

# Relationship between neutrophil percentage to albumin ratio and kidney disease: systematic review and meta-analysis

Kianoush Saberi<sup>1</sup>, Abnoos Mokhtariardekani<sup>2</sup>, Shahnaz Sharifi<sup>3</sup>, Maede Safari<sup>4</sup>, Maryam Marahemi<sup>5</sup>, Niloofar Khosravi<sup>6</sup>, Roozbeh Roohinezhad<sup>7</sup>, Hamid Rastad<sup>8</sup>, Mahdi Razmi<sup>9\*</sup>

<sup>1</sup>Department of Anesthesiology, Medical Faculty, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup>Endocrinology and Metabolism Research Center, Institute of Basic and Clinical Physiology Science, and Physiology Research Center, Kerman University of Medical Sciences, Kerman, Iran

<sup>3</sup>Cardiovascular Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>4</sup>Urology Department, School of Medicine, Isfahan University of Medical Science, Isfahan, Iran

<sup>5</sup>Department of Infectious Diseases, School of Medicine, Jiroft University of Medical Sciences, Jiroft, Iran

<sup>6</sup>Anesthesiology Department, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

<sup>7</sup>Department of Urology, Hasheminejad Kidney Center, Iran University of Medical Sciences, Tehran, Iran

<sup>8</sup>Department of Internal Medicine, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>9</sup>Department of Anesthesia, A.K.C., Islamic Azad University, Aliabad Katoul, Iran

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## ABSTRACT

**Introduction:** The neutrophil percentage-to-albumin ratio (NPAR) has emerged as a valuable biomarker for the detection and assessment of inflammatory conditions. Given the prominent role of inflammation in the pathophysiology of kidney disorders, the present study aimed to examine the association between NPAR and the risk of developing kidney disease.

**Materials and Methods:** This study was conducted as a systematic review and meta-analysis, designed in accordance with the PRISMA guidelines. In line with this framework, the Cochrane, Scopus, Web of Science, Embase, and PubMed databases, as well as the Google Scholar search engine, were systematically searched up to December 19, 2025. All statistical analyses were performed using STATA version 14.

**Results:** Elevated NPAR was significantly associated with an increased risk of kidney disease in the overall population (OR = 1.62, 95% CI: 1.37–1.91), as well as among men (OR = 1.31, 95% CI: 1.15–1.50), women (OR = 1.30, 95% CI: 1.14–1.48), and individuals younger than 60 years (OR = 1.71, 95% CI: 1.42–2.06). Participants in the highest NPAR quartile demonstrated a markedly greater risk of kidney disease compared with those in the first quartile (OR = 2.04, 95% CI: 1.46–2.84), the third quartile (OR = 1.40, 95% CI: 1.13–1.72), and the second quartile (OR = 1.19, 95% CI: 1.07–1.31). Similarly, individuals in the third NPAR tertile exhibited a substantially higher risk relative to the first tertile (OR = 4.40, 95% CI: 2.26–8.58) and the second tertile (OR = 2.63, 95% CI: 1.34–5.19). Furthermore, elevated NPAR was identified as a significant risk factor for both chronic kidney disease (CKD) (OR = 1.46, 95% CI: 1.17–1.82) and diabetic kidney disease (OR = 1.86, 95% CI: 1.43–2.43).

**Conclusion:** Elevated NPAR was associated with a higher likelihood of developing kidney disease, and this risk increased progressively with rising NPAR levels. Men demonstrated a slightly greater vulnerability compared with women, and a younger age (<60 years) further amplified this association. Additionally, individuals with higher NPAR values exhibited a greater propensity for developing diabetic kidney disease than CKD.

**Registration:** This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: [CRD420251273807](https://doi.org/10.34172/jrip.2026.38738)) and Research Registry (UIN: [reviewregistry2069](https://doi.org/10.34172/jrip.2026.38738)) websites.

**Implication for health policy/practice/research/medical education:**

The higher neutrophil percentage-to-albumin ratio (NPAR) is associated with increased risk of kidney disease, with the risk escalating as NPAR rises. This association is slightly stronger in men and amplified in those under 60. Elevated NPAR also indicates a greater risk of diabetic kidney disease compared to chronic kidney disease.

