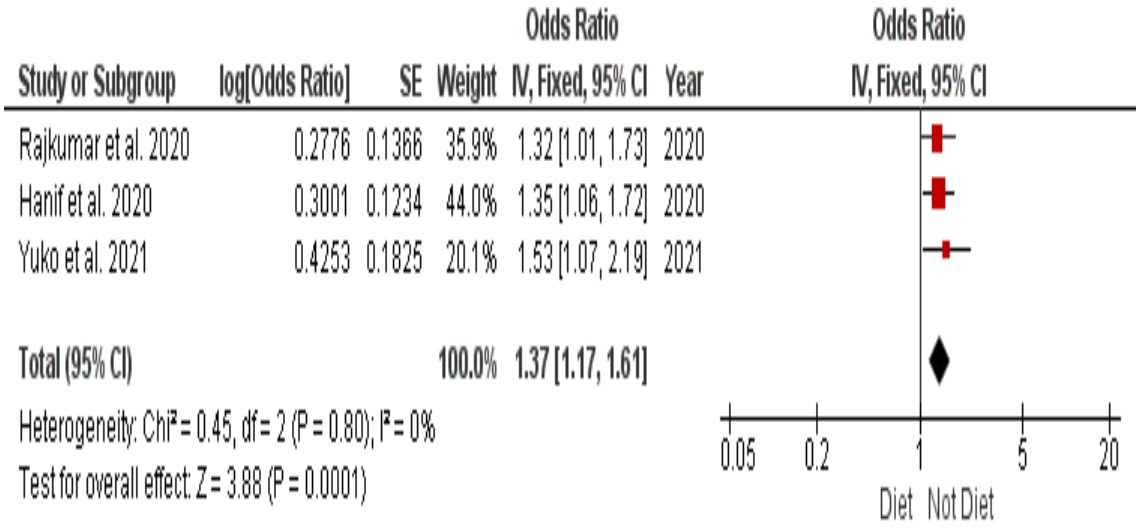


**Figure 6.** Forest Plot of Not Diet for Hypertension

Figure 7, a funnel plot, shows that the estimated distribution of effects from the primary study meta-analysis lies more to the right of the vertical line representing the mean estimate than to the left, indicating publication bias. Because the publication bias tends to be to the right of the average vertical line in the same direction as placing the diamond shape on the forest plot, the publication bias tends to overestimate the effect of not dieting on the incidence of hypertension in the elderly (overestimate).

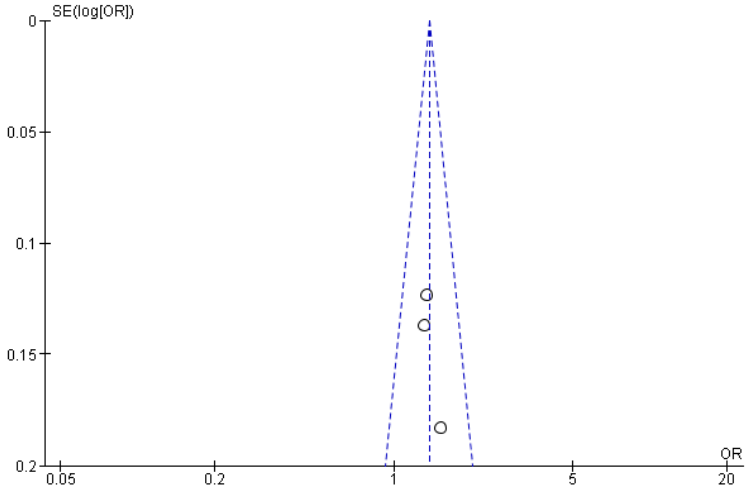


**Figure 7.** Funnel Plot of The Effect of Diet on Hypertension in The Elderly

**Table 2**
Results of The Analysis of The Correlation Between Lifestyle (Smoking, Physical Activity, Diet) and The Incidence of Hypertension in The Elderly

