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Review

Meta-analysis of the prevalence of arterial hypertension in Kazakhstan

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Abstract. *Background and aim:* Arterial hypertension is a major global health concern and a leading risk factor for cardiovascular diseases, stroke, and kidney failure. The prevalence of hypertension continues to rise due to sedentary lifestyles, urbanization, and aging populations. In Kazakhstan, hypertension represents a growing burden, with an estimated 3.8 million affected adults and low control rates. This systematic review and meta-analysis assessed the prevalence of arterial hypertension in Kazakhstan by synthesizing data from observational studies. *Methods:* A systematic literature search was conducted across PubMed, Scopus, Science Direct, Web of Science, and Google Scholar. Studies were selected based on predefined inclusion and exclusion criteria. Data extraction followed PRISMA guidelines. The Newcastle–Ottawa Scale (NOS) was used to evaluate the quality. Meta-analysis was performed to calculate the pooled estimates with heterogeneity assessed through evaluation and meta regression. *Results:* Out of 335 titles assessed a total of five studies met the inclusion criteria, involving 4,716 participants from multiple regions of Kazakhstan. The pooled prevalence of arterial hypertension was 27% (95% CI: 20–34%), with significant heterogeneity (I^2 = 99%). Meta-regression suggested that the year of publication was a significant predictor of prevalence variability. Studies varied in terms of study design, population characteristics, and diagnostic criteria. *Conclusions:* This review revealed high prevalence of hypertension in Kazakhstan. Targeted public health interventions, enhanced primary care, and improved data collection are essential to reduce disease burden. Emphasizing health education, regional policy planning, and digital health tools will support better hypertension control across the country. (www.actabiomedica.it)

Key words: arterial hypertension, prevalence, systematic review, meta-analysis, Kazakhstan

Introduction

Arterial hypertension is a leading global public health issue, significantly contributing to cardiovascular diseases, stroke, and kidney failure. The World Health Organization (WHO) states that hypertension has an impact on approximately 1.28 billion adults worldwide, with nearly 46% of cases undiagnosed and untreated, especially in nations with low and moderate incomes, where access to healthcare is still restricted (1). Understanding the burden of arterial hypertension in Kazakhstan requires the use of prevalence data, which guides healthcare policy and resource allocation by revealing trends and the efficacy of preventative measures (2). According to the Global Burden of Disease paper, one of the biggest preventable reasons of mortality around the world is hypertension, contributing to an estimated 10 million deaths yearly (3). Because

of sedentary lifestyles, urbanization, and ageing populations, the prevalence of hypertension is still rising despite improvements in preventative and treatment methods(3). Kazakhstan is a multiethnic country with a population of over 19 million (4), and hypertension is becoming a bigger problem there. As of 2019, approximately 3.8 million adults aged 30–79 years in Kazakhstan were living with hypertension, with control rates remaining low at 31% (1). Genetic predisposition, environmental influences, and age-related factors are key contributors to arterial hypertension (5). In 2014, Kazakhstan reported a mortality rate of 33.1 per 100,000 population due to arterial hypertension, which increased over the subsequent years (6). Hypertension and cardiovascular diseases impose a growing economic burden on Kazakhstan due to increased healthcare utilization and productivity losses (2). Additionally, the economic burden of non-communicable diseases, such as arterial hypertension, to Kazakhstan 2017 was estimated to be 2.3 trillion tenge, or 4.5% of GDP (1). The majority of these losses were incurred indirectly through lost productivity due to disability and early death (1). Furthermore, modeling studies suggest that the prevalence of cardiovascular diseases is expected to increase over the next five years (7). Despite the growing burden of hypertension in Kazakhstan, in a comprehensive synthesis of existing prevalence data has been lacking. Nationally, representative pooled data are crucial for identifying population-level trends, informing resource allocation, and evaluating the effectiveness of health polices and interventions. The aim of this systematic review and meta- analysis is to estimate the pooled prevalence of arterial hypertension among adults in Kazakhstan and to assess study - level factors contributing to heterogeneity in reported rates.