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**Introduction**

Kidney disease encompasses a wide spectrum of pathological conditions. Chronic kidney disease (CKD), in particular, is characterized by a progressive decline in renal function (1). CKD has emerged as a major global public health concern, affecting more than 850 million individuals worldwide as of 2021 (2). Projections indicate that by 2040, CKD may become the fifth leading cause of mortality globally (3). Acute kidney injury (AKI) is likewise associated with increased mortality and a substantial risk of progression to end-stage kidney failure, with many affected patients ultimately requiring dialysis or renal replacement therapy (4). Furthermore, approximately half of all individuals with diabetes develop diabetic kidney disease (DKD), which represents one of the leading causes of end-stage kidney failure worldwide (5,6).

During inflammatory conditions, neutrophil counts typically increase, whereas serum albumin levels tend to decline (7,8). Recent studies combining these two biomarkers have demonstrated that the neutrophil percentage-to-albumin ratio (NPAR) may serve as a valuable indicator for identifying inflammatory diseases, such as non-alcoholic fatty liver disease, heart failure, fibrosis, septic shock, and tuberculosis (9-12). Inflammation is highly prevalent among cases with CKD and plays a pivotal role in both the onset and progression of the disorder (13,14). Moreover, elevated NPAR has been closely associated with an increased risk of mortality in patients with AKI (15).

The NPAR is calculated by dividing the proportion of neutrophils by the serum albumin level and serves as an indicator of systemic inflammatory status (16). An elevated neutrophil percentage is a known predictor of bloodstream infections (17), whereas reduced albumin levels are associated with heightened inflammatory burden and increased susceptibility to infections (18,19). Overall, higher NPAR values may indicate a pro-inflammatory and catabolic state associated with adverse renal outcomes (20). Moreover, the incorporation of reliable inflammatory biomarkers such as NPAR has the potential to enhance risk stratification and facilitate timely clinical intervention (21,22). From a preventive and therapeutic perspective, early identification of individuals at elevated risk is of critical importance (20). Therefore, the present study aimed to investigate the association between elevated NPAR levels and the risk of developing kidney disease.

**Materials and Methods****Study design**

This meta-analysis study evaluated the association between NPAR and kidney disease, and its review protocol, developed in accordance with the PRISMA guidelines (23), was registered in both the PROSPERO (International Prospective Register of Systematic Reviews) and Research Registry databases.

**Search strategy**

The Cochrane, Scopus, Web of Science, Embase, and PubMed databases, as well as the Google Scholar search engine, were systematically searched up to December 19, 2025, without restrictions on time or geographical location. The search was conducted using standardized keywords and Medical Subject Headings (MeSH). Boolean operators (AND, OR) were applied to combine terms and enhance the sensitivity and specificity of the search. Additionally, manual searching was performed by screening the reference lists of the included studies.

**PECO Framework**

- Population (P): Studies that investigated the association between the neutrophil percentage-to-albumin ratio (NPAR) and the risk of kidney disease.
- Exposure (E): Higher levels of NPAR.
- Comparison (C): Lower levels of NPAR.
- Outcomes (O): Risk of developing kidney disease.

**Inclusion and exclusion criteria**

This review included studies that assessed the relationship between the NPAR and the risk of kidney disease. Studies were excluded if they did not provide sufficient data for quantitative synthesis, were published in non-credible or non-peer-reviewed sources, appeared as duplicate records, focused solely on patients with established kidney disease and evaluated only disease progression, failed to meet the required quality standards during appraisal, or were presented as case reports, letters to the editor, review articles, or conference posters. In addition, studies for which full-text access could not be obtained despite contacting the authors were also excluded.

**Quality assessment**

Two reviewers independently assessed the methodological quality of the included studies using the Newcastle–Ottawa Scale (NOS). This instrument consists of nine criteria,

each evaluated through a star-based scoring system (24). Studies earning six or more stars were considered to have sufficient methodological robustness and were therefore eligible for inclusion in the meta-analysis.

