Immunopathologia Persa
http immunopathol.com
DOI:10.34172/ipp.2025.43861

Association between oxidative balance score and nephrolithiasis; a systematic review and meta-analysis

Zahra Bazargani, **Leila Johari**, **Elham Kebriyaei***

Clinical Research Development Unit, Department of Pediatric, Valiasr Hospital, Fasa University of Medical Sciences, Fasa, Iran

***Correspondence to**
Elham Kebriyaei, Email: Elhamkebriyaei@yahoo.com

Received 4 Feb. 2025
Revised: 10 Apr. 2025
Accepted 13 Apr. 2025
ePublished 20 Apr. 2025

Keywords: Oxidative balance score, Kidney calculi, Kidney stone, Nephrolithiasis

Abstract

Introduction: Nephrolithiasis is a prevalent urological condition. Given the kidney's vulnerability to oxidative stress-induced damage, exploring the relationship between the oxidative balance score (OBS) and nephrolithiasis formation holds significant clinical relevance. This study systematically reviews and meta-analysis the association between OBS and nephrolithiasis.

Materials and Methods: A comprehensive literature search was conducted across ProQuest, PubMed, Embase, Web of Science, Cochrane, and Google Scholar through January 20, 2025, without time restrictions. Data were imported into SPSS 19 and analyzed using STATA 14.

Results: A higher OBS was associated with a reduced risk of nephrolithiasis in the overall population (OR: 0.74, 95% CI: 0.70, 0.79), as well as in men (OR: 0.98, 95% CI: 0.96, 0.99) and women (OR: 0.98, 95% CI: 0.96, 0.99). Additionally, increasing OBS was inversely correlated with kidney stone risk across quartiles; quartile 2 (OR: 0.78, 95% CI: 0.80, 0.87), quartile 3 (OR: 0.75, 95% CI: 0.68, 0.83), and quartile 4 (OR: 0.68, 95% CI: 0.59, 0.77). Both dietary OBS (OR: 0.97, 95% CI: 0.96, 0.98) and lifestyle OBS (OR: 0.95, 95% CI: 0.90, 1.00) were associated with a lower risk of nephrolithiasis. Among hypertensive patients, a higher OBS correlated with reduced nephrolithiasis risk (OR: 0.97, 95% CI: 0.96, 0.99), whereas in diabetic patients, the association was not statistically significant (OR: 1.00, 95% CI: 0.96, 1.04).

Conclusion: A higher total OBS, along with dietary and lifestyle OBS, was significantly linked to a lower risk of nephrolithiasis. Notably, increased OBS scores were consistently associated with a decreased likelihood of nephrolithiasis formation.

Registration: This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD42025643705) and Research Registry (UIN: reviewregistry1952) website.

Citation: Bazargani Z, Johari L, Kebriyaei E. Association between oxidative balance score and nephrolithiasis; a systematic review and meta-analysis. Immunopathol Persa. 2025;11(2):e43961. DOI:10.34172/ipp.2025.43861.

Introduction

A person's exposure to oxidants and antioxidants is assessed using an oxidative balance score (OBS) scale, primarily influenced by diet and lifestyle (1). By integrating a broad spectrum of pro-oxidants and antioxidants, OBS serves as a robust indicator of systemic oxidative stress (2). Previous studies indicated that OBS significantly affects various diseases, including respiratory disorders, metabolic syndrome, type 2 diabetes, and cardiovascular diseases (3). Higher OBS values reflect greater antioxidant levels and lower oxidative stress (4,5). Given its high metabolic activity, the kidney is particularly susceptible to oxidative stress-related damage (6), a key factor in the progression of kidney disease (7,8).

Nephrolithiasis is among the most common urological conditions (9), with its global incidence and prevalence steadily increasing over recent decades. This condition imposes a significant economic and healthcare burden, with annual costs exceeding $2 billion in the United States alone (10). Although kidney stones primarily affect adults under 50 years, they can occur at any age (11). Multiple factors such as sex, race, age, lifestyle, and dietary habits contribute to stone formation (12,13). Additionally, nephrolithiasis is associated with an elevated risk of renal cell carcinoma (14) and chronic kidney disease (CKD) (15), highlighting its clinical significance.

While some studies report no significant association between OBS and nephrolithiasis (2,16), others suggest that higher OBS levels may reduce the risk of nephrolithiasis (17,18). Given these conflicting findings, this study conducts a systematic review and meta-analysis to comprehensively evaluate the relationship between OBS and nephrolithiasis.

