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REVIEW

Epidemiology of urolithiasis in Europe and Latin America: A systematic review

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Summary

Background: The epidemiology of urolithiasis may vary in different geographical areas in relation to various environmental factors; therefore it is important to review the information on its prevalence and incidence in different countries of the world. The aim of this study was to conduct an updated systematic review and meta-analysis on the prevalence and incidence of urinary calculi in Europe and Latin America
Methods: Two separate searches were performed on EMBASE and PubMed databases. The MESH terms used were "prevalence", "incidence", "epidemiology" "urinary calculi" in title or abstract. Each separate search focused on a specific geographic area: Europe or Latin America, which included Southern America, Central America and the Caribbean.
Publications between January 1, 1981, and February 28, 2026 were included. We retrieved 1,234 records in PubMed and 7,140 in EMBASE for Europe and 152 records in PubMed and 963 in EMBASE for Latin America. Two independent reviewers screened articles based on a priori protocol.
Studies reporting population-based estimates of urinary calculi prevalence or incidence in children and adults were included. In total, 66 and 17 studies were included in the systematic review for Europe and Latin America, respectively. For Europe, 11 studies reported data on both prevalence and incidence, 24 on prevalence and 31 on incidence. For Latin America, 10 studies reported prevalence data and 7 studies reported incidence data.
Results: Random-effects models using the Freeman-Tukey double-arcsine transformation produced a pooled prevalence of kidney stones in Europe of 7.2% (95% CI, 5.55% to 9.05%). Pooled prevalence was 7.03% (95% CI, 5.14% to 9.18%) in Southern/Mediterranean/Balkan Europe and 7.52% (95% CI, 4.50% to 11.24%) in Central/Northern Europe. Pooled prevalence of kidney stones for studies published before year 2000 was 7.37% (95% CI, 4.53% to 10.81%) and 7.11% (95% CI, 5.31% to 9.15%) for studies published in 2000 and later. A meta-regression model indicated that the prevalence of kidney stones was not detectably different in Northern compared with Southern Europe and in study published before compared with those published after 2000. Pooled prevalence of kidney stones in Latin America was 6.02% (95% CI, 3.58% to 9.03%).
Study heterogeneity was deemed as "considerable" either in studies in Europe (I^2 = 99.86%, $p < 0.0001$) and Latin America (I^2 = 99.09%, $p < 0.0001$). The overall risk of bias was low to moderate. Incidence values are highly variable depending on the study design and the populations studied. In 3 studies on pediatric populations, incidence ranged between 1.8 and 6.5 cases per year per 100,000 inhabitants.
Conclusions: The prevalence values of urolithiasis were not different across different areas of Europe and have remained stable over the last 20 years. The prevalence of urolithiasis in Latin America appears to be lower compared to Europe.

KEY WORDS: *Urolithiasis; Prevalence; Incidence.*

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INTRODUCTION

The epidemiology of urolithiasis varies greatly depending on the geographic area where it is assessed and even within the same geographic area over time. This variability is due to dietary habits, lifestyle, and environmental conditions such as average temperature and humidity levels (1). In fact, urinary stones form because of changes in urine composition of genetically predisposed individuals exposed to various environmental factors. Furthermore, epidemiological indices depend on the structure of a specific population in terms of sex and age, as the tendency to form stones is gender- and age-dependent.
The unique characteristics of urolithiasis do not allow it to be classified as either a chronic or acute disease. Urolithiasis consists of a series of events (stone formation) that can manifest as acute episodes or remain asymptomatic. An acute episode can resolve with the passage of the stone or its surgical removal. However, stone formation often has a recurrent pattern, resulting in the disease persisting over time and becoming chronic.
In certain countries, surgical procedures and outpatient services are recorded in a registry system that allows for consideration of all possible diagnoses related to urinary stones. In other healthcare systems, primary patient care is entrusted to general practitioners who record all pathological events of the patients they care for, including episodes related to urinary stones.
The epidemiology of urolithiasis can be described by prevalence and incidence values.
Prevalence values estimate the number of subjects in a

population who have been affected -at least once- by urolithiasis, which is, in this case, considered a chronic disease. Prevalence is described through cross-sectional cohort studies that investigate the presence of self-reported urinary stones through interviews or questionnaires. Some studies supplement this type of survey with systematic imaging tests to diagnose on-site urinary stones, which may be asymptomatic.

Incidence values estimate the number of acute episodes (described as colics or as surgical procedures) occurring in a defined period of time (generally one year) in a population, as an indicator of an acute disease.

Incidence assessment is often based on recording acute events that require hospital care for the treatment of painful symptoms (colic) or for surgical removal of stones. This approach may underestimate the incidence of the disease because it does not include asymptomatic stones, cases managed on an outpatient basis, and cases that do not require hospitalization (spontaneous expulsion, watchful waiting). When the incidence is estimated from systematic longitudinal follow-up measurements with periodic checks over time of a cohort of subjects, the estimated incidence values may be higher.