### Data extraction

Data extraction was performed independently by two reviewers using a standardized form developed in SPSS version 19. The extracted information included key study characteristics such as the first author's name, study location and year, type of kidney disease assessed, reported NPAR levels, effect estimates related to the risk of kidney disease associated with elevated NPAR, study design, participants' age, and other relevant clinical or methodological variables.

### Statistical analysis

For the quantitative synthesis, the logarithm of the odds ratio (OR) was used to harmonize effect estimates across studies. Statistical heterogeneity was assessed using the  $I^2$  statistic. A fixed-effects model was applied when heterogeneity was low, whereas a random-effects model was employed in the presence of moderate to high heterogeneity. All analyses were conducted using STATA version 14, and a  $P$  value of less than 0.05 was considered statistically significant.

### Results

A total of 215 records were identified through database searches. After removing 102 duplicate entries, 113 records remained for screening, of which 52 were excluded based on title and abstract review. Full-text retrieval was attempted for 61 reports, however 11 could not be obtained. The remaining 50 full-text articles were assessed for eligibility, and 42 were excluded for reasons such as publication in non-credible journals, inclusion of patients with established kidney disease and evaluation of disease-progression outcomes, inadequate methodological quality, or being case reports, letters to the editor, review articles, or conference posters. Ultimately, 8 studies met the inclusion criteria and were incorporated into the final review (Figure 1).

The reviewed articles encompassed eight studies published in 2024 and 2025, conducted across the United States and China, with designs primarily cross-sectional except for two cohort studies from China. Total sample sizes included 46202 patients, varied widely, ranging from 734 to 25,236 participants in the included studies (Table 1).

Higher NPAR levels, compared with lower NPAR levels, were associated with a significantly strengthened risk of kidney disease (OR = 1.62, 95% CI: 1.37–1.91). Moreover, studies that reported sex-specific outcomes indicated that elevated NPAR, relative to lower values, increased the

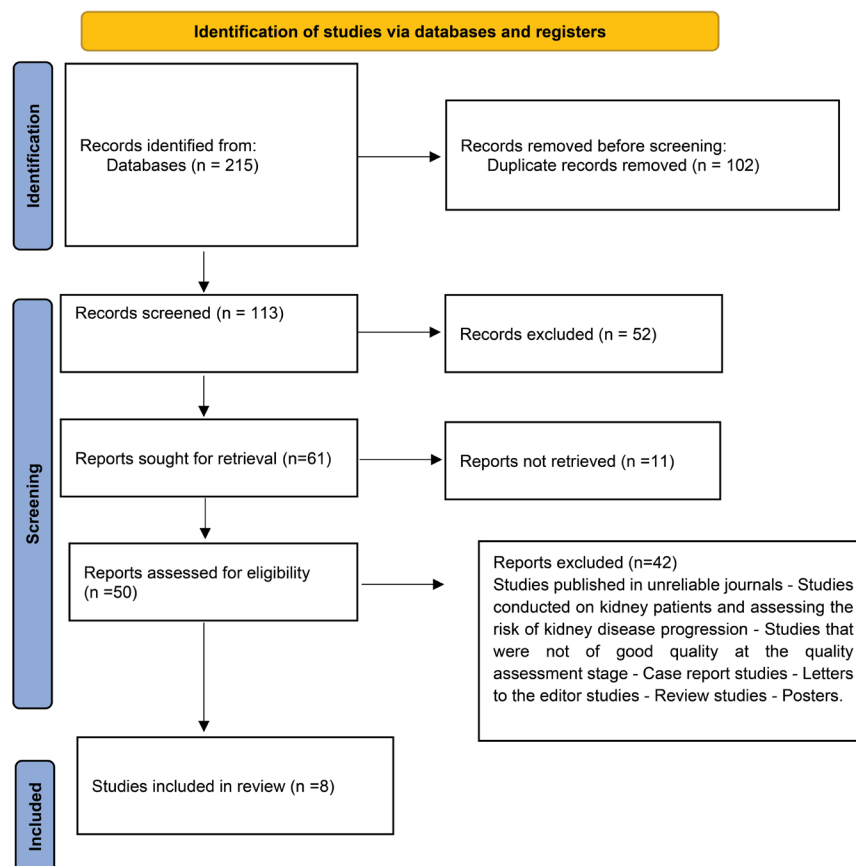
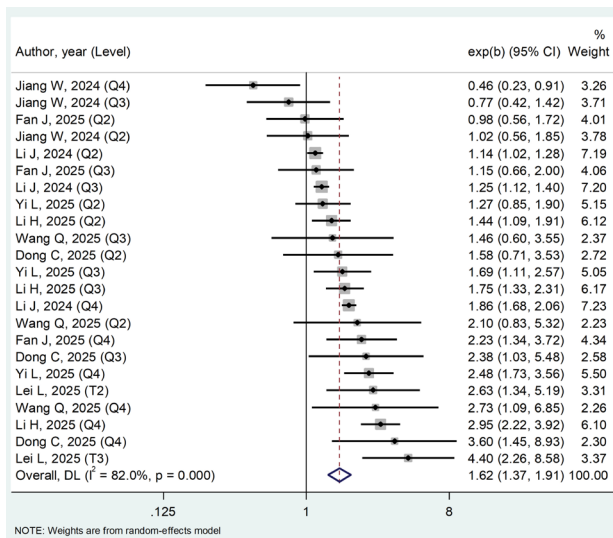