Materials and Methods

This study follows the Preferred Reporting

Key point

A higher total oxidative balance score, along with dietary and lifestyle oxidative balance score (OBS), was significantly linked to a lower risk of nephrolithiasis. Notably, increased oxidative balance score were consistently associated with a decreased likelihood of kidney stone formation.

Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (19), and its protocol is registered in PROSPERO (the International Prospective Register of Systematic Reviews) and the Research Registry.

Search strategy

A comprehensive search was conducted in Web of Science, Cochrane, ProQuest, PubMed, Embase, and Google Scholar through January 20, 2025, without restrictions on publication date or geographic region. The search strategy incorporated Medical Subject Headings (MeSH) and related terms, combined with Boolean operators (AND, OR) to optimize results. Additionally, manual searches were performed to ensure comprehensive coverage. For example, the search strategy in Web of Science was structured as follows: Kidney Calculi OR Kidney Stone OR Nephrolithiasis (All Fields) AND Oxidative Balance Score (All Fields).

PECO

The study focused on research examining the relationship between OBS and nephrolithiasis. The exposure was defined as elevated OBS, while the comparison group comprised individuals in the lowest OBS stratum. The primary outcome was the association between OBS and nephrolithiasis formation.

Inclusion criterion

Observational studies investigating the relationship between OBS and nephrolithiasis were included.

Exclusion criteria

Studies were excluded if they demonstrated poor methodological quality, lacked full-text availability, had provisional acceptance status, were duplicate publications, provided insufficient data, or were conference or congress proceedings.

Quality assessment

Two independent authors assessed study quality using the Newcastle-Ottawa Scale, which awards up to one star per item (except for the comparison item), with total scores ranging from 0 (lowest quality) to 10 (highest quality) (20).

Data extraction

Two investigators independently extracted data on country of origin, publication year, author, participant age, study design, sample size, and the associations between OBS and kidney stones (with 95% confidence intervals) for both the overall population and by gender, and etc. Any discrepancies were resolved by consensus.

Statistical analysis

The odds ratios (ORs) were log-transformed, and the studies were then pooled. Between-study heterogeneity was evaluated using the I^2 statistic, and a random-effects model was applied to combine the results. Data were processed using SPSS version 19 and analyzed with STATA version 14, with statistical significance set at $P < 0.05$.

Results

The initial database search identified 79 articles, from which 36 duplicates were removed. After screening abstracts, five studies were excluded due to lack of full-text access. Among the 38 remaining articles, 25 were eliminated due to insufficient statistical data. Of the 13 studies that advanced to further evaluation, eight were excluded based on additional criteria, resulting in a final selection of five studies for analysis (Figure 1).

All articles included in the analysis were cross-sectional and conducted in the United States. The cumulative sample comprised 73 285 participants who were evaluated at various stages of the research process (Table 1).

As shown in Figure 2, higher OBS was significantly associated with a reduction in kidney stone risk (OR: 0.74, 95% CI: 0.70, 0.79). Analysis by OBS quartiles revealed a consistent protective effect with risk reductions in quartile 2 (OR: 0.78, 95% CI: 0.80, 0.87), quartile 3 (OR: 0.75, 95% CI: 0.68, 0.83), and quartile 4 (OR: 0.68, 95% CI: 0.59, 0.77). Notably, a dose–response relationship was observed,

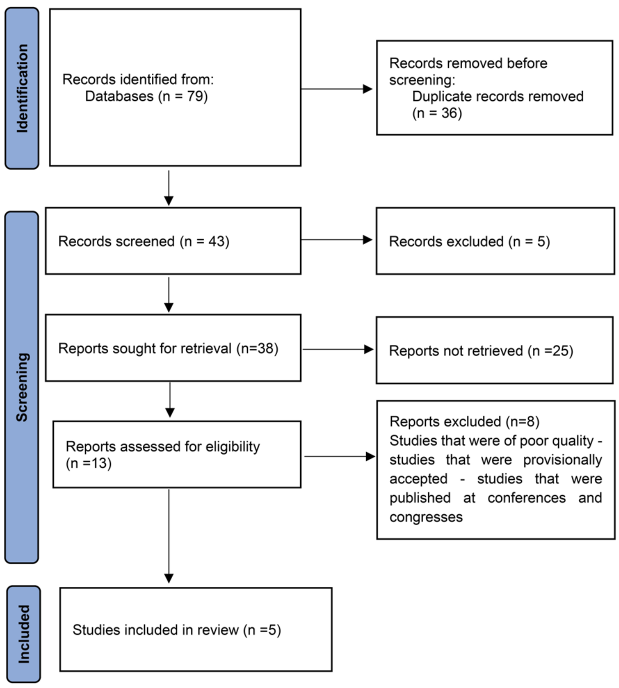

Figure 1. The PRISMA flowchart of study selection.