| Author (Year, Location) | Sample Size/ Age | Smoking | Physical Activity | Diet | Key Findings |
|---|---|---|---|---|---|
| Yamaguchi (2021, Philippines) | 168 / ≥50 yrs | Significant correlation | No significant correlation | Significant correlation (salt intake) | Smoking and a high-salt Diet are associated with hypertension; physical activity is not significant. |
| Kapoor et al. (2021, India) | 897 / >50 yrs | No significant correlation | Significant correlation | - | Physical activity reduces hypertension risk; smoking is not significantly associated. |
| Kimani et al. (2019, Kenya) | 229/>50 years | Significant correlation | - | Significant correlation | Smoking and a high-salt Diet are associated with hypertension; physical activity has not been researched. |
| Ding et al. (2020, China) | 302/ > 45 years | Significant correlation | Significant correlation | - | Smoking and Physical Activity are associated with hypertension; Diet has not been researched. |
| Rajkumar (2020, India) | 263 Participants | Significant correlation | Significant correlation | Significant correlation | Smoking, high-salt Diet, and physical activity are associated with hypertension |
| Hanif et al. (2021, Bangladesh) | 2482/≥60 years | Significant correlation | Significant correlation | No, Significant correlation | Smoking and Physical Activity are associated with hypertension; Diet has not been researched. |
| Mehboudi et al. (2017, Iran) | 3000/⩾60 years | No, Significant correlation | - | - | Smoking is not associated with hypertension; Physical Activity and Diet have not been researched. |
| You et al. (2018, China) | 7113/ ⩾ 45 years | Significant correlation | - | - | Smoking is associated with hypertension; Physical Activity and Diet have not been researched. |

## DISCUSSION

This systematic review and meta-analysis investigated the risk factors associated with hypertension. 50% of the articles stated that there was a significant relationship between smoking and the incidence of hypertension in the elderly; the variable physical activity was known to be 37.50%, and there was a significant relationship between physical activity and the incidence of hypertension in the elderly. In contrast, eating patterns were known; 50% stated that there was a relationship between Diet and incidence of hypertension in the elderly.

Hypertension is prevalent in the elderly population, and its management requires tailored approaches that take into account the complexities of aging. Lifestyle changes, proper medication management, and regular monitoring of blood pressure are essential to control hypertension and prevent its complications in older adults. In this regard, systolic blood pressure increases, while diastolic blood pressure decreases after the age of 60 years. These mechanisms reflect the complex and interconnected factors that drive hypertension in the elderly, underlining the need for a nuanced understanding of this condition in older populations to guide effective treatment and management strategies (13,18). The effects of untreated hypertension are widespread and serious. It can reduce life expectancy by 10-20 years and drastically impair quality of life. However, managing and lowering blood pressure can prevent these complications. Studies have also shown that controlling hypertension can help protect against cognitive decline and dementia, further emphasizing the importance of early detection and treatment. Therefore, it is essential to monitor blood pressure regularly and seek medical advice if levels are high, to prevent damage to organs and improve overall health and longevity (7,11). Although some are significant. However, in other studies, there is no relationship between smoking and hypertension in the elderly (19).

Managing hypertension effectively requires a comprehensive, multifaceted approach that combines healthy lifestyle changes with appropriate medical treatments. By adopting these strategies, individuals can enhance their cardiovascular health, lower the risk of complications, and lead a healthier life (20). Aged 15 years and over obtained data on risk factors, such as the proportion of people who eat less vegetables and fruit by 95.50%, the proportion of lack of physical activity is 35.50%, the proportion of smoking is 29.30%, and the proportion of central obesity is 31%. The proportion of general obesity is 21.80%. The data above demonstrates were increasing when compared to 2013.