Figure 1. The PRISMA flowchart of study selection.

**Table 1.** Basic information about the articles reviewed

Author, year	Country	Type of Study	Sample size	Mean age (year)	Type of kidney disease	Level	OR	Low	Up
Yi L, 2025 (25)	USA	Cross-sectional	10526	46.64	DKD	Total	1.16	1.11	1.22
					DKD	Q2	1.27	0.85	1.91
					DKD	Q3	1.69	1.11	2.56
					DKD	Q4	2.48	1.73	3.56
Li H, 2025 (26)	USA	Cross-sectional	2263	59.41	DKD	Total	2.56	2.04	3.22
					DKD	Q2	1.44	1.08	1.90
					DKD	Q3	1.75	1.33	2.31
					DKD	Q4	2.95	2.22	3.93
Dong C, 2025 (27)	USA	Cross-sectional	1027	68	AKI	Total	1.04	1	1.07
					AKI	Q2	1.58	0.72	3.57
					AKI	Q3	2.37	1.05	5.58
					AKI	Q4	3.598	1.482	9.12
Jiang W, 2024 (28)	China	Cohort	734	64.42	AKI	Total	0.28	0.09	0.85
					AKI	Q2	1.02	0.56	1.85
					AKI	Q3	0.77	0.42	1.42
					AKI	Q4	0.46	0.23	0.91
Lei L, 2025 (29)	China	Cohort	3041	52.05	AKI	Total	1.05	1.03	1.08
					AKI	T2	2.63	1.33	5.19
					AKI	T3	4.40	2.26	8.57
Wang Q, 2025 (30)	USA	Cross-sectional	939	72.21	CKD	Q2	2.1	0.83	5.32
					CKD	Q3	1.46	0.60	3.55
					CKD	Q4	2.73	1.09	6.86
Fan J, 2025 (31)	USA	Cross-sectional	2436	57.67	CKD	Total	1.13	1.06	1.20
					CKD	Q2	0.98	0.56	1.72
					CKD	Q3	1.15	0.66	2
					CKD	Q4	2.23	1.33	3.71
Li J, 2024 (32)	USA	Cross-sectional	25236	49.69	CKD	Total	1.09	1.08	1.11
					CKD	Q2	1.14	1.01	1.27
					CKD	Q3	1.25	1.12	1.40
					CKD	Q4	1.86	1.68	2.07

CKD: Chronic kidney disease; DKD: Diabetic kidney disease; AKI: Acute Kidney Injury; Q2: Quartile 2; Q3: Quartile 3; Q4: Quartile 4; NR: Not reported; USA: United States of America; OR: Odds ratio.