Table 1. Summarized information of the studies

Index	Author, year	Country	Type of study	Sample size	Mean age (year)	Stage
OR	Lin G, 2024 (16)	USA	Cross-sectional	12519	NR	Q 2 Q 3 Q 4
OR	Chen Q, 2024 (17)	USA	Cross-sectional	17988	46.86	Q 2 Q 3 Q 4
OR	Lei X, 2024 (5)	USA	Cross-sectional	3231 3315 2841	44 44 45	Q 2 Q 3 Q 4
OR	Song R, 2024 (18)	USA	Cross-sectional	5829 7324 5998	48.8 47.99 47.01	Q 2 Q 3 Q 4
OR	Ke R, 2023 (2)	USA	Cross-sectional	4447 5620 4173	46.86 46.36 46.31	Q 2 Q 3 Q 4

NR: Not reported; OR: Odds ratio; Q: Quartile.

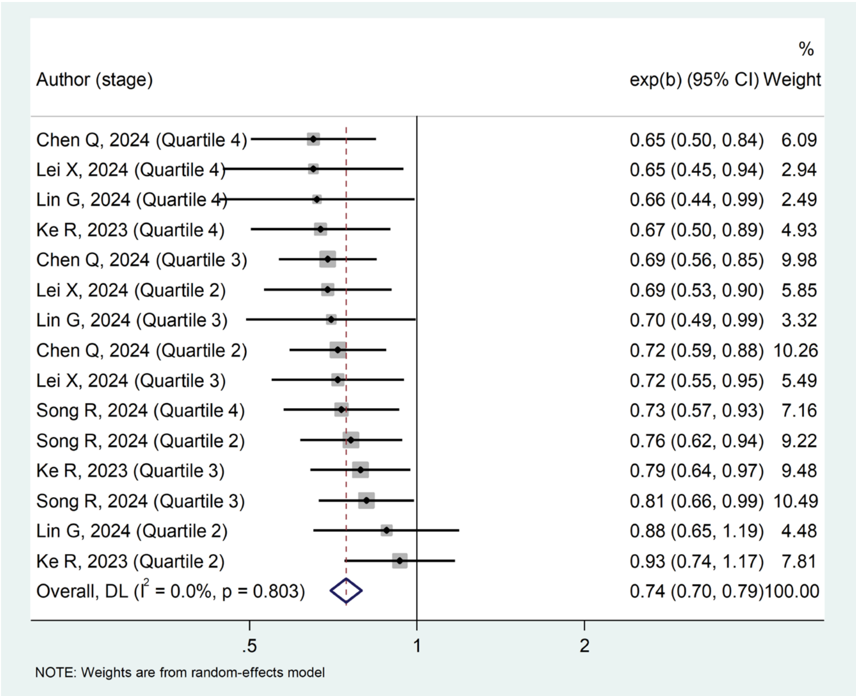

Figure 2. Forest plot showing the association between OBS and kidney stone.

with higher OBS scores corresponding to progressively lower kidney stone risk (Figure 3).

As illustrated in Figures 4 and 5, elevated OBS demonstrated protective effects in both males (OR: 0.98, 95% CI: 0.96, 0.99) and females (OR: 0.98, 95% CI: 0.96, 0.99). Note that only three studies provided gender-stratified data. Moreover, Figures 6 and 7 indicate that both dietary OBS (OR: 0.97, 95% CI: 0.96, 0.98) and lifestyle OBS (OR: 0.95, 95% CI: 0.90, 1.00) were linked to reduced kidney stone risk.

Among hypertensive patients, higher OBS was associated with a significant reduction in kidney stone risk (OR: 0.97, 95% CI: 0.96, 0.99). In contrast, among diabetic patients the relationship did not reach statistical significance (OR: 1.00, 95% CI: 0.96, 1.04), as illustrated in Figures 8 and 9.

Meta-regression analysis revealed that the association between higher OBS and kidney stone risk was not significantly moderated by year ($P = 0.213$) or sample size ($P = 0.362$), as depicted in Figures 10 and 11.

Figure 12 demonstrated that publication bias was not statistically significant ($P = 0.220$).