Data from the Global Burden of Disease Study were recently made available, which systematically evaluated the number of incident cases of urinary stones, the age-standardized incidence, mortality, and *disability-adjusted life-years* (DALYs) of urinary stone disease from 2000 to 2021 at the global, regional, and national levels (2-4).

The estimated values from this study are derived from clinical informatics data, including inpatient admissions, outpatient (including general practitioner) visits, and health insurance claims, which are processed with statistical tools that are not easily controlled and reproducible. While representing a valuable source of information, these data still require comparison and confirmation using conventional and transparent statistical procedures based on systematic reviews of published studies available in electronic databases.

A large number of descriptive studies of urinary stones in Europe have produced mixed results. However, surprisingly, unlike other areas of the world (5-9), to our best knowledge European studies, describing the frequency of the disease in its various geographical regions (which present cultural and climatic differences), or analyzing variations over time due to economic conditions and lifestyle changes, have never been systematically reviewed.

Latin America, which broadly includes South America, Central America, Mexico and the Caribbean, is a geographical macro-area with cultural, linguistic, and lifestyle similarities with some Southern European countries for historical reasons and due to the massive migration flows from Europe to South America in the 19th and early 20th centuries. The number of epidemiological studies on urolithiasis is far lower than those available in Europe, and systematic review of urolithiasis epidemiology is not yet available for this area.

The aim of this systematic review was to assess the prevalence and incidence of urolithiasis in Europe and, secondarily, in Latin America and, where possible, to perform pooled analyses and comparisons.

MATERIALS AND METHODS

Protocol and registration

The review was conducted in accordance with the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) guidelines (10, 11). It was registered on the PROSPERO platform under the number 1334962 (*https://www.crd.york.ac.uk/PROSPERO/* accessed on March 2026).

Search strategy

A database search of studies between 1981 and 2025 was conducted in March 2026 on PubMed and EMBASE using the MESH terms "*prevalence*", "*incidence*", "*epidemiology*" "*urinary calculi*".

Two separate searches were done for the countries of Europe and the countries of Latin America. The string used for the searches are below reported.

Search 1

(Epidemiology OR Incidence OR Prevalence) AND (Urinary calculi) AND (Austria OR Belgium OR France OR Germany OR Liechtenstein OR Luxembourg OR Monaco OR Netherlands OR Switzerland OR Albania OR Andorra OR Bosnia and Herzegovina OR Croatia OR Greece OR Italy OR Kosovo OR Malta OR Montenegro OR North Macedonia OR Portugal OR San Marino OR Serbia OR Slovenia OR Spain OR Vatican City OR Denmark OR Estonia OR Finland OR Iceland OR Ireland OR Latvia OR Lithuania OR Norway OR Sweden OR United Kingdom OR Belarus OR Bulgaria OR Czechia OR Hungary OR Moldova OR Poland OR Romania OR Russia OR Slovakia OR Ukraine).

Search 2

(Epidemiology OR Incidence OR Prevalence) AND (Urinary calculi) AND (Argentina OR Bolivia OR Brazil OR Chile OR Colombia OR Ecuador OR Guyana OR Paraguay OR Peru OR Suriname OR Uruguay OR Venezuela OR Mexico OR Belize OR Costa Rica OR El Salvador OR Guatemala OR Honduras OR Nicaragua OR Panama OR Antigua OR Barbuda OR Bahamas OR Barbados OR Cuba OR Dominica OR Dominican Republic OR Grenada OR Haiti OR Jamaica OR St. Kitts OR Nevis OR St. Lucia OR St. Vincent OR the Grenadines OR Trinidad OR Tobago)

Relevant data were also searched through other sources, including handsearching from the reference lists of included articles.

Types of studies

We considered studies published in the period from January 1st, 1981 to February 28th, 2026.

Inclusion criteria

Inclusion criteria were: 1) observational studies 2) reporting incidence or prevalence in human patients diagnosed with urinary calculi 3) papers written in English or Spanish.

Studies based on data from Global Burden of Disease dataset, narrative reviews, systematic reviews, meta-analyses, letters to the editor, clinical trials, and experimental studies were excluded.

Studies conducted in Turkey, whose territory is predominantly located in Asia, were not included in the review. Conversely, data from the Russian Federation were considered in relation to its territories located in Europe.

Types of subjects
Participants of both gender living in Europe or Latin America were involved irrespective of their age or ethnicity.

Diagnosis of urinary calculi
Subjects were considered affected by urinary calculi if (i) they self-reported a history of urinary stones or (ii) had a documented diagnosis of urinary calculi by imaging modalities or autoptic examination or (iii) were submitted to surgical procedures for stone removal.

