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The Impact of the Mediterranean Diet on Blood Pressure Reduction and Cardiovascular Outcomes in Patients with Arterial Hypertension: A Systematic Review

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ABSTRACT

Arterial hypertension is a major modifiable risk factor for cardiovascular diseases. Despite available pharmacological treatments, achieving optimal blood pressure control remains a global health challenge. Non-pharmacological interventions, particularly dietary optimization, play a crucial role in hypertension management. The Mediterranean diet has gained significant attention due to its cardioprotective properties. Objective: This systematic review aims to evaluate the effectiveness of the Mediterranean diet in reducing systolic and diastolic blood pressure and improving cardiovascular outcomes in patients with arterial hypertension. Methods: A systematic literature search was conducted following the PRISMA guidelines. Authors searched PubMed, Web of Science, and Scopus databases for clinical trials, observational studies, and meta-analyses published up to 2024. Search terms included "Mediterranean diet", "arterial hypertension", "blood pressure", and "cardiovascular risk". Studies evaluating specific dietary interventions with clearly reported quantitative blood pressure outcomes were included. Results: Adherence to the Mediterranean diet significantly reduces cardiovascular risk by improving lipid profiles, glycemic control, and blood pressure regulation. Evidence suggests consistent reductions in both systolic and diastolic blood pressure. These benefits are driven by mechanisms such as reduced systemic inflammation, improved endothelial function, increased vascular elasticity, and beneficial modulations of the gut microbiota. Conclusion: Incorporating the Mediterranean diet into hypertension management represents an effective and evidence-based strategy for cardiovascular disease prevention. It supports a comprehensive lifestyle approach that is vital for optimal cardiovascular health.

Keywords: Mediterranean diet, arterial hypertension, cardiovascular diseases, disease prevention, dietary interventions, blood pressure control

1. INTRODUCTION

Arterial hypertension is one of the most prevalent modifiable risk factors for cardiovascular diseases, significantly contributing to the incidence of coronary artery disease, stroke, and heart failure. Globally, the prevalence of hypertension continues to rise, imposing a massive clinical and economic burden on healthcare systems. Although pharmacological treatments are highly effective, achieving optimal blood pressure targets in the general population remains inconsistent. Consequently, non-pharmacological interventions, including regular physical activity, weight management, and targeted nutritional strategies, are positioned as the cornerstone of hypertension prevention and management.

Among various dietary patterns, the Mediterranean diet (MedDiet) is widely recognized as one of the best-documented nutritional models possessing potent cardioprotective effects. The MedDiet is characterized by a high intake of vegetables, fruits, whole grains, legumes, and fish; the use of extra virgin olive oil as the primary fat source; and the moderate consumption of animal products, dairy, and red wine. Numerous epidemiological studies and large-scale clinical trials have continually demonstrated an inverse relationship between MedDiet adherence and cardiovascular morbidity.

Despite the abundance of literature discussing the cardiovascular benefits of the MedDiet, many existing reviews amalgamate hypertension with other metabolic syndromes or fail to critically synthesize the exact magnitude of blood pressure reduction. Furthermore, there is a need to distinguish the direct effects of the MedDiet from associated confounders such as sodium reduction or weight loss. Moreover, the integration of new diagnostic models and precision medicine techniques necessitates updated perspectives on evaluating dietary impacts on clinical outcomes.

Therefore, the objective of this systematic review is to comprehensively evaluate the specific impact of the Mediterranean diet on blood pressure reduction in patients with arterial hypertension. This review aims to synthesize recent clinical and mechanistic evidence, assess the methodological quality of available studies, and highlight the biological mechanisms driving these hypotensive effects. By addressing conflicting data and methodological limitations in current research, this review provides an updated synthesis to guide both clinical practice and future nutritional investigations.

2. MATERIALS AND METHODS

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2.1 Search Strategy and Data Sources.

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive literature search was performed using three major electronic databases: PubMed/MEDLINE, Scopus, and Web of Science. The search strategy employed a combination of Medical Subject Headings (MeSH) and free-text terms. The primary keywords used were: ("Mediterranean diet" OR "MedDiet") AND ("arterial hypertension" OR "high blood pressure" OR "systolic blood pressure" OR "diastolic blood pressure") AND ("cardiovascular risk" OR "endothelial function"). The search was restricted to articles published in English, with a focus on literature from the last decade to ensure the inclusion of the most current clinical evidence.

2.2 Inclusion and Exclusion Criteria.

To ensure the high quality and relevance of the summarized data, strict selection criteria were applied. The inclusion criteria were: (1) randomized controlled trials (RCTs), prospective cohort studies, and significant meta-analyses; (2) studies specifically reporting changes in systolic blood pressure (SBP) or diastolic blood pressure (DBP) as primary or secondary outcomes; (3) study populations exclusively comprising adults (over 18 years of age) with diagnosed prehypertension or arterial hypertension. The exclusion criteria were: (1) non-peer-reviewed articles, editorials, and conference abstracts; (2) studies where the Mediterranean diet was inseparable from other major lifestyle interventions that obscured the diet's specific effect; (3) studies lacking quantitative blood pressure data; and (4) animal models or purely in vitro studies.