Materials and Methods

Search strategy

An initial search was conducted in the National Institute for Health Research's PROSPERO CRD420250555422 database to identify ongoing or existing systematic reviews on the prevalence of arterial hypertension in Kazakhstan. This validation supported registering the current study protocol in the PROSPERO database. Subsequently, a systematic search was conducted across five electronic sources: PubMed, Scopus, Science Direct, Web of Science and Google Scholar. The search strategy employed the following keywords: "arterial hypertension," "hypertension," "high blood pressure," and "Kazakhstan." The search string was structured as follows: ("arterial hypertension" OR "hypertension" OR "high blood pressure") AND ("Kazakhstan" OR "Kazakh adults"). Filters were applied to include English-language, peer-reviewed observational studies such as cross-sectional, case-control, and cohort studies.

Eligibility criteria

The inclusion and exclusion criteria guided in the study selection process. The inclusion criteria required that the studies be observational, including cross-sectional, case-control, and cohort studies, reporting the prevalence of arterial hypertension. Only studies published in English and conducted within Kazakhstan were considered. Additionally, peer-reviewed articles with extractable prevalence data were included. The exclusion criteria eliminated studies with incomplete or inaccessible full texts and publications in languages other than English. Review articles, editorials, abstracts, conference proceedings, and case reports were excluded. Articles that lacked information on arterial hypertension prevalence in Kazakhstan and duplicate study results were also excluded. Furthermore, studies in which all participants had already been diagnosed with arterial hypertension, without general population prevalence data, were not considered. Additionally, large-scale epidemiologic studies involving over 100,000 patients were excluded if they did not report extractable prevalence data for the general population.

Selection of studies and data extraction

The literature review and synthesis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines(8). After duplicate removal, two independent reviewers (YS & IK) assessed the search results' applicability to the study's

Table 1. Newcastle - Ottawa quality assessment scale results

Study	Selection	Comparability	Outcome	Total
Cross-sectional studies				
Nugmanova, 2008 (9)	3	1	3	7
Footman, 2013 (10)	3	1	2	6
Supiev, 2015 (11)	3	1	3	7
Markabayeva, 2018 (12)	4	1	2	7
Makhambetshin, 2024 (13)	4	1	2	7

goals, and the titles and abstracts were examined. The full texts of studies that met the initial inclusion criteria were retrieved for a comprehensive assessment. From eligible studies, the following data were extracted: the first author's last name, year of publication, study design, and the region within Kazakhstan where the study was conducted. Information on the total population assessed, the number of participants diagnosed with arterial hypertension, and the sampling methodology were also collected. The diagnostic criteria used for hypertension, participant demographics such as age and gender distribution, and body mass index (BMI), when available, were also recorded. Two independent reviewers (YS & IK) retrieved the data using a standard data collection template. To ensure consensus and accuracy, any discrepancies in the study selection or data extraction process were resolved through consultation with a third reviewer (YK). If data were missing or unclear, assumptions were made based on other reported variables or excluded from analysis.

Risk of bias (Quality) assessment

Risk of bias was assessed using the Newcastle–Ottawa Scale (NOS) for cross-sectional studies, as recommended by the Cochrane Non-Randomized Studies Methods Working Group. The NOS evaluates studies based on three primary domains: selection (four criteria), comparability (one criterion), and outcome (two criteria). Each criterion is assigned up to one point, while the comparability criterion can receive a maximum of two points. The total score ranges from 0 to 9, with higher scores indicating better study quality. For this review, two independent reviewers conducted the quality assessment, resolving any disagreements through discussion with a third reviewer. Studies scoring seven points or higher were categorized as high-quality, while those scoring four points or lower were considered low-quality. The results of the quality assessment are presented in Table 1, demonstrating that all included studies had a NOS score of 6 or higher, indicating moderate to high quality with a minimal risk of bias.

Statistical analysis plan

The pooled mean prevalence of arterial hypertension in Kazakhstan was calculated using RStudio (version 2024.12.1+563) Two packages, 'meta' and 'metafor', were used for analysis (8, 9). A random-effects model was utilized to calculate the pooled arterial hypertension prevalence with results presented alongside 95% confidence intervals. Forest plots were created to display the pooled estimates visually. The proportions were logit-transformed for heterogeneity analysis, and meta-regression based on the year of publication, influence analysis, and leave-one-out analysis was performed. As fewer than ten studies were available, Egger's test and funnel plot construction were not performed to assess publication bias. Subgroup analysis was conducted based on the data source (14).

