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Excessive Dietary Salt Consumption and the Risk of Hypertension: A Systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - Universidad del cauca.

Review stage at the time of initial registration - Completed but not published.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2026110031

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 9 November 2026 and was last updated on 9 November 2026.

INTRODUCTION

Review question / Objective Dietary sodium (salt) intake is widely regarded as a modifiable determinant of blood pressure, yet the magnitude, consistency, and clinical relevance of this association across contemporary study designs remain incompletely characterized. Objective. To systematically review and quantitatively synthesize the association between reduced versus higher dietary sodium intake and systolic blood pressure (SBP) in randomized controlled trials, and to synthesize narratively the evidence on sodium intake and hypertension-related outcomes from large prospective cohorts and other study designs not amenable to quantitative pooling, in adults (≥18 years).

Rationale Contemporary systematic reviews of dietary salt and blood pressure vary considerably in their eligibility windows, their handling of crossover versus parallel trial designs, and their treatment of studies poorly suited to standard effect-size pooling, such as ecological analyses and studies lacking a genuinely comparable control condition. The apparent discordance between trial-based blood-pressure endpoints and cohort-based hard-outcome endpoints has rarely been addressed within a single synthesis that explicitly separates these two evidence streams rather than forcing them into a common quantitative framework. Furthermore, the clinical and public-health interpretation of a pooled mean difference in blood pressure requires explicit discussion of population-level implications, since even modest average reductions can translate into substantial reductions in cardiovascular events across an entire population. This review was undertaken to address these gaps.

Condition being studied Hypertension (elevated systolic blood pressure) in relation to dietary sodium (salt) intake, in adults (≥18 years).

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METHODS

Search strategy This review was conducted and is reported in accordance with the PRISMA 2020 statement. Seven bibliographic sources were searched: PubMed/MEDLINE, Scopus, Web of Science Core Collection, ScienceDirect, SpringerLink, the Cochrane Library (CDSR and CENTRAL), and Google Scholar (first 200 relevance-ranked records screened), supplemented by ClinicalTrials.gov, citation tracking of included studies, and a supplementary currency search for recently published (2024–2026) studies. Search terms combined ("excessive salt consumption" OR "dietary sodium" OR "sodium intake" OR "urinary sodium excretion") AND ("hypertension" OR "blood pressure" OR "systolic blood pressure"), restricted to human studies published in English between 1 January 1996 and 31 October 2026. In this study, the PICOS strategy was used, as detailed below. Because this is a retrospective registration, the eligibility criteria, outcomes, and statistical analysis plan reported here reflect the protocol as actually applied throughout the completed revie.

Participant or population Adults (≥18 years), including hypertensive, normotensive/high-normal, and mixed community populations.

Intervention Reduced dietary sodium or salt intake, or lower measured/estimated urinary sodium excretion, achieved through controlled feeding of defined sodium levels, behavioral dietary counseling (with or without provision of low-sodium foods), or potassium-enriched salt substitution.

Comparator Higher sodium intake or usual diet, assessed as a genuinely independent or validly paired (crossover) within-trial or within-cohort contrast.

Study designs to be included Randomized controlled trials (parallel, crossover, and factorial designs) for quantitative synthesis (meta-analysis); prospective cohort, case-control, cross-sectional, cluster-randomized multi-component, and ecological time-trend studies for narrative synthesis, following Synthesis Without Meta-analysis (SWiM) reporting principles.

Eligibility criteria Adults aged ≥18 years; RCT, cohort, case-control, cross-sectional, or systematic review/meta-analysis design; quantified dietary salt/sodium intake or urinary sodium excretion and its association with SBP or hypertension risk; published in English, 1 January 1996–31 October 2026. For quantitative synthesis, trials additionally had to report, or permit calculation of, a mean difference in SBP between two genuinely independent or validly paired sodium-intake conditions, with a measure of precision and sample size, and a statistically confirmed between-arm sodium contrast. Excluded: animal studies, participants <18 years, case reports/series, and studies reporting only composite dietary-quality scores without a sodium-specific estimate.