Outcomes
The following primary outcomes were measured: rate of (i) prevalence or (ii) incidence of urinary calculi.

Selection of studies
A title and abstract screening to exclude documents that did not meet the inclusion criteria was performed independently by two authors. Full texts were downloaded to analyze them and to extract relevant information. Controversies were resolved by a third researcher. Duplicate references were deleted.

Data extraction
Data extraction was conducted by two authors using a standardized form. The following information was obtained from each study: author(s), publication year, study design, rate of prevalence and/or incidence, characteristics of the studied population, including age and gender distribution (if available).
In case of missing or insufficient information, we analyzed the issue, considering the impact of missing data on the meta-analysis results.

Quality evaluation of methodology
Two authors independently performed the quality assessment by identifying potential biases using the JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data (12, 13). Disagreements were resolved by discussion. High risk of bias did not influence exclusion of studies from this systematic review. The JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data was applied to all included studies. Each study was evaluated across the nine standard JBI items, and scored (1 = Yes, 0 = No/Unclear/NA); an overall quality percentage was also calculated. The nine domains were the standard JBI items: Q1 Appropriate sampling frame, Q2 Appropriate sampling method, Q3 Adequate sample size, Q4 Clear description of subjects and setting, Q5 Sufficient coverage of the sample, Q6 Valid methods for identifying the condition, Q7 Standard, reliable measurement, Q8 Appropriate statistical analysis, Q9 Adequate response rate or appropriate management of low response. To evaluate the adequacy of sample sizes for prevalence and incidence studies, the standard formula $n = Z^2 \cdot P(1 - P)/d^2$ was used, assuming an expected prevalence of 15% and incidence of 1% (1000/100,000), a 95% confidence level (Z = 1.96), and an absolute precision of 0.3%. This yielded to a required sample of approximately 545 and 4,244 individuals for prevalence and incidence, respectively. To account for potential non response and drop outs, the sample size was increased by 10%, resulting in a final target of approximately 600 and 4,670 participants.

Statistical analysis
Pooled prevalence estimates were evaluated for kidney stones in Europe and Latin America. For the European data, pooled prevalence estimates were also analyzed (i) by geographic macro-region – Central/Northern Europe versus Southern/Mediterranean/Balkan Europe – and (ii) by publication period, comparing studies published before 2000 (pre-2000) with those published in 2000 or later (2000+). For each study, the number of kidney stone cases and the total sample size were considered. Effect sizes were calculated as arcsine-transformed proportions using the Freeman-Tukey double-arcsine method to stabilize variance and reduce the influence of extreme proportions. Random-effects models were fitted using *Restricted Maximum Likelihood* (REML) estimation to obtain pooled prevalence estimates for each subgroup. To assess whether pooled prevalences differed between Northern and Southern Europe or between Pre-2000 and 2000+ studies, we performed meta-regression analyses including all studies in a single model, with geographic region or publication period entered as categorical moderators. Heterogeneity was interpreted according to Cochrane criteria as: of low importance ($I^2 \leq 40\%$), moderate ($I^2 = 30\text{-}60\%$), substantial ($I^2 = 50\text{-}90\%$), or considerable ($I^2 \geq 75\%$). Forest plots were generated to visualize individual study estimates and pooled effects stratified by geographic region or publication period. Pooled estimates were back-transformed to the proportion scale to facilitate interpretation. Potential publication bias and small-study effects were evaluated using funnel plots and Egger's test. All analyses were performed using the metafor package in the R statistical environment.

RESULTS
The study selection process is depicted in the PRISMA flowchart (Figure 1).
Search #1 found 1,234 records in PubMed and 7,140 in EMBASE (total n = 8,374)
After reading the title (or abstract) of the 1,234 records retrieved in PubMed and the 7,140 records retrieved in EMBASE, 212 (80 + 132) records were selected for a full text evaluation, which resulted in the elimination of another 120 (46 + 74) papers for various reasons (duplicates, reviews of previous works, papers reporting data already reported in a previous paper, incomplete data, data from the Global Burden of Diseases).
Ninety-two (34 + 58) papers were selected, which were reduced to 56 after eliminating 36 duplicates present in both PubMed and EMBASE. Ten additional papers retrieved from other sources (including Google Scholar) were added, for a total of 66 papers included in the systematic review. Finally, the review considered 66 studies, of which 11 reported data on both prevalence and incidence (14-24), 24 on prevalence (25-48), and 31 on incidence (49-79).