Results

Included study characteristics

The initial database search identified 335 articles across five databases: PubMed (145), Scopus (48), Web of Science (39), ScienceDirect (78), and Google

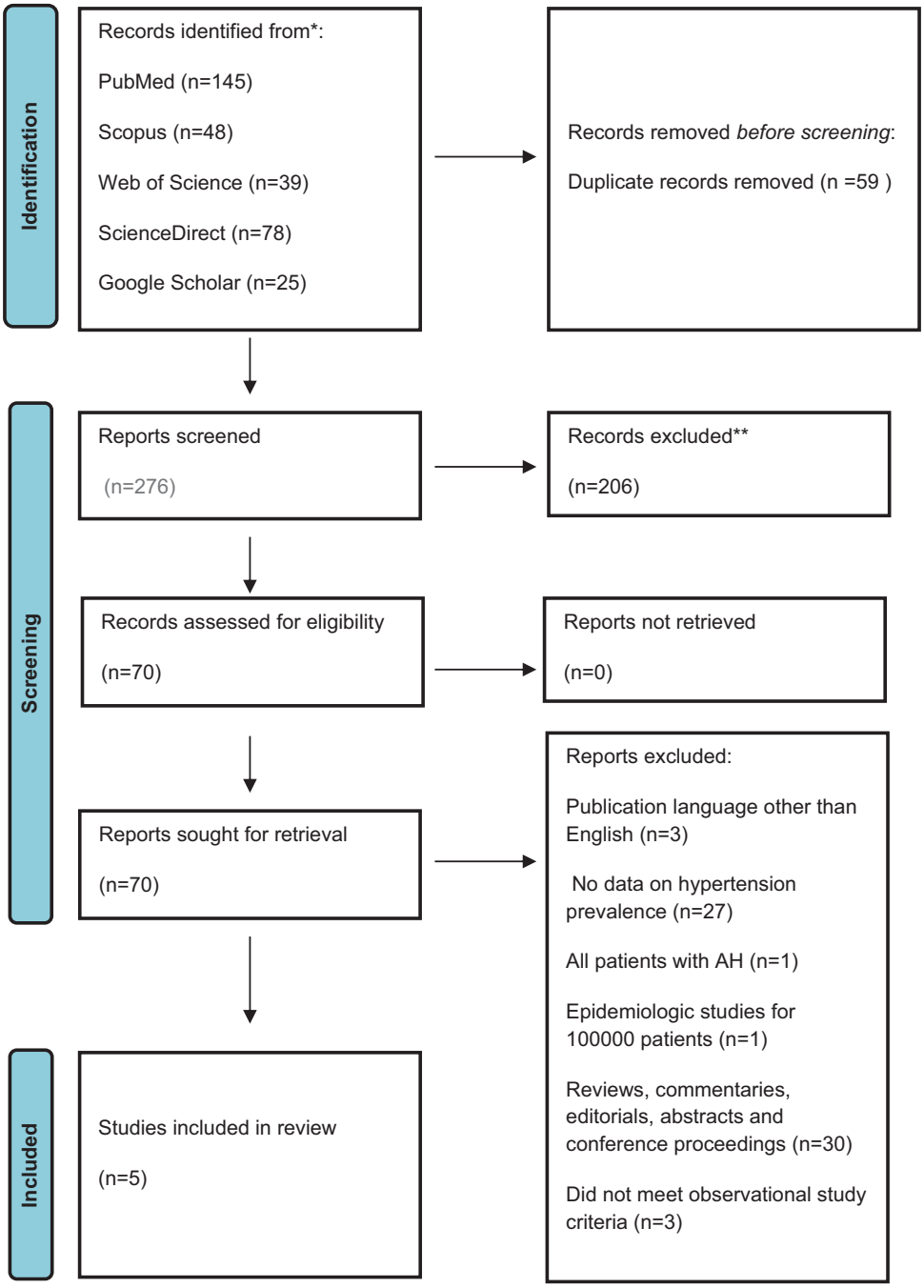

Figure 1. PRISMA flow diagram of study selection process.