Information sources PubMed/MEDLINE, Scopus, Web of Science Core Collection, ScienceDirect, SpringerLink, the Cochrane Library (CDSR, CENTRAL), Google Scholar, and ClinicalTrials.gov, supplemented by citation tracking of included studies and a supplementary currency search for studies published in 2024–2026.

Main outcome(s) Nine randomized trials (ten effect sizes; n = 1926) met the eligibility criteria for quantitative synthesis. Reduced sodium intake was associated with a significantly lower systolic blood pressure (pooled mean difference −5.95 mmHg, 95% CI −8.01 to −3.90; I^2 = 88.9%), larger among hypertensive participants (−6.55 mmHg) than normotensive/mixed populations (−4.56 mmHg; p for subgroup difference = 0.353).

Additional outcome(s) Fourteen additional studies, including six large prospective cohorts, a cluster-randomized multi-component trial, a cross-sectional analysis, a case-control study of dietary habits and salt sensitivity, and a real-world propensity-matched salt-substitute cohort (combined n > 930,000), were synthesized narratively. Cohort evidence on hard outcomes (incident hypertension, cardiovascular events) was heterogeneous and, in one large population-based cohort, paradoxical (higher cardiovascular mortality in the lowest sodium tertile).

Data management Records from database searching and citation tracking were screened against the eligibility criteria, and full texts of potentially eligible reports were assessed in detail. For each included study, first author/year, country, design, population characteristics, sodium-intake contrast, assessment method, duration, SBP outcome, and its measure of precision were extracted. Extracted data were cross-checked against the original publication for every included study; for a subset of pre-2013 trials, summary data were additionally cross-verified against the trial-level data table of the 2013 Cochrane/BMJ systematic review. The full study-selection process is summarized in a PRISMA 2020 flow diagram.

Quality assessment / Risk of bias analysis Risk of bias in the nine randomized trials contributing to the quantitative synthesis was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool across five domains (randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, selection of the reported result), each rated low risk / some concerns / high risk. Two trials were judged at low overall risk; the remaining seven were judged to have some concerns, principally because participants could not be blinded to their assigned diet; no trial was judged at high risk. The fourteen narratively synthesized studies were appraised using the Newcastle-Ottawa Scale (NOS), adapted to each design; ten were rated good quality and four fair.

Strategy of data synthesis Trial-specific mean differences in SBP (mmHg) and standard errors were pooled using the DerSimonian and Laird random-effects model, selected a priori given the clinical and methodological diversity of included trials. Between-study heterogeneity was quantified using Cochran's Q statistic and the I^2 index, and between-study variance (τ^2) was estimated using the DerSimonian-Laird moment estimator. All statistical computations were performed in Python (v3.11; NumPy and SciPy); a two-sided $p < 0.05$ was considered statistically significant. Findings from the fourteen studies not amenable to quantitative pooling were synthesized narratively following Synthesis Without Meta-analysis (SWiM) reporting principles.

Subgroup analysis A prespecified subgroup analysis compared pooled effects in hypertensive versus normotensive/mixed populations, tested with a chi-squared test for subgroup interaction ($Q_{between} = 0.86$, $df = 1$, $p = 0.353$); the limited statistical power available with only ten effect sizes likely explains why this difference did not reach significance.

Sensitivity analysis Small-study effects were explored visually with a funnel plot and formally with Egger's regression test; given the small number of pooled effect sizes ($k = 10$, the conventional minimum for this test), this result (Egger's intercept = –4.54, $p = 0.017$) is interpreted cautiously rather than as definitive evidence of publication bias.

Language restriction English.

Country(ies) involved Colombia.

Other relevant information None.

Keywords Resmetirom; metabolic dysfunction-associated steatotic liver disease; metabolic dysfunction-associated steatohepatitis; thyroid hormone receptor beta agonist; LDL-cholesterol; fibrosis.

Dissemination plans Peer-reviewed publication (manuscript submitted to Cardiology Research, Elmer Press); the extracted trial-level dataset and analysis code (Python) are provided as supplementary material.

Contributions of each author

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