Discussion

Higher OBS values were associated with up to a 26% reduction in kidney stone risk. Specifically, risk decreased progressively across quartiles; 22% in quartile 2, 25% in

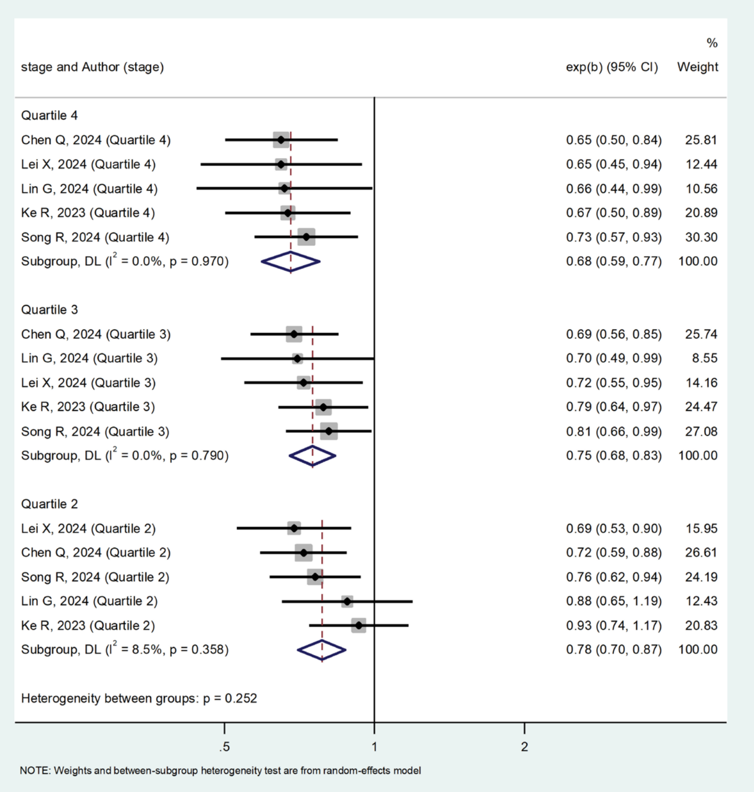

Figure 3. Forest plot showing the association between OBS and kidney stone by stage.

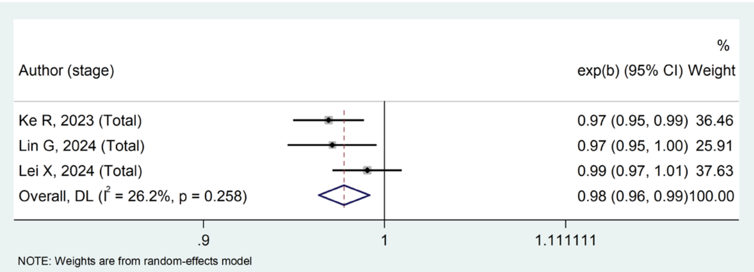

Figure 4. Forest plot showing the association between OBS and kidney stone in males.

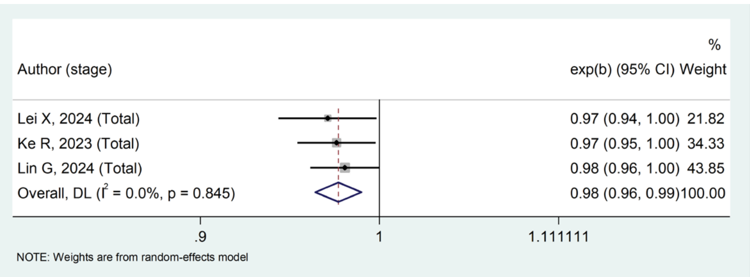

Figure 5. Forest plot showing the association between OBS and kidney stone in females.

quartile 3, and 32% in quartile 4. Among hypertensive patients, a modest 3% reduction in kidney stone risk was observed. Additionally, elevated dietary OBS and lifestyle OBS were linked to 3% and 5% reductions in kidney stone risk, respectively. In contrast, no significant association was found between higher OBS and nephrolithiasis in diabetic patients.