Scholar (25). After removing 59 duplicates, 276 unique articles were screened. After initial evaluation, 70 articles were retrieved for full text evaluation. Of these, three were excluded due to being published in languages other than English, and 27 were excluded for lacking data on the prevalence of arterial hypertension. One article was excluded as it included only patients with arterial hypertension, (15) while another was an epidemiological study involving over 100,000 participants (6). Additionally, 30 articles were identified as

Table 2. Summary of study characteristics of included articles

First Author, Year	Year	Region/ City	Study design	Assessment period	Total	Cases	Assessment method	Male
Nugmanova, 2008 (9)	2008	Karaganda	Registry analysis	T1 non pilot T2 non pilot T1 pilot T2 pilot	940 940 939 939	131 120 195 149	Blood pressure measurement	n/a
Footman, 2013 (10)	2013	Multiregion	Cross-sectional	2001–2010	2000 1800	496 450	Interview	887 854
Supiyev, 2015 (11)	2015	Astana	Cross-sectional	2012-2013	497	350	Blood pressure measurement	233
Markabayeva, 2018 (12)	2018	Semey	Cross-sectional	2013	1755	655	Blood pressure	707
Makhambetshin, 2024 (13)	2024	Multiregion	Cross-sectional	2013	19314	7011	ESC, ESH, and EAS guidelines	3515

Abbreviations: ESC = European Society of Cardiology, ESH = European Society of Hypertension, EAS = European Atherosclerosis Society.

reviews, commentaries, editorials, abstracts, or conference proceedings, and three articles did not meet the criteria for observational studies. Ultimately, five studies met all inclusion criteria and were included in the systematic review. These studies provide comprehensive data on the prevalence of arterial hypertension among adults in Kazakhstan. Figure 1 shows a PRISMA flow diagram illustrating the study selection process.

The included research was published from 2008 to 2024.Two studies were multiregional, and the remaining three studies were conducted in Astana, Semey and Karaganda. The five studies included a total of 4,716 participants with varying demographic characteristics. One study was a registry analysis, while the remaining four were cross-sectional in design. Table 2 summarizes the characteristics of the included studies.

Prevalence of Arterial Hypertension in Kazakhstan

Nine subgroups from five studies reported data on arterial hypertension prevalence. Using a random-effects model, the pooled prevalence of arterial hypertension was 27% (95% CI, 20 –34%), with significant heterogeneity (I^2 = 99%). The results of the meta – analysis of arterial hypertension prevalence are presented in Figure 2. Individual studies reported variable prevalence rates, ranging from 14% (9) to 70% (11). Subgroup analysis showed that, based on registry data, the pooled prevalence was lower at 16% (95% CI: 13–19%), with high heterogeneity (I^2 = 88%). In contrast, the pooled prevalence based on cross-sectional study data was 38% (95% CI: 29–47%), also with high heterogeneity (I^2 = 99%).

Meta - regression analysis

A meta-regression analysis revealed a positive association between study publication year and the pooled prevalence of arterial hypertension. The analysis indicates that more recent studies report higher prevalence rates of hypertension, and this relationship was statistically significant (p = 0.02). The figure illustrates the regression line with individual studies plotted as points, showing the relationship between the year of publication and arterial hypertension prevalence (Figure 3).

Heterogeneity assessment

An influence analysis was performed to identify studies with the greatest impact on the pooled estimate. Diagnostic plots (Figure 4A) indicate that the study by Supiyev et al. (11), which reported a prevalence rate of 70% (95% CI: 66–74%), had the most substantial influence on the pooled estimate. This finding is further supported by the leave-one-out