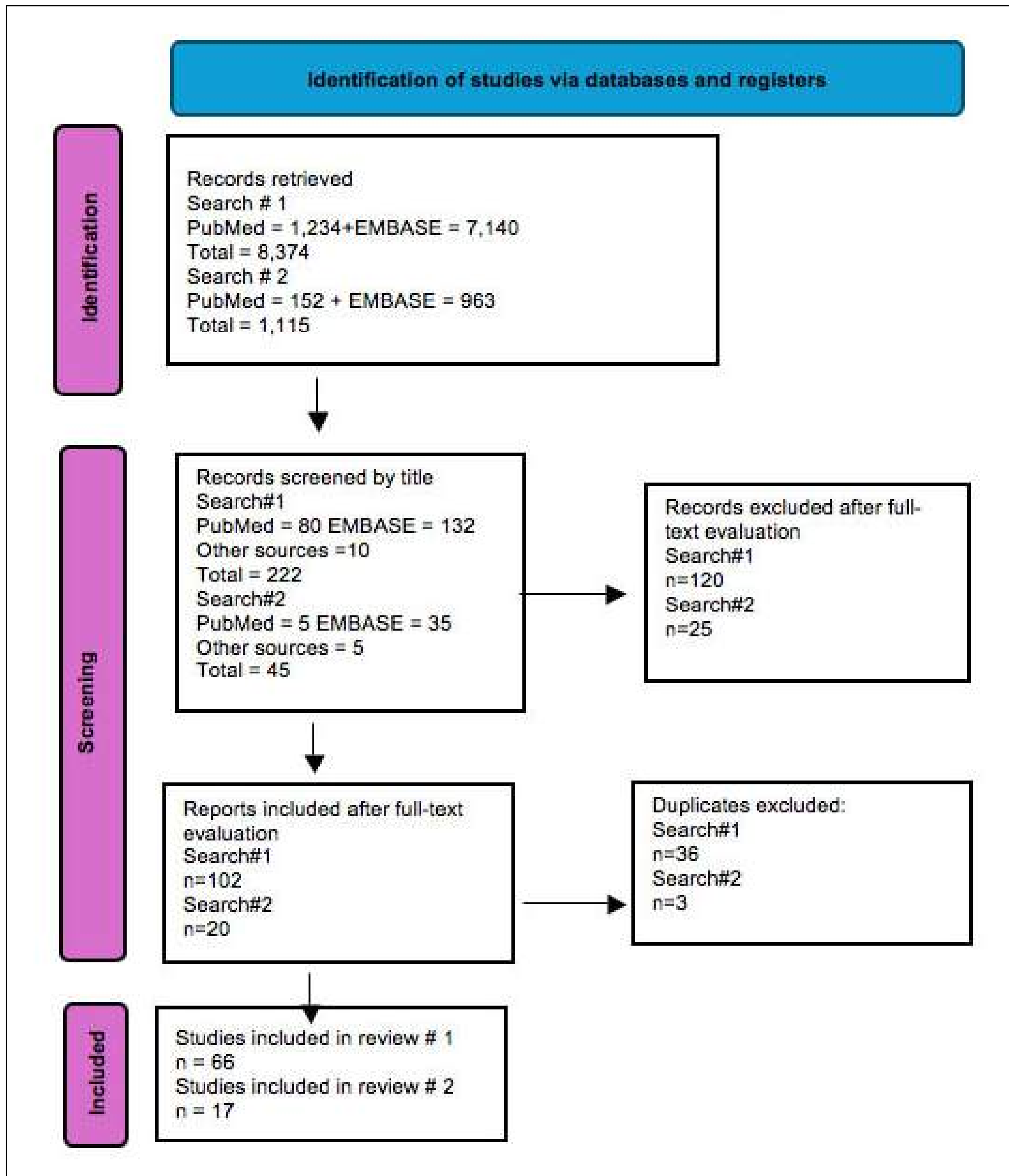

Figure 1.
PRISMA flowchart depicting the study selection process.

Search #2 found 152 records in PubMed and 963 in EMBASE (total n = 1,115).
After reading the title (or abstract), 40 reports were selected (5 from PubMed and 35 from EMBASE), which were reduced to 15 after reading the full text and after eliminating 25 papers which did not have sufficient data for analysis or presented data from the Global Burden of Disease. The selected reports (4 from PubMed and 11 from EMBASE) were reduced to 12 after elimination of 3 duplicates retrieved in both PubMed and EMBASE. Five additional papers retrieved from other sources (including Google Scholar) were added, for a total of 17 papers. Ten studies reported prevalence data, and seven studies reported incidence data.
The characteristics of the studies included in the review are shown in Table 1 (Prevalence and Incidence in Europe), Table 2 (Prevalence in Europe), Table 3 (Incidence in Europe), Table 4 (Prevalence in Latin America) and Table 5 (Incidence in Latin America).