**Figure 2.** Forest plot showing the association between NPAR and kidney disease.

risk of kidney disease in both men (OR = 1.31, 95% CI: 1.15–1.50) and women (OR = 1.30, 95% CI: 1.14–1.48) (Figure 2).

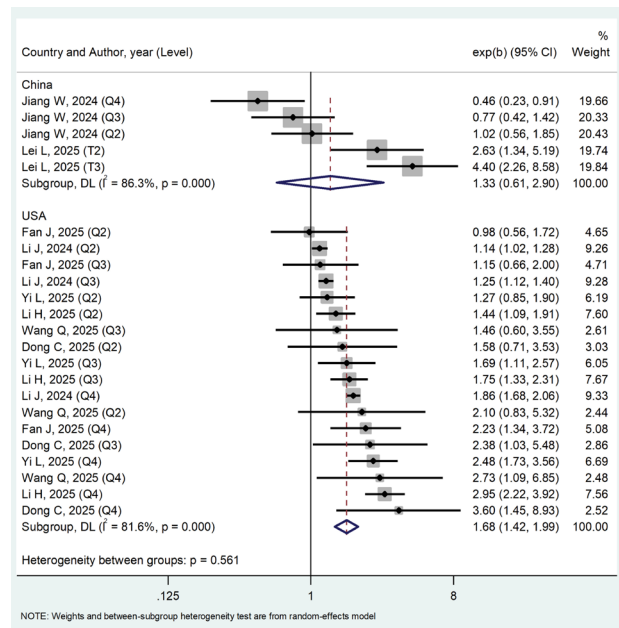
Subgroup analyses by countries indicated that in China, higher NPAR levels were not meaningfully accompanying by the risk of kidney disease (OR = 1.33, 95% CI: 0.61–2.90). In contrast, in the United States, elevated NPAR compared with lower levels was associated with an increased risk of kidney disease (OR = 1.68, 95% CI: 1.42–1.99). These findings suggest that U.S. nationality may act as a potential risk factor for kidney disease (Figure 3).

Subgroup analysis based on study design indicated that in cohort studies (OR = 1.33, 95% CI: 0.61–2.90), higher NPAR levels were not significantly associated with the risk of kidney disease. In contrast, in cross-sectional studies (OR = 1.68, 95% CI: 1.42–1.99), elevated NPAR was associated with an increased risk of developing kidney disease (Figure 4).

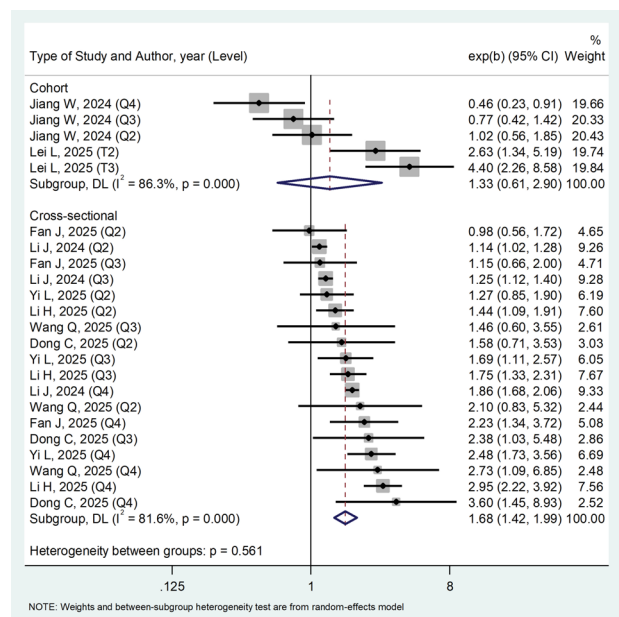
Comparison of different NPAR levels with the reference category showed that the highest quartile of NPAR was associated with an increased risk of kidney disease compared with the first quartile (OR = 2.04, 95% CI: 1.46–2.84), the third quartile (OR = 1.40, 95% CI: 1.13–1.72), and the second quartile (OR = 1.19, 95% CI: 1.07–1.31). In addition, the highest tertile of NPAR increased the risk of kidney disease relative to both the first tertile (OR = 4.40, 95% CI: 2.26–8.58) and the second tertile (OR = 2.63, 95% CI: 1.34–5.19; Figure 5).