Findings from previous studies support our results. Chen et al reported that each unit increase in OBS corresponded to a 3% reduction in kidney stone risk (OR: 0.97, 95% CI: 0.96, 0.98) (17). Similarly, Ke et al confirmed an inverse relationship between OBS and kidney stone risk (OR:

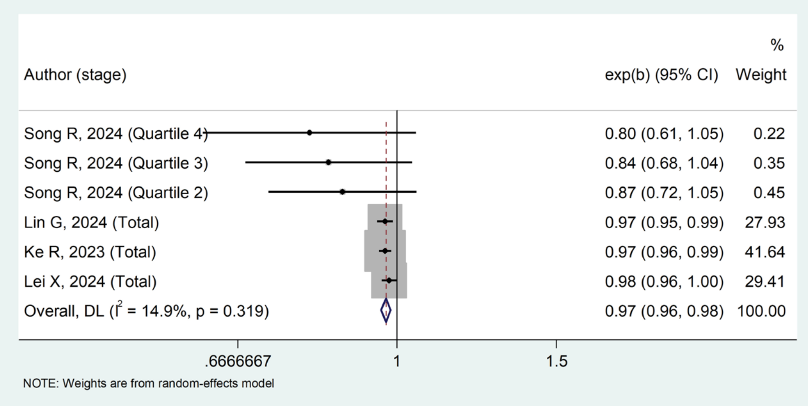

Figure 6. Forest plot showing the association between dietary OBS and kidney stone.

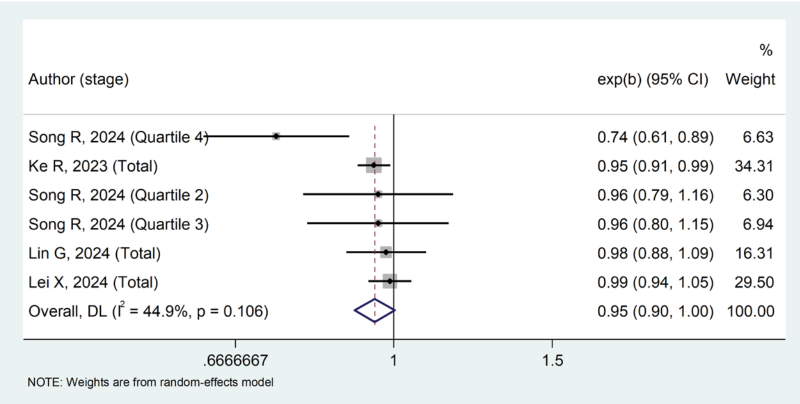

Figure 7. Forest plot showing the association between lifestyle OBS and kidney stone.

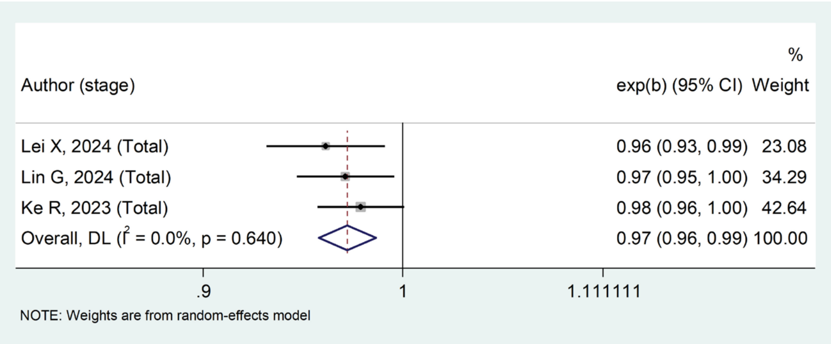

Figure 8. Forest plot showing the association between OBS and kidney stone in patients with hypertension.

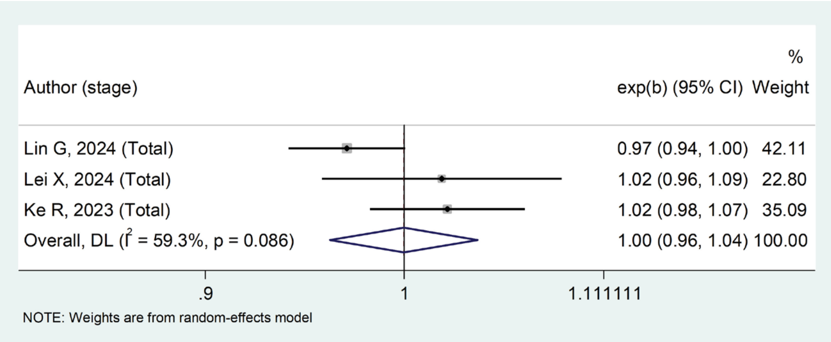

Figure 9. Forest plot showing the association between OBS and kidney stone in patients with diabetes.