Studies on prevalence in Europe

Thirty-five studies reported on prevalence in 17 European countries (13-47). Prevalence was evaluated in Croatia (n = 2), Denmark (n = 1), Finland (n = 1), France (n = 1), Greece (n = 1), Iceland (n = 1), Italy (n = 10), Kosovo (n = 1), Germany (n = 3), The Netherlands (n = 1), Poland (n = 1), Serbia (n = 1), Spain (n = 5), Sweden (n = 2), Switzerland (n = 1), UK (n = 2), and Ukraine (n = 1).
In two countries the prevalence was estimated by the same study group in two different periods of time. In Germany, *Hesse et al.* (17) showed an increase of prevalence from 4% in 1979 to 4.7% in 2001; in Italy, *Trinchieri et al.* (16) found an increase from 5.9% in 1987 to 9% in 2001.

Table 1.
Characteristics of included studies on both prevalence and incidence in Europe (n = 11) (14-24).

Ref	Author, year	Country	Population	Prevalence	Incidence	Notes
14	Tschope 1981	Germany	261 male and 242 female patients (age 15-65 years)	6.9%	620/100,000 .	
15	Vahlensieck 1982	Germany	10,130 individuals >18 yrs Jan 1980 Jun 1980 Two nationwide surveys by interviews	4%	540/100,000	M/F for incidence 2:1 and for prevalence 1:1 183 M/4620 3.96% 225 F/5510 4.08% annual mortality rate 879 cases in 1974 to 427 cases in 1979
16	Ljunghall 1987	Sweden	health survey of 50-year-old men 10-year followup 1781 participants	19%	500 /100,000	47% recurrent
17	Trinchieri 2000	Italy	Rosate village (Milan) interviews	1986 M 6.8% F 4.9% 1998 M 10.1% F 5.8%	400/100,000 600/100,000 (M) 180/100,000 (F)	
18	Hesse 2003	Germany	A representative sample of 7500 persons from all over Germany	4% (1979) 4.7% (2001)	(year 1979) 540 x 100,000 (year 2000) 1.470 x 100000	9.7% of the 50-64 year old males in 2000 had already had urinary stones (females: 5.9%) Recurrence 42%
19	Stamatiou 2006	Greece	Rural area of Thebes questionnaire 422 subjects Year 2005	15%	12/422 in year 2005 (2843 x 100,000)	M 17.5% F 13.2%
20	Indridason 2006	Iceland	Reykjavik Study, a population-based cohort study carried out between 1967 and 1991 9039 men aged 33-80 years and 9619 women aged 33-81 years	age-standardized prevalence 4.3% M 3.0% F	562 x 100 000 (M) 197 x 100 000 (F)	M>F Family history of nephrolithiasis in 25% Incidence increased significantly with age
21	Prezioso 2014	Italy	HS database at least two years of clinical history at 31 December 2012 900.944 subjects age over 17 years	37316 cases 4.14%	Incidence 2090 cases 223 x 100.000	M 4.53% F 3.78% Highest prevalence in Campania 6.08% Highest incidence in Sicilia 315 for 100,000 in group 65-74 yrs 318 for 100,000
22	Cano-Castiñeira 2015	Spain	multistage randomized procedure 40 to 65 years currently living in Andalusia. phone interviews 2439 subjects	Prevalence 16.4% (95% CI: 14.87-17.85%)	Incidence 1200/100,000 (95% CI: 740-1640)	Family history of kidney stones (odds ratio OR: 1.91; 95% CI: 1.51-2.40

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23	Thomas 2013	Sweden	Cohort of Swedish Men (COSM) The Swedish Mammography Cohort (SMC) (men n = 48,850; women n = 39,227)	Prevalence at baseline (registered +self reported) M 1389+4153/48850 11.3% F 429+1290/39227 4.4%	Incidence during 13-year follow-up M 707/35545 421,611 person-years F 290/33050 403,575 person-years	not strong association between dietary cadmium and kidney stone risk at the exposure levels seen in the general population
24	Stritt 2026	Switzerland	SKIPOGH multicenter cohort 1,128 participants by random sampling of general population of Lausanne, Geneva, and Bern (2009–2012) Renal US at baseline + questionnaire	T 5.6% M 6.1% F 5.1%	Median 3-year follow-up 49 new cases incidence of 4.3% (4.1% M 4.6% F)	diabetes mellitus (OR 2.81) family history (OR 9.89) higher serum creatinine (OR 1.02)

Prevalence was estimated in Croatia 3.2-5.9%, Denmark 3.8%, Finland 3.0/1.8%, France 9.8%, Greece 15%, Iceland 3.9%, Italy 1.72-16.7%, Kosovo 2.8%, Germany 4-6.9%, The Netherlands 8.4%, Poland 12.85%, Serbia 5.6%, Spain 2.75-16.4%, Sweden 8.23-19%, Switzerland 7.8%, UK 3.5-3.8%, Ukraine 3.6% (Table 1 and 2) (13-47). Prevalence data were elaborated using the Freeman-Tukey transformation. After back-transformation, random-effects models produced a pooled prevalence of kidney stones of 7.2% (95% CI, 5.55% to 9.05%).

