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DISCOVERY SCIENTIFIC SOCIETY

Effect of alcohol consumption on the risk of kidney stones formation: Systematic review

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ABSTRACT

Introduction: Nephrolithiasis, commonly known as kidney stone disease, is a disease that involves the formation of crystal clusters in favorable conditions. It occurs under favourable conditions when the urine is supersaturated with specific compounds. It can affect the entire urinary tract causing specifics symptoms, complications and damages. The aim of this review is to summarize the latest research on the effect of alcohol consumption on the risk of developing nephrolithiasis. *Methods:* A systematic literature search was conducted from January 2014 to August 2024 via PubMed, Scopus and Google scholar databases with the following keywords (Kidney stones OR urolithiasis OR nephrolithiasis AND alcohol OR beer OR wine). The main outcome of interest was the effect of alcohol consumption on the risk of urolithiasis. *Results:* Out of 1973 articles found in databases, only 7 met the criteria for inclusion in the final review. 6 studies showed negative association between alcohol and risk of developing kidney stones. Only one study found no significant association between alcohol consumption, frequency and prevalence of kidney stones. *Conclusions:* Our systemic review suggests that alcohol intake is associated with a decreased risk of urolithiasis.

Keywords: Kidney stones, urolithiasis, nephrolithiasis, alcohol

1. INTRODUCTION

Urolithiasis, one of the most common urinary tract diseases, is a serious health problem worldwide. It is characterized by the presence of mineral and organic deposits in the urinary tract, which can cause serious clinical implications such as colic pain, urinary tract infections, or renal failure. According to epidemiological data, the prevalence and incidence of kidney stones are increasing all over the globe. They vary between different countries and are influenced by factors such

as: climate, race, sex, age, diet and other socio-economic factors (Shastri et al., 2023). Prevalence described in the literature varies between 5 to 10%, primarily depending on age and gender.

Generally, prevalence increases with age and becomes relatively stable in both genders over 60 (Stamatelou and Goldfarb, 2023). It is slightly higher among males, but the gap is narrowing (Chewcharat and Curhan, 2021). In terms of occupation, epidemiological data identify two main exposed groups: Workers in hot climate conditions, which promotes dehydration, and those exposed to kidney toxins such as cadmium, oxalic acid, ethylene glycol ethers (Järup et al., 1997; Laerum and Aarseth, 1985; Laitinen et al., 1996). The occurrence of kidney stones depends on the climate and, consequently the geographical location. A well-established risk factor increasing the incidence of kidney stones is high temperatures (Ferrari et al., 2007; Masterson et al., 2013).

The formation of kidney stones (lithogenesis) is a multifactorial process caused by supersaturation of urine, which occurs under appropriate conditions (dehydration additionally increasing supersaturation, urine pH disturbances, ionic disturbances, diet, anatomical abnormalities of the urinary tract, general diseases) (Tamborino et al., 2024). Many studies suggest that alcohol may act as a protective factor, reducing the risk of kidney stones. The purpose of this review is to present an overview of recent findings on the relationship between alcohol intake and the risk of developing kidney stones.

2. MATERIALS AND METHODS

Inclusion and Exclusion Criteria

Inclusion criteria

Articles specific to KSD published between January 2014 to August 2024
Studies in English language
Adult patients >18 years
Case-control or cohort study and cross-section study

Exclusion criteria

Case reports, review articles and meta-analyses
Animal studies
Laboratory studies

Search strategy and study selection

The study search was done using PubMed, Scopus and Google Scholar databases using keywords: Kidney stones, urolithiasis, nephrolithiasis, alcohol, beer, wine. Boolean operators (OR and AND) were used for better search results. The search was limited to articles published in English between January 2014 to August 2024. The process of identifying articles was conducted by two independent researchers. After an initial assessment of all potentially relevant articles by reviewing titles and abstracts, we excluded those not related to the research topic, as well as case reports, review articles, and meta-analyses. The article screening process adhered to the PRISMA guidelines (Figure 1).

Analysis

Due to the heterogeneous nature of the research, a narrative approach was used to analyze the data.

Quality assessment

Quality bias assessment of included studies was performed using the Newcastle–Ottawa Scale (NOS). The NOS score ranges between 0 to 9. NOS scores of ≥7 were identified as high-quality studies, scores 4-6 were identified as moderate quality and studies ≤3 as poor quality.