The results were further stratified by kidney disease type, showing that higher NPAR levels were a significant risk factor for CKD (OR = 1.46, 95% CI: 1.17–1.82) and DKD (OR = 1.86, 95% CI: 1.43–2.43). However, no significant association was observed between elevated NPAR and the risk of AKI (OR = 1.62, 95% CI: 0.93–2.84; Figure 6).

Participants were stratified into two groups based on



**Figure 3.** Forest plot showing the association between NPAR and kidney disease by countries.



**Figure 4.** Forest plot showing the association between NPAR and kidney disease by study design.

mean age. Among individuals younger than 60 years, higher NPAR levels were associated with an increased risk of kidney disease (OR = 1.71, 95% CI: 1.42–2.06). However, in participants aged 60 years and older, elevated NPAR was not significantly associated with kidney disease risk (OR = 1.43, 95% CI: 0.92–2.21; Figure 7).

## Discussion

This meta-analysis demonstrated that elevated NPAR levels were associated with a 62% increase in the overall

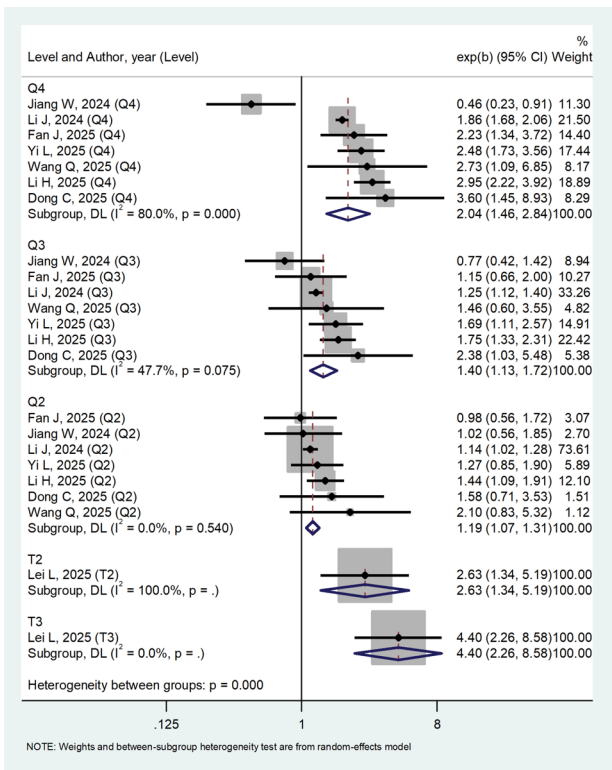


Figure 5. Forest plot showing the association between NPAR and kidney disease by level of NPAR.

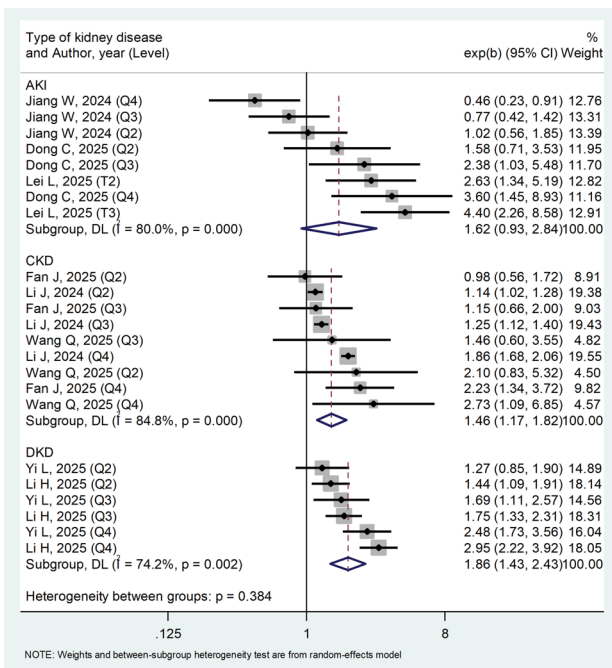


Figure 6. Forest plot showing the association between NPAR and kidney disease by type of kidney disease.