Table 2.
Characteristics of included studies on prevalence in Europe (n = 24) (25-48).

Ref	Author, year	Country	Population	Prevalence	Notes
25	Robertson 1983	UK (England)	Leeds inhabitants 800000 Postal survey 2% population	3.8%	High rate family history of stones male/female ratio 2:1
26	Torres Ramirez 1984	Spain	16.492 home interviews	2.75%	M-to-F of gypsies with lithiasis was 0.59 compared to 1.54 per cent in others
27	Inmark (Rousaud) 1986	Spain	Home interviews April 1985-February 1986 2238 participants (600 families)	4.16%	(15.1% of families)
28	Coppi 1987	Italy	Rosate village (Milan) 1575 subjects Structured interviews	5.9%	
29	Scott 1987	Scotland (central belt)	7000 subjects 3398 subjects X-rayed	3.5%	M to F (1.03:1)
30	Nikkita 1988	Finland	Tampere city aged 20-69 yrs Sep 1980-Feb 1982 Questionnaire 5252 subjects	3.0% M 1.8% F	
31	Cappuccio 1990	Italy	Olivetti factory in Pozzuoli, a suburban area of Naples. 688 male workers (87.9% of the male workforce) aged 21-68	16.2%	urolithiasis 13.4% (68/509) in the normotensive subjects 20.3% (24/118) in the untreated hypertensives 32.8% (20/61) in the treated hypertensives
32	Borghi 1990	Italy	Parma city 6000 mail questionnaire 2404 responders	6.1%	
33	Kurennaia 1992	Ukraine	Autopsies N=100	3.6%	
34	Cirillo 1994	Italy .	Gubbio Population Study 3,625 subjects	3.50%	1,658 M 1,967 F 4.58% M 2.59% F
35	Grases 1994	Spain	Balearic Islands 1500 subjects Year 1990	14.3%	Higher in rural area

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36	Serio 1999	Italy	medical records of patients treated at the ASTIF in Fiuggi ISTAT sample of 62000 subjects 1983 1993-94	1.17% 1983 1.72% 1993-94	
37	Hercberg 1999	France	SU.VI.MAX study Basal questionnaire 1993-94 14000 volunteers representative of French population >45 years	9.8%	M to F M 13.6% (45-60 yrs) F 7.6% (35-60 yrs)
38	Cappuccio 1999	Italy	503 male workers 21-68 yrs Follow-up 8 yrs	10.3%	higher in hypertensive than in normotensive men (19/114 (16.7%) versus 33/389 (8.5%)
39	Tucak 2000	Croatia	28 firms in Osijek. 7833 workers 15.7% of active working population	5.9%	higher incidence in men aged 30 to 50 years.
40	Rudan 2002	Croatia	villages of three Croatian islands: Brac, Hvar and Korcula	1.5% 2.3% 5.4%	Prevalence by genealogical F value 1.5% low F 2.3% moderate F ($p<0.10$), 5.4% high F ($p<0.001$)
41	Stasevic 2010	Kosovo	422 subjects	12/422 2.80%	
42	Stoller 2010	Denmark	twins registered in the Odense-based Danish Twin Registry 18,122 patients (9,061 twin pairs)	3.8%	4.9% M 3.0% F
43	Croppi 2012	Italy	cohort representative of the general population in Florence, Italy 1543 adults from a population of over 25,000 subjects followed by 22 general practitioners (GPs)	7.5 % (CI 95 %. 6.2-8.9 %)	M = F increasing with age until 55-60 years and then decreasing. 50 % recurrent Higher rate for GPs prescribing more US (adjusted PR 1.80, 95 % CI 1.11, 2.94; p = 0.020)
44	Arias Vega 2017	Spain	population aged from 40 to 65 years, combining 2 random samples (PreLiRenA and PreLiRenE studies) Telephone interview 4,894 subjects	15.0% [95% CI] 14.5-15.5).	Risk factors age (61-65 years; OR=1.39; 95% CI 1.06-1.80) high social class (OR=1.98; 95% CI 1.29-2.62) family history (OR=2.22; 95% CI 1.88-2.65) high blood pressure (OR=1.68; 95% CI 1.39-2.02) overweight/obesity (OR=1.31; 95% CI 1.12-1.54) Correlation average annual temperatures in the Spanish regions (r=0.59; P=.013)
45	Jovic 2018	Serbia	Data on a total of 14,587 respondents aged 15 years or older selected by a	Jovic 2018	
46	van de Pol 2019	Netherlands Cohort Study on diet and cancer.	A randomly sampled subcohort of 5000 (2411 M, 2589 F) at baseline	8.4% history of kidney stones 365 /3987 (8.4%)	267 (12.9) M 98 (4.3) F 365 /3987 (8.4)
47	Doloni 2024	Italy	Italian National Institute of Statistics' "Aspects of Daily Life" survey (N = 45,597) 22,217 subjects drinking from bottled plastic water (BW)	700 with stones NA 1351	
48	Szymanski 2025	Poland	representative sample by proportionate quota sampling technique internet interview 10,029 adults	1289 RSFs lifetime prevalence 12.85%	No sex difference lifetime prevalence 12.85%

Table 3.
Characteristics of included studies on incidence in Europe (n = 31) (49-79).