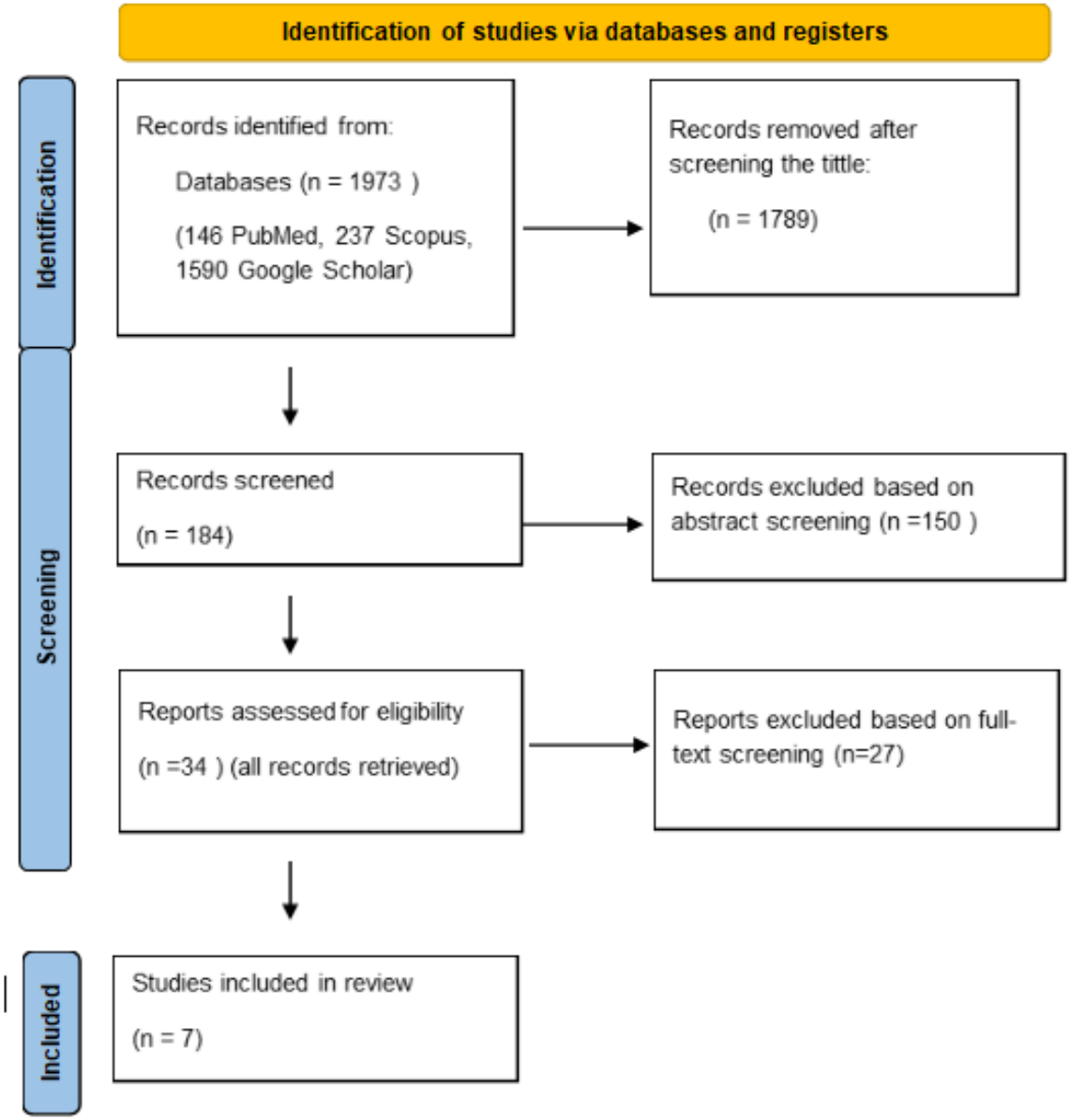

Figure 1 PRISMA flow diagram.

3. RESULTS AND DISCUSSION

Our search strategy identified a total of 1973 articles, 146 from PubMed, 237 from Scopus and 1590 from Google Scholar databases. Primary title selection excluded 1789 articles. After screening the abstract, we selected 34 articles. Finally, 8 articles were included after a full-text analysis. Figure 1 illustrates the process of identification and selection. Among the included articles, three were cross-sectional studies and four were cohort studies. Three studies were conducted in the US, two in the UK, one in Korea and one in China. Six studies found a negative correlation between alcohol consumption and kidney stones formation (Kim et al., 2022; Littlejohns et al., 2020; Shringi et al., 2024; Turney et al., 2014; Wang et al., 2021; Wei et al., 2024).