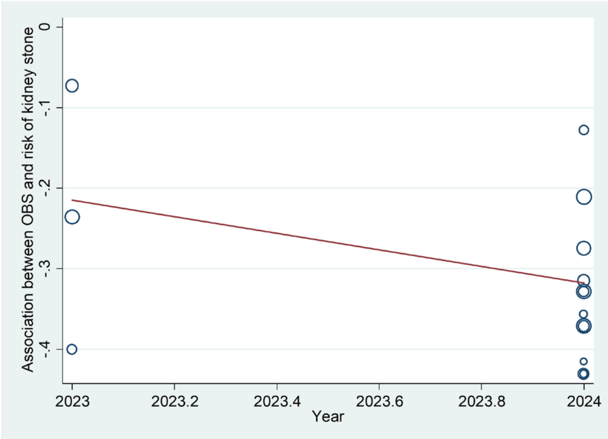

Figure 10. Meta-regression of the relationship between OBS and kidney stone by year.

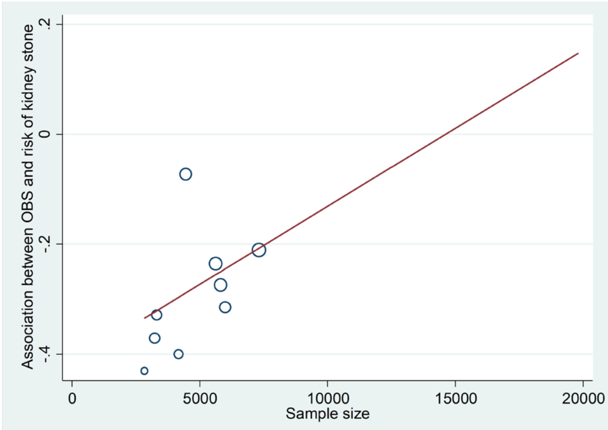

Figure 11. Meta-regression of the relationship between OBS and kidney stone by sample size.

0.97, 95% CI: 0.96, 0.99) (2), while Lei et al demonstrated a significant negative correlation (OR: 0.98, 95% CI: 0.96, 0.99) (5). Lin et al also found that higher OBS was linked to lower kidney stone risk (OR: 0.97, 95% CI: 0.95, 0.99) (16), and Song et al concluded that individuals in the highest OBS quartile had a significantly lower risk of nephrolithiasis (OR: 0.73, 95% CI: 0.57, 0.92) (18). Collectively, these findings reinforce the hypothesis that higher OBS may contribute to a reduced risk of kidney stones.

Beyond nephrolithiasis, OBS has also been linked to other kidney-related conditions. Chen et al found that higher OBS was associated with a reduced risk of CKD (OR: 0.98, 95% CI: 0.97, 0.99) (21). Likewise, Liu et al reported that individuals in the highest OBS quartile had a 26% lower risk of CKD compared to those in the lowest quartile (OR: 0.74, 95% CI: 0.63, 0.87) (22). Yin et al further confirmed a significant reduction in CKD risk with increasing OBS (OR: 0.70, 95% CI: 0.53, 0.92) (23). Additionally, Liu et al demonstrated that higher OBS levels were associated with a lower risk of diabetic kidney disease (OR: 0.61, 95% CI: 0.46, 0.80), a reduced likelihood of low estimated glomerular filtration rate (eGFR) (OR:

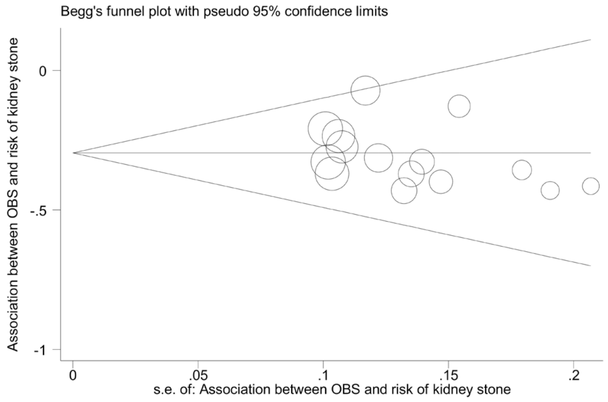

Figure 12. Diagram of publication bias.

0.46, 95% CI: 0.33, 0.64), and a decreased incidence of albuminuria (OR: 0.68, 95% CI: 0.51, 0.92) (24). Similarly, Wang et al reported a lower risk of hyperuricemia among individuals in the second (OR: 0.85, 95% CI: 0.72, 0.99), third (OR: 0.71, 95% CI: 0.58, 0.85), and fourth quartile s (OR: 0.48, 95% CI: 0.38, 0.61), with the second quartile also associated with a reduced risk of gout (OR: 0.70, 95% CI: 0.51, 0.97) (25). Furthermore, Yang et al observed an inverse association between OBS levels and both serum uric acid concentration and hyperuricemia prevalence (OR: 0.68, 95% CI: 0.61, 0.75) (26). Overall, these studies align with our findings, collectively suggesting that higher OBS and the corresponding reduction in oxidative stress not only lowers the risk of nephrolithiasis but also decreases the incidence of other kidney-related disorders, including CKD, diabetic kidney disease, albuminuria, gout, hyperuricemia, and low- eGFR levels. Given these benefits, monitoring and optimizing OBS could serve as an effective strategy for reducing the burden and healthcare costs associated with kidney disease.