Ref	Author,year	Country	Design-population	Incidence	Notes
49	Ahlstrand & Tiselius 1981	Sweden	district served by only one hospital	140/100,000	37% recurrent stone formers. No significant seasonal variation
50	Laerum 1983	Norway	general practice in a rural, partly industrialized area of Eastern Norway	200 x 100,000	male patients (2.7:1) A peak stone incidence was found in the middle-aged groups (30-60 years)
51	Simon 1986	France	Nephrology out-patient clinic of a hospital serving a population of about 250,000. 222 patients 1980-1984	15.6 x 100,000	M to F 1:1 patients (112 men and 112 women) peak of incidence between 30 and 39 years
52	Power 1987	England and Wales 18 towns	Additional information for 1980 from Hospital Activity Analysis*	22/100,000 28/100,000*	56/100,000 in Canterbury to 15/100,000 in Burton-on-Trent
53	Romero Pérez 1992	Spain	Health Care region of Marina Alta including 11 health care areas, all centralized into one single Local Hospital	350 cases 280 x100,000	M>F
54	Ripa 1995	Spain	Hospitalization in Reina Sofia Hospital in Tudela (Navarra) two year-period May 1988 and May 1990	785 cases in two years for 76.286 inhabitants 510 x 100,000	Uncommon in children Frequent in adults: 7.92 per thousand men/year and 4.97 per thousand women/year, M to F 1.52:1
55	Alapont Perez 2001	Spain	districts of La Sierra and Hellin (Albacete, Spain). January 1992 and December 1992 887 pts	266 x 100,000	M to F 1.26:1 Mean age 51.34 years (bimodal distribution with peaks in the 4th and 7th decades)
56	Albar Arregui 2004	Spain	epidemiology of the disease in the Area III of Zaragoza	350 x 100,000	M>F
57	Edvardsson 2005	Iceland	All children less than 18 years Iceland 1995-2000 26 patients	5.6 x100,000 < 18 yrs 6.3 x 100,000 < 16 yrs	15 females, 11 males F>M
58	Trinchieri 2006	Italy	Lecco Hospital 495 visits were registered	158 x 100,000	M to F 2.19
59	Turney 2012	UK	Data from the Hospital Episode Statistics (HES) in UK	83,050 in 2010	
60	Edvardsson 2013	Iceland	Computerized databases of all major hospitals and medical imaging centers 5945 incident patients adults	108 x100,000 1995-89 138 x100,000 2005-08	From 130 to 140 per 100,000 M From 73 to 91 per 100,000 F M>F
61	Milošević 2014	Croatia	Data from pediatric institutions in the country	6.5/100,000 children < 18 years.	41 M and 35 F (ratio 1.17:1) mean age at diagnosis was 9.7 (range 0.8-16)
62	Turney 2014	UK	Oxford arm of the European Prospective Investigation into Cancer and Nutrition using data from Hospital Episode Statistics in England and Scottish Morbidity Records	51,336 participants 303 participants attended hospital with a new kidney stone	
63	Nazri 2015	Kosovo	Hospital admission to the University Clinical Center of Kosova	203 admissions 16.8/100000 (estimated)*	* Kosovo inhabitants (1 800 000)
64	Heers 2016	UK England	Hospital Episode Statistics (HES)	Total n° stone hospital episodes 83 050 in 2009-2010 86 742 in 2014-2015	
65	Ni Raghallaigh 2016	UK England	Hospital Episode Statistics (HES) Health and Social Care Information Centre (HSCIC)	110 x 100,000 in 2003/04 160 x 100,000 in 2013/14	with prevalence in men and women increasing from 15 and 6 per 10,000 to 21 & 11 per 10,000 respectively
66	Rukin 2017	England	Hospital Episode Statistics (HES) online data. 2006/2007 and 2013/2014	93,039 in 2013/2014	