The study quality scores assessed by the NOS ranged from 7 to 8 (Table 1). Shringi et al., (2024) examined NHANES 2007-2018 to analyze association between alcohol intake and prevalent kidney stones. 29684 participants took part in the analysis. Analysis of the type of alcohol (beer, wine, liquor) and dose was conducted. Beer (OR = 0.79, 95% CI: 0.64–0.97, p = 0.02) and wine (OR = 0.75, 95% CI:

0.59–0.96, p = 0.03) intakes had lower odds of prevalent nephrolithiasis, while liquor intake had no association (OR= 1.08 (0.77-1.52. P=0.63). In addition, beer and wine have a dose-dependent effect on kidney stone formation. Moderate to heavy beer intake and moderate wine intake are associated with a lower risk of urolithiasis.

Wei et al., (2024) found that an increase in alcohol consumption was associated with a decreased risk of developing kidney stones in adults. In the unadjusted analysis, mild drinkers had 21% lower odds (OR 0.79; 95% CI, 0.68–0.92), moderate drinkers had 40% lower odds (OR 0.60; 95% CI, 0.49–0.73), and heavy drinkers had 50% lower odds (OR 0.50; 95% CI, 0.41–0.62) of developing kidney stones compared to former drinkers, with all results being statistically significant (p < 0.01). Zhou et al., (2023) in cross-sectional study revealed that alcohol consumption is not significantly linked to the prevalence of kidney stones.

They divided 26401 participants into 11 subgroups based on 11 different questions and showed that none of these 11 samples demonstrated a significant association with kidney stones. Wang et al., (2021) in a large prospective cohort study on Chinese adults demonstrated that drinking > 30g of pure alcohol were associated with reduced risk of kidney stones. aHR for individuals consuming 30-59.9 g of ethanol daily compared to those who never drank last year was (0.79, 95% CI, 0.72-0.87). The risk did not decrease with higher alcohol consumption (ptrend = 0.346). A lower risk of kidney stones was consistently noted among weekly and strong spirits drinkers but not among consumers of other types of alcohol.

A study based on Oxford data Turney et al., (2014) of the EPIC observed that only individuals consuming 16 grams or more of alcohol daily had a reduced risk of kidney stones compared to those consuming 1 to 7 grams per day (HR = 0.65, 95% CI: 0.47–0.91, p=0.04). Littlejohns et al., (2020) demonstrated that the risk of urolithiasis decreased linearly with increasing alcohol consumption (p for trend <0.001) per 200 mL/d alcohol (HR= 0.85, 95% CI, 0.82–0.88). Study based on Korean cohort using data from the Korean National Health Insurance Service- Health Screening Cohort Kim et al., (2022) showed that alcohol intake was linked with reduced odds for kidney stones disease (aOR = 0.89, 95% CI, 0.86–0.92, p < 0.001) (Table 1).

Table 1 Characteristics of published studies on alcohol intake and risk of urolithiasis

Autor	Year of publication	Period of time	Region	Sample size	Age (years)	Gender	Type of alcohol	NOS	Study type
(Shringi et al., 2024)	2024	2007-2018	USA	29684	≥ 20	Mixed	Beer/wine/liquor	7	Cross-sectional study
(Wei et al., 2024)	2024	2007-2018	USA	24446	≥ 20	Mixed	Alcohol (not specified)	7	Cross-sectional study
(Zhou et al., 2023)	2023	2007-2016	USA	26401	≥ 20	Mixed	Alcohol (not specified)	7	Cross-sectional study
(Wang et al., 2021)	2021	2004-2008	China	502621	30-79	Mixed	Alcohol (Beer, wine, weak and strong spirits)	8	Prospective cohort study
(Kim et al., 2022)	2022	2002-2019	Korea	141975	≥ 40	Mixed	Alcohol (not specified)	7	Cohort study
(Turney et al., 2014)	2014	1993-1999	UK	51336	≥ 20	Mixed	Alcohol (not specified)	8	Prospective cohort study
(Littlejohns et al., 2020)	2019	2006-2010	UK	439072	40-69	Mixed	Alcohol (not specified)	8	Prospective cohort study

NOS- Newcastle- Ottawa Quality Assessment Scale

Our systematic review summarized the results from 7 scientific studies, of which 4 were cohort studies and 3 were cross-sectional studies. Based on selected studies, we concluded that alcohol consumption significantly reduces the risk of urolithiasis. Only one of the 7 studies did not show a substantial association between alcohol intake and the risk of urolithiasis. We additionally analyzed the 2014 meta-analysis Wang et al., (2015) and the outcomes were similar to ours. The aim behind this systemic review was to reassess the situation based on the papers published after 2014.