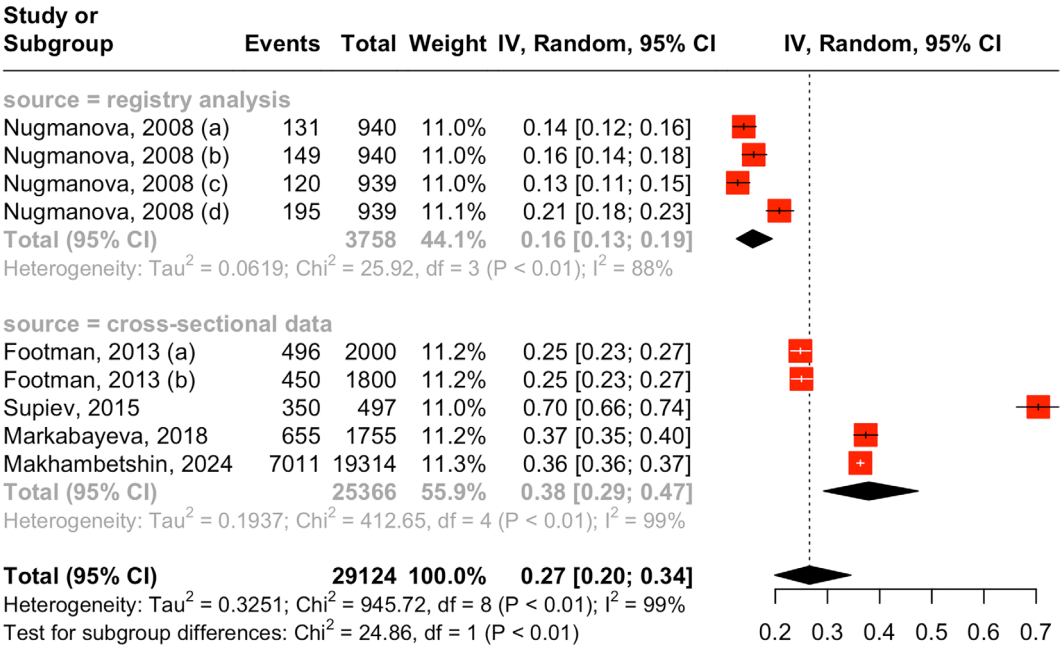

Figure 2. The pooled prevalence of arterial hypertension in Kazakhstan. Abbreviations**:** CI – Confidence Interval; Footman,2013 (10) (a) – cohort of 2001; Footman,2013 (10) (b) – cohort of 2010; Nugmanova,2008 (9) (a) – T1 non pilot; Nugmanova,2008 (9) (b)-T2 non pilot; Nugmanova,2008 (9) (c)-T1 pilot; Nugmanova, 2008 (9) (d)-T2 pilot;

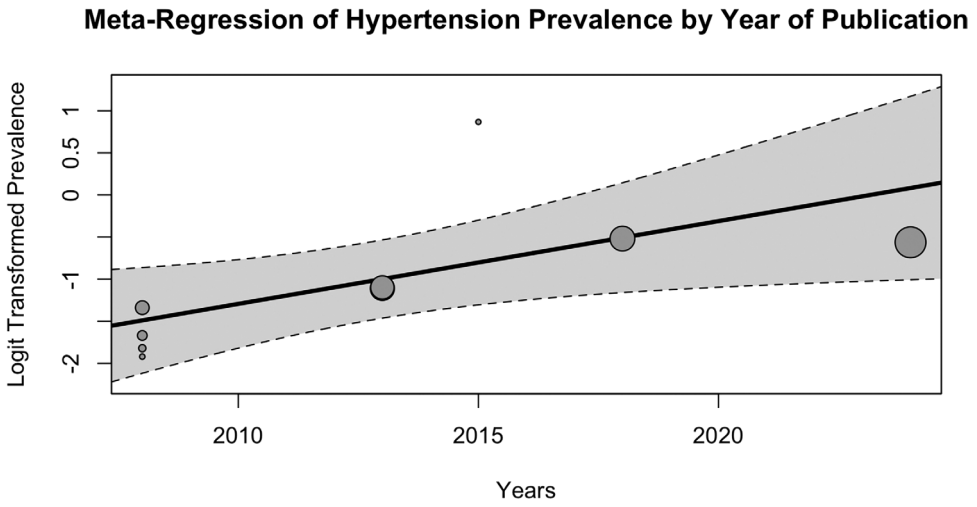

Figure 3. Meta-regression analysis of arterial hypertension prevalence by year of publication.

analysis (Figure 4B). When the Supiyev et al. study (11) was excluded, the pooled estimate dropped to its lowest value of 22% (95% CI: 17–29%), suggesting that this study significantly inflated the overall effect size. In contrast, the removal of other studies did not result in meaningful changes to the pooled estimate, indicating that their influence was minimal.