risk of kidney diseases, a 46% increase in the risk of CKD, and an 86% increase in the risk of DKD. Furthermore, subgroup analyses showed that individuals with high NPAR had a 30% higher risk of kidney disease among

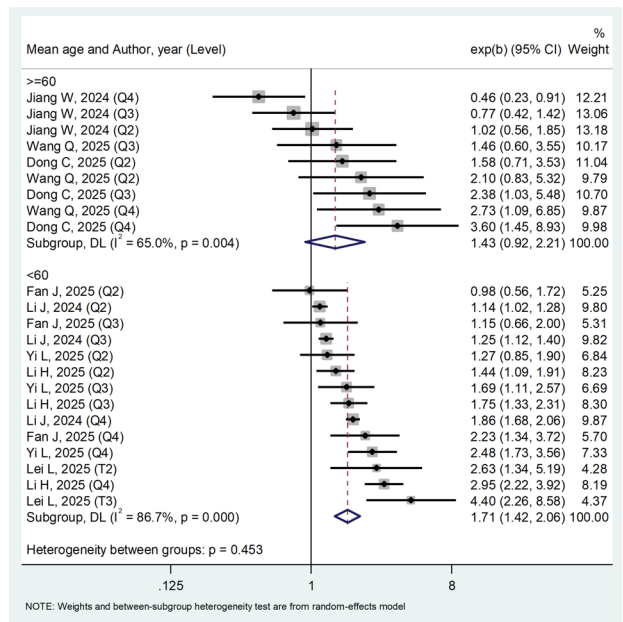


Figure 7. Forest plot showing the association between NPAR and kidney disease by mean age.

women, a 31% higher risk among men, and a 71% higher risk among participants younger than 60 years. In the cross-sectional study conducted by Fan et al, higher NPAR levels were associated with an increased risk of CKD (OR = 1.13, 95% CI: 1.06–1.20) (31). Similarly, in the cross-sectional study by Yi et al, elevated NPAR showed a positive association with the risk of DKD (OR = 1.16, 95% CI: 1.11–1.22) (25). These findings are consistent with the results of the present study, as both investigations demonstrated that higher NPAR serves as a risk factor for the development of CKD and DKD.

In a study conducted by Li et al on patients with diabetes, higher NPAR levels were associated with an increased risk of DKD, with risk estimates rising across quartiles: Q2 (OR = 1.44, 95% CI: 1.08–1.90), Q3 (OR = 1.75, 95% CI: 1.33–2.31), and Q4 (OR = 2.95, 95% CI: 2.22–3.93) (26). In another investigation by Li et al and colleagues, elevated NPAR similarly increased the risk of CKD, with reported odds ratios of 1.19 (95% CI: 1.07–1.31) for Q2, 1.53 (95% CI: 1.39–1.69) for Q3, and 2.78 (95% CI: 2.53–3.05) for Q4 (32). These findings align closely with the results of the present meta-analysis, as all studies consistently demonstrated that higher NPAR levels correspond to a greater likelihood of developing kidney disease. In contrast, evidence regarding AKI was inconsistent. In a cross-sectional study by Dong et al, elevated NPAR was identified as a risk factor for AKI (OR = 1.04, 95% CI: 1.00–1.07) (27). Conversely, Jiang et al reported that higher NPAR was associated with a reduced risk of AKI (OR = 0.28, 95% CI: 0.09–0.85) (28). These findings diverge from the results of the current meta-analysis, which found no significant association between increased NPAR levels and the possibility of AKI.