Conclusion

This systematic review and meta-analysis found that higher OBS levels including dietary and lifestyle OBS were significantly associated with a reduced risk of nephrolithiasis formation. The protective effects of elevated OBS were observed in both men and women, suggesting that gender does not significantly influence this relationship. Furthermore, higher OBS scores were linked to lower oxidative stress levels, ultimately reducing the risk of nephrolithiasis. Notably, elevated OBS also lowered kidney stone risk among hypertensive patients, highlighting its potential therapeutic benefits in this population. Given the growing global burden of nephrolithiasis, strategies to improve oxidative balance through diet and lifestyle modifications may serve as an effective approach to reducing kidney stone incidence and associated healthcare costs.

Limitations of the study

This study has several limitations. All included studies were cross-sectional, conducted in the United States, and involved participants with a mean age of 40–49 years. As a result, subgroup analysis based on study design, age, or geographic region were not performed. Additionally, the relatively small number of included studies may limit the robustness of our conclusions. Future research should include prospective cohort studies with diverse populations to strengthen the evidence supporting the association between OBS and nephrolithiasis.

Acknowledgments

The authors would like to thanks Yassamin Rabiei for guidance and editing of manuscript registration on the PROSPERO and research registry websites.

Authors' contribution

Conceptualization: Zahra Bazargani, Elham Kebriyaei.
Data curation: Elham Kebriyaei.
Formal analysis: All authors.
Investigation: Elham Kebriyaei
Methodology: All authors.
Project administration: Elham Kebriyaei.
Resources: Leila Johari.
Software: Leila Johari.
Supervision: Elham Kebriyaei.
Validation: Zahra Bazargani.
Visualization: Zahra Bazargani.
Writing–original draft: Zahra Bazargani, Leila Johari.
Writing–review & editing: Elham Kebriyaei.

Ethical issues

This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO website with (ID: CRD42025643705) and Research Registry website with (Unique Identifying Number (UIN) reviewregistry1952). Besides, ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the author.

Conflicts of interest

The authors declare that they have no competing interests.

Funding/Support

None.