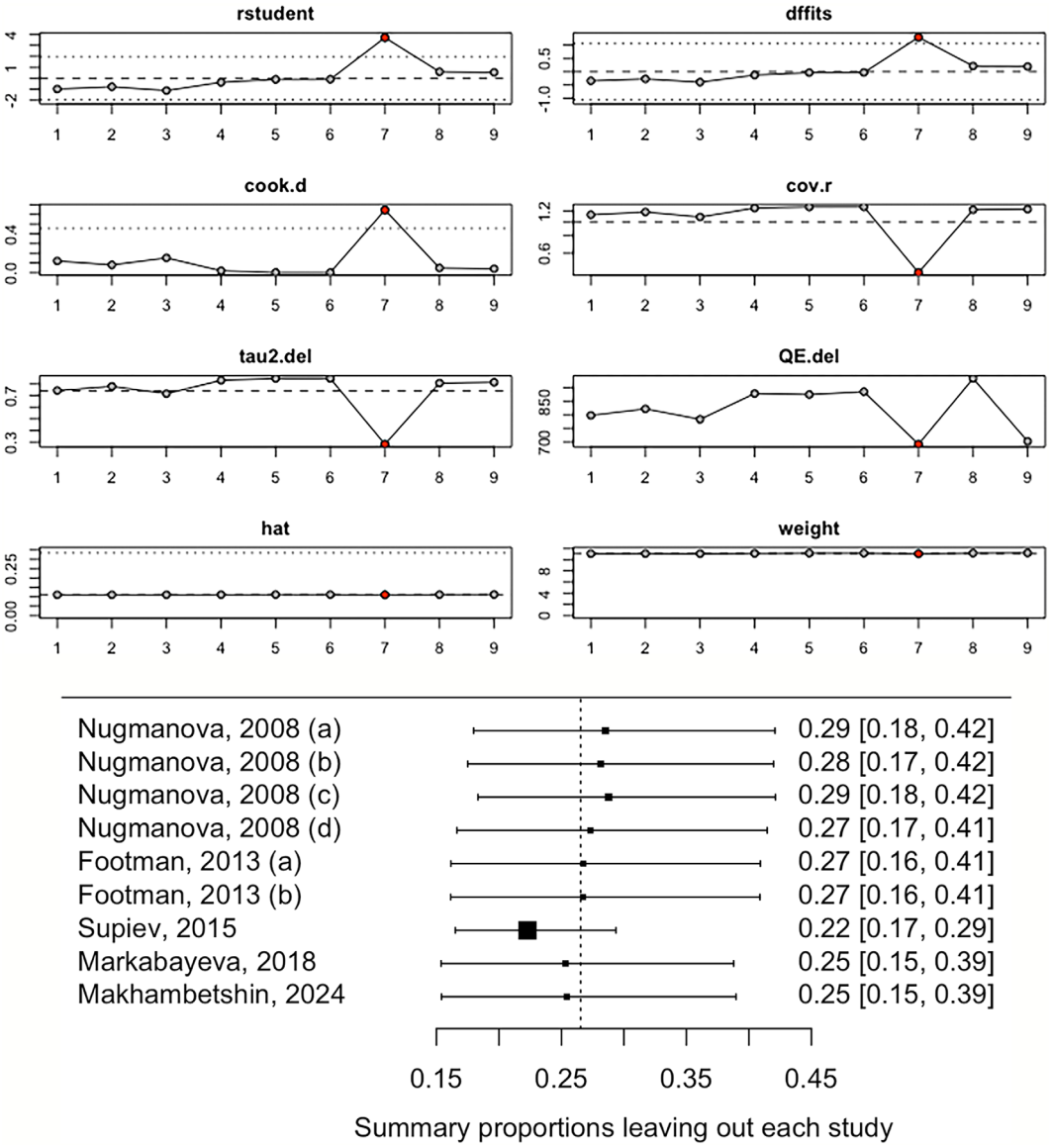

Figure 4. Influence analysis of hypertension prevalence studies: (A) influence plot; (B) leave-one-out analysis. Abbreviations**:** Footman, 2013 (10) (a) – cohort of 2001; Footman, 2013 (10) (b) – cohort of 2010; Nugmanova,2008 (9) (a)-T1 non pilot; Nugmanova, 2008 (9) (b) – T2 non pilot; Nugmanova, 2008 (9) (c) – T1 pilot; Nugmanova, 2008 (9) (d) – T2 pilot;