2.3 Study Selection and Data Extraction.

Initial screening of titles and abstracts was performed to remove duplicates and irrelevant records. Full texts of potentially eligible articles were then retrieved and evaluated against the predefined criteria. Extracted data included study design, characteristics of the study population, duration of the dietary intervention or observation period, specific dietary components analyzed, and quantitative outcomes regarding blood pressure reduction.

2.4 Quality Assessment and Risk of Bias.

The methodological quality and risk of bias of the included studies were evaluated. For observational studies, criteria based on the Newcastle-Ottawa Scale were utilized, assessing selection bias, comparability, and outcome assessment. For RCTs, the Cochrane Collaboration's tool for assessing risk of bias was considered, evaluating aspects such as randomization, allocation concealment, blinding, and handling of incomplete outcome data. A critical evaluation of these methodological aspects is integrated into the discussion section of this review.

Overall, the initial database search yielded 485 records across the selected databases. After removing 124 duplicate entries, the remaining 361 titles and abstracts were screened for relevance. Of these, 283 were excluded for not meeting the inclusion criteria (e.g., non-clinical focus, animal models, or irrelevant topics). The full texts of the remaining 78 articles were thoroughly assessed for eligibility. During this phase, an additional 38 studies were excluded, primarily due to a lack of quantitative blood pressure outcomes or the presence of inseparable concurrent lifestyle interventions. Ultimately, 40 studies and meta-analyses met all criteria and were included in this systematic review.

3. RESULTS AND DISCUSSION

3.1 Magnitude of Blood Pressure Reduction.

Recent large-scale meta-analyses and umbrella reviews have consistently demonstrated that high adherence to the Mediterranean diet effectively lowers both systolic (SBP) and diastolic blood pressure (DBP). However, the absolute magnitude of reduction varies across literature due to differences in baseline population health, follow-up duration, and study designs. In primary prevention samples characterized by normotension or prehypertension, the SBP reduction is typically moderate, ranging from 2.0 to 4.0 mmHg. Conversely, in targeted populations—such as older adults with established vascular stiffness—SBP reductions can reach 5.5 mmHg, as demonstrated by Jennings et al. [3]. Highly supervised clinical interventions featuring rigorous adherence monitoring have occasionally reported reductions up to 9.2 mmHg, though such within-group improvements are rarely sustained in free-living conditions [8, 12, 14]. Thus, framing the expected clinical outcome requires differentiating between tightly controlled trials and real-world dietary habits: a population-wide average SBP reduction of 3–5 mmHg is the most realistic estimate. At the population level, even a 2 mmHg decrease in SBP translates into a 10% lower risk of stroke mortality, highlighting the clinical relevance of the MedDiet pattern.

3.2 Disentangling Dietary Effects from Confounders.

A critical issue in nutritional epidemiology is separating the intrinsic, direct effects of the MedDiet from residual confounders. Notably, components of the Mediterranean diet—such as high fiber intake and a low glycemic index—naturally promote satiety and facilitate weight loss. Because a 1 kg reduction in body weight translates to approximately a 1 mmHg drop in SBP, part of the blood pressure reduction attributed to the MedDiet in free-living populations is heavily confounded by concurrent weight reduction [31,33]. Additionally, while the traditional MedDiet is not inherently a low-sodium regimen, adoption of this diet often correlates with a marked reduction in ultra-processed food consumption, inadvertently leading to decreased dietary sodium intake. Strict adjustment for body mass index (BMI) changes, physical activity levels, and urinary sodium excretion in recent trial analyses narrows the direct hypotensive effect size. Consequently, while the synergistic combination of biological compounds from the MedDiet holds substantial merit, the diet is most effective when integrated into a lifestyle modification package encompassing weight management and controlled sodium consumption [10, 36].

3.3 Conflicting Evidence and Potential Adherence Challenges.

Despite overwhelming evidence favoring the MedDiet, several large observational studies highlight conflicting or neutral findings that warrant critical evaluation. For instance, findings from specific subgroups within the SUN cohort [32] and metabolic meta-analyses [24] noted instances where high nominal adherence to the MedDiet was paradoxically linked to higher SBP or no significant blood pressure benefit. These discrepant results can be primarily attributed to methodological limitations: the use of self-reported food frequency questionnaires (FFQs) often leads to misclassification bias and overestimation of adherence by participants. Furthermore, variations in the quality of "Mediterra-

nean components" (e.g., consumption of commercially processed versus freshly prepared olive oil and wine) can shift the dietary health profile. Furthermore, the universal implementation of the MedDiet faces socioeconomic challenges globally, as accessibility to high-quality extra virgin olive oil and fresh fish remains a barrier for low-income demographics in non-Mediterranean countries. These conflicting notes underscore the need for culturally adapted, accessible variations of the MedDiet as opposed to a rigid, one-size-fits-all prescription.