An important lifestyle modification that has been shown to lower blood pressure is reducing body weight for individuals who are obese or overweight. Adopting the DASH (Dietary Approaches to Stop Hypertension) Diet, which is rich in potassium and calcium, along with a low-sodium diet, regular physical activity, and reduced alcohol consumption, can also help. In some patients, blood pressure is well controlled on single antihypertensive therapy, and reducing salt and body weight can free patients from drug use. JNC VII recommends the DASH diet, a diet rich in fruits, vegetables, and low-fat dairy products with reduced levels of total fat and saturated fat. The recommended sodium is <2.4 g (100 ml)/day (9). However, it is crucial for patients, especially those with existing target organ damage (such as heart, kidney, or eye complications due to high blood pressure), to consult their healthcare provider before starting an exercise regimen. A healthcare professional can recommend the most suitable type and intensity of exercise, tailored to individual health needs (12).

Alcohol consumption and smoking are significant independent risk factors for cardiovascular disease, and their combined effects in hypertensive individuals are particularly detrimental. Smoking accelerates atherosclerosis and elevates blood pressure, exacerbating. Managing hypertension effectively requires a comprehensive, multifaceted approach that combines healthy lifestyle changes with appropriate medical treatments. By adopting these strategies, individuals can enhance their cardiovascular health, lower the risk of complications, and lead a healthier life (20). Aged 15 years and over obtained data on risk factors, such as the proportion of people who eat less vegetables and fruit by 95.50%, the proportion of lack of physical activity is 35.50%, the proportion of smoking is 29.30%, and the proportion of central obesity is 31%. The proportion of general obesity is 21.80%. The data above demonstrates were increasing when compared to 2013.

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alcohol consumption, is also an effective strategy. In some patients, blood pressure is well controlled on single antihypertensive therapy, and reducing salt and body weight can free patients from drug use. JNC VII recommends the DASH diet, a diet rich in fruits, vegetables, and low-fat dairy products with reduced levels of total fat and saturated fat. The recommended sodium is <2.4 g (100 ml)/day (9). However, it is crucial for patients, especially those with existing target organ damage (such as heart, kidney, or eye complications due to high blood pressure), to consult their healthcare provider before starting an exercise regimen. A healthcare professional can recommend the most suitable type and intensity of exercise, tailored to individual health needs (12).

Alcohol consumption and smoking are significant independent risk factors for cardiovascular disease, and their combined effects in hypertensive individuals are particularly detrimental. Smoking accelerates atherosclerosis and elevates blood pressure, exacerbating the risk for heart disease and stroke. Therefore, hypertensive patients who smoke should receive targeted counseling to quit smoking and reduce alcohol intake, along with regular monitoring and treatment to manage their hypertension (21). The combination of smoking, excessive alcohol consumption, and high blood pressure can significantly increase the risk of cardiovascular diseases. These factors contribute to a vicious cycle that damages the arteries, raises the heart's oxygen demand, and further strains the cardiovascular system.

There are eight articles, and the results obtained indicate that there is a relationship between smoking, physical activity, and Diet with hypertension. However, several variables were not studied, namely age (4), Diet (22–26), and physical activity (17,24,25). Thus, the results obtained can be predicted to be subject to analysis bias in this study. We also conducted meta-analyses using a random-effects model to pool the effect estimates of several frequently reported factors. Additionally, we separately pooled the estimates of factors from high-quality studies using the JBI (15).

### Research Limitations

The weakness of this research lies in the differences in population, criteria inclusion, method, and categorization of variables. Nonetheless, the quality of studies that have undergone the selection process as automatic monitors can reduce the possibility of bias and test heterogeneity.

## CONCLUSION

Based on a systematic review of research, it is known that a lifestyle consisting of smoking, physical activity, and Diet is one of the lifestyles that can affect the incidence of hypertension in the elderly.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

## AUTHOR CONTRIBUTIONS

FN is responsible for planning, data collection, data analysis, and drafting of the manuscript. AI does the analysis and filtering of the data, while MI prepares the scripts. N is responsible for data collection, data analysis, and cross-sectoral coordination. All authors also read and approved the final manuscript.

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