Alcohol's effect on kidney stones

Complexity of the mechanism

The mechanism of the relationship between alcohol and the risk of nephrolithiasis is based on the multi-pathway biochemical effects of alcohol, its metabolites, and biochemical additives contained in various types of alcoholic beverages. Currently, the effect of alcohol on kidney stone formation remains unclear and there are many suggested possible pathways through which alcohol may either reduce or increase the risk of nephrolithiasis (Wang et al., 2023). All this, together with the fact that alcohol is still the most commonly consumed psychoactive substance, forces us to explore the problem in more detail and leaves an open space for further research (Balawender et al., 2024).

Alcohol as a protector

The protective effect of alcohol seems to be due to its capability to supress the secretion of vasopressin and to induce a diuretic effect Hirvonen et al., (1999), which results in an increased frequency and volume of micturition. All of this, with the additional suggested effect of diluting metabolites in urine and blood, may contribute to a reduced risk of disease (De-Lorimier, 2000). Additionally, alcoholic beverages are fluids that consist of varying amounts of water and additional substances responsible for other effects that contribute to a reduced risk of kidney stones. Increased fluid intake is a recognized factor in reducing the risk of kidney stones.

As for the additional effects of other substances, it is emphasized that the possible beneficial effect of wine may be due to the antioxidants and phytochemicals contained in it De-Lorimier, (2000), Zecher et al., (2009), which help prevent the crystallization of stones, and beer is probably associated with the large amount of water supplied with it, the effect of the biochemical action of ethanol, in particular increasing diuresis, and the content of excipients contained in hops. It seems that the substances contained in it can reduce bone resorption, thus reducing calciuria (Wang et al., 2015).

Alcohol as a promoter

On the other hand, it has been suggested that alcohol may promote the formation of kidney stones. One possible mechanism is the action of the main ingredient in alcoholic beverages, ethanol. It is metabolized to acetaldehyde, which contributes to DNA damage by disrupting synthesis and repair. Additionally, it has a pro-inflammatory effect and leads to oxidative stress. The pro-inflammatory effect may lead to kidney injury with subsequent fibrosis and the formation of kidney stones (Jones et al., 2021; Varga et al., 2017).

Moreover, the action of alcohol is associated with increased production of uric acid metabolites, which may contribute to the formation of urolithiasis (Singh et al., 2011). Apart from kidney stones, alcohol also causes many health problems, including CVD, liver disease, neoplasia and behavioral disorders (Griswold et al., 2018). Finally, it is worth mentioning that it is a widely addictive psychoactive substance and overconsumption is known to be a major contributor to global mortality.

4. CONCLUSION

In summary, our study indicates that alcohol is linked with a reduced risk of kidney stones. Further research is required to confirm our findings and to investigate the exact cause behind this phenomenon. Considering the beneficial effects of alcohol along with its negative effects, it seems possible to substitute these types of fluids with others, such as tea, which also have a beneficial effect with less pronounced side effects (Wang et al., 2021). Moreover, we cannot look at alcohol only in terms of the alcohol-kidney stone relationship, ignoring the overall impact of this substance, not only on various biochemical systems of the body but also on its social impact, impact on public health and health care costs related to other diseases to which ethanol consumption contributes.

Author's contribution

Conceptualization: AZ and MA; Methodology: AZ and MB; Software: MK and MW; Validation: MK and MW; Formal analysis: AB and KS; Investigation: JBK and KH; Resources: AB and KS; Data curation: PK and ML; Writing- Original- draft preparation: AZ and MK; Writing-review and editing: PK and ML; Supervision: JBK and KH; Project administration: MB, AZ, MK, MW, AB, KS, JBK, ML, KH, PK, MA.

Informed consent

Not applicable.

Ethical approval

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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