References

1. Hernández-Ruiz Á, García-Villanova B, Guerra-Hernández EJ, Carrión-García CJ, Amiano P, Sánchez MJ, et al. Oxidative Balance Scores (OBSs) Integrating Nutrient, Food and Lifestyle Dimensions: Development of the NutrientL-OBS and FoodL-OBS. Antioxidants (Basel). 2022;11:300. doi: 10.3390/antiox11020300.
2. Ke R, He Y, Chen C. Association between oxidative balance score and kidney stone in United States adults: analysis from NHANES 2007-2018. Front Physiol. 2023;14:1275750. doi: 10.3389/fphys.2023.1275750.
3. Liu X, Liu X, Wang Y, Zeng B, Zhu B, Dai F. Association between depression and oxidative balance score: National Health and Nutrition Examination Survey (NHANES) 2005-2018. J Affect Disord. 2023;337:57-65. doi: 10.1016/j.jad.2023.05.071.
4. Li Y, Liu Y. Adherence to an antioxidant diet and lifestyle is associated with reduced risk of cardiovascular disease and mortality among adults with nonalcoholic fatty liver disease: evidence from NHANES 1999-2018. Front Nutr. 2024;11:1361567. doi: 10.3389/fnut.2024.1361567.
5. Lei X, Wen H, Xu Z. Higher oxidative balance score is associated with lower kidney stone disease in US adults: a population-based cross-sectional study. World J Urol. 2024;42:222. doi: 10.1007/s00345-024-04919-0.
6. Sureshbabu A, Ryter SW, Choi ME. Oxidative stress and autophagy: crucial modulators of kidney injury. Redox Biol. 2015;4:208-14. doi: 10.1016/j.redox.2015.01.001.
7. Daenen K, Andries A, Mekahli D, Van Schepdael A, Jouret F, Bammens B. Oxidative stress in chronic kidney disease. Pediatr Nephrol. 2019;34:975-991. doi: 10.1007/s00467-018-4005-4.
8. Popolo A, Autore G, Pinto A, Marzocco S. Oxidative stress in patients with cardiovascular disease and chronic renal failure. Free Radic Res. 2013;47:346-56. doi: 10.3109/10715762.2013.779373.
9. Khan SR, Pearle MS, Robertson WG, Gambaro G, Canales BK, Doizi S, et al. Kidney stones. Nat Rev Dis Primers. 2016;2:16008. doi: 10.1038/nrdp.2016.8.
10. Thongprayoon C, Krambeck AE, Rule AD. Determining the true burden of kidney stone disease. Nat Rev Nephrol. 2020;16:736-746. doi: 10.1038/s41581-020-0320-7.
11. Sorokin I, Mamoulakis C, Miyazawa K, Rodgers A, Talati J, Lotan Y. Epidemiology of stone disease across the world. World J Urol. 2017;35:1301-1320. doi: 10.1007/s00345-017-2008-6.
12. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol. 2010;12:e86-96.
13. Ziemba JB, Matlaga BR. Epidemiology and economics of nephrolithiasis. Investig Clin Urol. 2017;58:299-306. doi: 10.4111/icu.2017.58.5.299.
14. Scales CD Jr, Smith AC, Hanley JM, Saigal CS; Urologic Diseases in America Project. Prevalence of kidney stones in the United States. Eur Urol. 2012;62:160-5. doi: 10.1016/j.eururo.2012.03.052.
15. Keller JJ, Chen YK, Lin HC. Association between chronic kidney disease and urinary calculus by stone location: a population-based study. BJU Int. 2012;110:E1074-8. doi: 10.1111/j.1464-410X.2012.11380.x.
16. Lin G, Zhan F, Zhu J, Xue L, Wei W. Relationship between oxidative balance score and kidney stone prevalence in US adults. Int Urol Nephrol. 2024;56:877-885. doi: 10.1007/s11255-023-03866-w.
17. Chen Q, Bao W, Kong X, Zhu J, Hou S, Zhang Y, et al. Association between the oxidative balance score and kidney stones in adults. World J Urol. 2024;42:425. doi: 10.1007/s00345-024-05144-5.
18. Song R, Wu K, Ma M, Wang L, Jiang Y, Li J, et al. Association between oxidative balance score and kidney stones: data from the national health and nutrition examination survey (NHANES). BMC Nephrol. 2024;25:190. doi: 10.1186/s12882-024-03607-w.
19. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al; PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4:1. doi: 10.1186/2046-4053-4-1.
20. Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. Eur J Epidemiol. 2010;25:603-5. doi: 10.1007/s10654-010-9491-z.
21. Chen X, Wu Z, Hou X, Yu W, Gao C, Gou S, et al. Association of the oxidative balance score and chronic kidney disease: insights from the national health and nutrition examination survey 2009-2018. Front Nutr. 2024;11:1429191. doi: 10.3389/fnut.2024.1429191.
22. Liu C, Yang J, Li H, Deng Y, He P, Zhang J, Zhang M. Association

between chronic kidney disease and oxidative balance score: National Health and Nutrition Examination Survey (NHANES) 2005-2018. Front Nutr. 2025 3;11:1406780. doi: 10.3389/fnut.2024.1406780.

23. Yin Y, Zhao C, Niu Y, Qi J, Zhang Y, Lu B. Associations between oxidative balance score and chronic kidney disease events in US adults: a population-based study. Sci Rep. 2024;14:13743. doi: 10.1038/s41598-024-64147-9.
24. Liu C, Yang J, Li H, Deng Y, He P, Zhang J, et al. Association between oxidative balance score and diabetic kidney disease, low estimated glomerular filtration rate and albuminuria in type 2 diabetes mellitus patients: a cross-sectional study. Front Endocrinol (Lausanne). 2024;15:1412823. doi: 10.3389/fendo.2024.1412823.
25. Wang K, Wu J, Deng M, Nie J, Tao F, Li Q, et al. Associations of oxidative balance score with hyperuricemia and gout among American adults: a population-based study. Front Endocrinol (Lausanne). 2024;15:1354704. doi: 10.3389/fendo.2024.1354704.
26. Yang Y, Wu Z, An Z, Li S. Association between oxidative balance score and serum uric acid and hyperuricemia: a population-based study from the NHANES (2011-2018). Front Endocrinol (Lausanne). 2024;15:1414075. doi: 10.3389/fendo.2024.1414075.