Discussion

Arterial hypertension remains one of the most pressing global public health challenges due to its central role in the etiology of cardiovascular diseases, stroke, and chronic kidney disease. This systematic review and meta-analysis offer the first pooled estimate of hypertension prevalence among adults in Kazakhstan, synthesizing evidence from five observational studies. The analysis yielded a pooled prevalence of 27% (95% CI: 20–34%), highlighting a considerable burden of disease. Despite the limited number of studies and substantial heterogeneity, this estimate underscores the growing relevance of hypertension as a national health priority. The rising trend in hypertension prevalence observed in our analysis is consistent with findings

from regional and international studies. Although this upward trend was observed, the meta-regression analysis did not reveal a statistically significant association ($p > 0.05$). Potential confounding factors—such as regional differences, age distributions, and variations in diagnostic criteria—may have influenced the results. For example, data from the Unified Nationwide Electronic Healthcare System (UNEHS) reported a crude hypertension prevalence of 3,661 per 100,000 in 2014, with a continued upward trajectory through 2019 (6). Comparable prevalence estimates have been reported in neighboring countries, including Uzbekistan (41.9%) (16) and Kyrgyzstan (34.1%) (17). Globally, hypertension prevalence varies between 24% and 34% depending on age and region (3). In China, a recent meta-analysis found a pooled prevalence of 27.2% among adults, with notable urban–rural disparities, likely driven by rapid urbanization, aging, and dietary sodium intake (18). Similarly, a systematic review from India estimated an overall prevalence of 30.7%, with higher rates in urban (34.0%) than rural (27.6%) areas (19). These global comparisons reinforce the relevance of our findings and suggest that Kazakhstan's burden mirrors broader epidemiological patterns in emerging economies undergoing demographic and lifestyle transitions. Over the past decade, Kazakhstan has taken important steps to strengthen non-communicable disease (NCD) surveillance and expand preventive services. Notable initiatives include national screening programs, adoption of WHO STEPS surveys, and the integration of digital health infrastructure such as the Unified National Electronic Health System (UNEHS). Furthermore, the November 2022 launch of a national project to modernize rural healthcare demonstrates high-level policy commitment to closing service delivery gaps. Despite these advances, persistent barriers remain—particularly in rural areas—where hypertension awareness, screening coverage, and adherence to treatment are inadequate. For instance, the national hypertension control rate remains at a low 31% (20), indicating the need for stronger emphasis on treatment adherence, lifestyle modification, and patient engagement. Innovative tools such as the PHC-IMPACT framework are being piloted to monitor and improve primary healthcare performance for tracer conditions like hypertension, offering promising avenues for system-level improvements. While these findings contribute valuable insights, several limitations must be acknowledged. First, the small number of eligible studies and their heterogeneity limit the generalizability of the pooled estimate. Second, restricting the inclusion criteria to English-language publications may have resulted in selection bias, excluding relevant studies in Russian or Kazakh. Third, inconsistent reporting of diagnostic criteria across studies introduces the potential for misclassification bias. Additionally, the lack of disaggregated data by sex or risk factor profile precluded subgroup analyses, which are critical for targeted intervention design. Future research should prioritize nationally representative studies using standardized methodologies and longitudinal designs to monitor trends and policy impact over time. Furthermore, incorporating mixed-methods approaches may help elucidate patient-level and system-level barriers to effective hypertension control.

Conclusions

This systematic review provides the first pooled estimate of arterial hypertension prevalence among adults in Kazakhstan, revealing a significant and growing public health burden. Despite recent policy efforts and structural reforms, the persistently low control rates and regional disparities underscore the need for sustained investments in primary care, population-level prevention, and implementation research. Strengthening surveillance, harmonizing clinical guidelines, and addressing social and behavioral determinants of hypertension will be essential to reducing disease burden and achieving equitable cardiovascular health outcomes in Kazakhstan.

Ethics Approval: This study did not require ethical approval as it is a systematic review and meta-analysis based on previously published data.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that might pose a conflict of interest in connection with the submitted article.

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Administration. IK: Resources, Software, Data Curation, Supervision, Writing – Original Draft Preparation, Writing – Review and Editing. All authors have read and agreed to the published version of the manuscript and meet the ICMJE criteria for authorship.

Declaration on the Use of AI: None.

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