3.4 Comparison with the DASH Diet.

When analyzing nutritional interventions for hypertension, the Dietary Approaches to Stop Hypertension (DASH) diet remains the reference standard. Both the MedDiet and DASH strongly emphasize fruits, vegetables, whole grains, and the limitation of red meat [36]. While DASH typically yields a higher absolute reduction in blood pressure—largely due to its strict sodium restriction (<2300 mg/day) and structured mineral equilibrium (calcium, magnesium, potassium)—the Mediterranean diet demonstrates distinct advantages in lipid profile modulation and anti-inflammatory properties, particularly through its reliance on extra virgin olive oil. Consequently, while DASH may be superior for rapid reduction of acute stage 1 hypertension, the MedDiet offers a more holistic, long-term cardiovascular risk attenuation strategy, ensuring greater overall metabolic resilience [20, 36].

3.5 Molecular and Mechanistic Action.

Recent mechanistic evidence clarifies the biological pathways by which the MedDiet limits hypertension pathogenesis. Endothelial dysfunction—driven by reduced nitric oxide (NO) bioavailability and elevated endothelin-1—is an early marker of hypertension. The polyphenolic fraction of extra virgin olive oil exhibits potent protection against free fatty acid-induced endothelial damage by suppressing the NF-κB inflammatory pathway and advanced glycation end-product (AGE) formation, restoring vascular homeostasis [13, 15]. Furthermore, the potassium–magnesium balance inherent to high vegetable and legume intake mitigates sodium retention and neural smooth muscle tone abnormalities [38]. Emerging microbiome research further indicates that the MedDiet significantly enhances gut microbiota diversity; increased dietary fiber and phenolic consumption spur the production of short-chain fatty acids (SCFAs), directly mediating reductions in vascular tone and systemic low-grade inflammation [17].

4. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

4.1 Limitations of the Reviewed Evidence.

While this review aggregates robust evidence supporting the hypotensive effects of the Mediterranean diet, several limitations within the current literature must be acknowledged. First, the high heterogeneity among studies regarding observation durations, baseline demographic health, and dietary assessment tools limits the precision of an overall calculated effect size. Many observational studies rely on self-reported Food Frequency Questionnaires (FFQs), embedding inherent recall bias and overestimation of adherence. Second, defining what constitutes the "Mediterranean diet" varies geographically; non-Mediterranean cohorts often adopt modified versions of the diet, which may alter the concentration of essential polyphenols and particular fatty acids, making direct comparisons difficult. Furthermore, a significant subset of the analyzed data originates from high-income populations, thereby limiting the unadjusted generalizability of these findings to lower-income demographics where access to premium dietary components (e.g., extra virgin olive oil, fresh seafood) is restricted. Finally, as this paper functions as a comprehensive narrative and systematic synthesis rather than a direct statistical meta-analysis, the magnitude of blood pressure reduction discussed may still carry residual confounding despite efforts to disentangle weight loss and sodium intake dynamics.

4.2 Future Research Directions.

Future investigations should prioritize long-term, multi-center randomized controlled trials that meticulously isolate the dietary components of the Mediterranean pattern from other lifestyle variables like physical activity and sodium reduction. Additionally, embracing novel methodological and analytical approaches beyond traditional biostatistics is critical to obtaining accurate, reliable, and precise clinical outcomes in dietary research. Recently, advanced multimodal data systems, machine learning architectures, and signal-processing frameworks have begun revolutionizing the precision with which physiological and nutritional endpoints are modeled [41, 42, 43]. Incorporating robust analytical designs from physics-informed methodologies and complex network simulations can significantly enhance our predictive capacity regarding cardiovascular risk and individual dietary responsiveness [44, 45, 46]. Bridging conventional nutritional epidemiology with such computational paradigms presents a promising frontier for developing personalized medicine strategies targeting arterial hypertension [47].

5. CONCLUSION

Adherence to the Mediterranean diet represents a clinically viable, evidence-based nutritional strategy for mitigating the risk of arterial hypertension and improving vascular homeostasis. This dietary pattern robustly decreases both systolic and diastolic blood pressure, while concurrently offering extensive broad-spectrum cardiovascular benefits such as lipid profile optimization, enhanced endothelial function, and the systemic reduction of oxidative stress. While the absolute reduction in blood pressure is often moderate—and particularly reliant on concurrent weight management and sodium regulation—its population-level significance in preventing stroke and coronary events is profound. However, universal implementation requires critical consideration of socioeconomic accessibility and individual adherence challenges. To maximize therapeutic efficacy, the Mediterranean diet should not be viewed as an isolated remedy but rather as the foundational pillar of a comprehensive, culturally adaptable lifestyle prescription for cardiovascular disease prevention.

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