In a study conducted by Jia et al, increasing NPAR levels were associated with a higher risk of prostate cancer in men (OR = 1.12, 95% CI: 1.07–1.18) (33). Similarly, in a cross-sectional study by Xu et al, elevated NPAR was linked to an increased risk of stroke (OR = 1.09, 95% CI: 1.05–1.12) (34). Findings from the cross-sectional investigation by He et al also demonstrated a positive association between higher NPAR levels and diabetic retinopathy (ORs: 1.18, 95% CI: 1.00–1.39; and 1.24, 95% CI: 1.04–1.48) (35). In another study by Liu et al, elevated NPAR was shown to increase the risk of rheumatoid arthritis (OR = 1.27, 95% CI: 1.11–1.44) (36). Gao et al also reported that elevated NPAR levels were a risk factor for anemia (OR = 1.16, 95% CI: 1.13–1.18) (37). In another study conducted among women, Liang et al found a positive association between higher NPAR levels and an increased risk of breast cancer (OR = 1.05, 95% CI: 1.02–1.09) (38). Ji and colleagues further demonstrated that individuals in the highest NPAR quartile had a greater likelihood of developing metabolic syndrome compared with those in the lowest quartile (OR = 1.14, 95% CI: 1.03–1.27) (39). Collectively, these studies suggest that elevated NPAR is associated with increased risks of several conditions, including breast cancer, prostate cancer, stroke, diabetic retinopathy, rheumatoid arthritis, anemia, and metabolic syndrome. Consistent with these findings, the present meta-analysis showed that higher NPAR levels are also a risk factor for kidney disease. Thus, elevated NPAR may serve as a valuable prognostic indicator for the development of multiple diseases, including kidney disorders.

### Conclusion

Elevated NPAR levels were consistently associated with a higher likelihood of developing kidney disease, demonstrating a clear dose–response pattern in which increasing NPAR corresponded to progressively greater risk. Sex-stratified analyses suggested a modestly stronger association in men compared with women, indicating potential sex-related susceptibility. Age-based subgroup findings further revealed that individuals younger than 60 years with elevated NPAR exhibited a significantly increased risk, whereas this association was not statistically evident among older adults. Moreover, when stratified by kidney disease subtype, higher NPAR levels were most strongly linked to the development of DKD, underscoring a potentially distinct pathogenic relevance in this population. Collectively, these findings highlight NPAR as a promising biomarker for early risk stratification across specific demographic and clinical subgroups.

### Limitations of the study

This study has several limitations that should be considered when interpreting the findings. First, the number of eligible studies included in the meta-analysis was relatively small, which may limit the statistical power and the

precision of the pooled estimates. Second, the geographic distribution of the available studies lacked diversity, as most were conducted in the United States and China. This restricted representation may reduce the generalizability of the results to other populations with different ethnic, environmental, or healthcare characteristics.

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### Authors' contribution

**Conceptualization:** Kianoush Saberi and Roozbeh Roohinezhad.

**Data curation:** Kianoush Saberi and Niloofar Khosravi.

**Formal analysis:** Abnoos Mokhtariadekani and Maede Safari.

**Investigation:** Maede Safari and Mahdi Razmi.

**Methodology:** Abnoos Mokhtariadekani and Hamid Rastad.

**Project administration:** Mahdi Razmi and Kianoush Saberi.

**Supervision:** All authors.

**Validation:** Shahnaz Sharifi and Maryam Marahemi.

**Visualization:** Maryam Marahemi and Hamid Rastad.

**Writing—original draft:** All authors.

**Writing—review and editing:** All authors.

### Conflicts of interest

The authors declare that they have no competing interests.

### Declaration of generative artificial intelligence (AI) and AI-assisted technologies in the writing process

During the preparation of this work, the authors utilized AI tools (*Copilot* and *Grammarly*) to refine grammatical points and language style in their writing. Subsequently, the authors thoroughly reviewed and edited the content as necessary, assuming full responsibility for the accuracy and content of the publication.

### Ethical issues

This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO website with (ID: [CRD420251273807](#)) and the Research Registry website with (Unique Identifying Number [UIN] of [reviewregistry2069](#)). Besides, ethical issues (including plagiarism, data fabrication, and double publication) have been completely observed by the author.

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