67	Leone 2017	Spain	Seguimiento Universidad de Navarra Follow-up (SUN) Project. 6,094 subjects	735 new cases during a follow up of 9.6 years	
68	Edvardsson 2018	Iceland	Computerized databases of all major hospitals and medical imaging centers 5-year intervals 1999-2013 radiologic and surgical procedure codes subjects aged < 18 years	48/100,000 (M) 52/100,000 (F)	teenage females 3.7/100,000 1985-1989 11.0/100,000 1995-2004 8.7/100,000 2010-2013
69	Omarova 2018	Russia Dagestan	Ministry of Health of the Republic of Dagestan 2000-2016	12123 cases	Dagestan population 2.990.000 https://population.city/
70	Robinson 2020	U.K.	tertiary nephro-urology centres in Greater Manchester 2002-15 pediatric urolithiasis	1.77/100,000 person-years	M/F 1.3:1
71	Rendina 2020	Italy	"COMEGEN" general practitioners cooperative in Naples, Southern Italy. 12165 women > 40 yrs with idiopathic osteoporosis	516 cases of stone formation during a follow up of 19.5 months	idiopathic osteoporosis increased risk of incident nephrolithiasis
72	Littlejohns 2020	UK	UK Biobank 439 072 participants	2057 had hospital admission for stone during a 6.1 yr of follow-up	Reduced risk of stone formation by higher intake of total fluid (specifically tea, coffee, and alcohol but not water), and consumption of fruit and foods high in fibre Participants who developed an incident kidney stone were slightly older, were more likely to be male
73	Gadzhiev 2021	Russia	Data from the 'Ministry of Health' of the Russian Federation	656,911 and 889,891 urolithiasis cases were observed in 2005 and 2019 176,773 in 2005, 205,414 in 2019	
74	O'Connell 2021	Ireland	Hospital In-Patient Enquiry (HIPE) system Central Statistics Office (CSO 2005 to 2018.	74874 admissions related to urolithiasis 2005 102.1/100,000 M 43.6/100,000 F 2018 184.5/100,000 M 100.2/100,000 F	49420 (66%) males 25454 (34%) females 349.1/100,000 for males aged 45-64 years
75	Jour 2022	UK	Hospital Episode Statistics database 2015-2020	86 742 in 2014-2015 88 632 in 2019-2020 annual prevalence static at 0.14%	UK population 2014 64,865,916 2020 67,351,861 www.populationpyramid.net/
76	Sáenz-Medina 2023	Spain	minimum basic data set (MBDS) supported by the Health and Social Services Ministry of the Spanish Government. 2017-2020	106,407 hospitalizations 56.7 x 100,000 inhabitants	56.8% M
77	Moczeniat 2024	Poland	214,063	692.4 hospital admissions for urological diseases per 100,000 21.8% for urinary calculi (kidney and ureteral stones, lower urinary tract stone, unspecified renal colic)	M to F M 57.2% Mean age 54.4 yrs
78	Pedersen 2025	Denmark	10 094 male Danish firefighters (3455 full-time + 6639 part-time/volunteer) Diagnosis of kidney disease were retrieved from the Danish National Patient Registry 1994 to 2014	122 cases (full-time) 115 cases (part-ime) Standardized Incidence Ratio 1.36 (1.13 - 1.63) 0.96 (0.80 to 1.16)	227 stone episodes in a period of 20 years in 10,094 subjects that is abut 115x100,000

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79	Zhang 2025	UK	Data from 288 041 participants in the UK Biobank with no prior history of kidney stones from 2006 to 2024	3298 participants (1.14%) developed kidney stones	magnesium levels in water can decrease kidney stone risk water hardness, calcium concentration, and calcium carbonate concentration have no significant impact on the formation of kidney stones

Table 4.
Characteristics of included studies on prevalence of urinary calculi in Latin America (including South America, Central America and Caribbean) (n = 9) (80-89).

Ref	Author, year	Country	Population	Prevalence	Note
80	Medina-Escobedo 1996	Mexico	Yucatan 1996 1>year From a total of 5 832 questionnaires, 2176 M 3656 F	Defined diagnosis of renal stones 132 M 191 F 323 T 5.5% Probable diagnosis 66 M 216 F 282 T 4.8%	Family history of urolithiasis was positive in 44%
81	Plata 1998	Bolivia	First Clinical and Epidemiological Program of Renal Diseases from rural and metropolitan areas in Bolivia. (educational campaign in three selected areas of Bolivia) 14,082 apparently healthy subjects 1019 patients selected by urine dip-stick examination 65% confirmed (N=701)	1.3% (9 of 701)	1.3% (9 of 701)
82	Reyes Rabanal 2002	Cuba	La Havana N=1504	38 2.52%	Caucasians (3.2%) M (3.2%)
83	Reyes 2002	Cuba	área de salud urbana de la Ciudad de La Habana sample selected from a population of 19.538 by two-stage probabilistic and equiprobable sampling (confidence 95%) N=1400	4.64% (CI 4.63- 4.65%)	
84	Pinduli 2006	Argentina	Probabilistic domiciliary sample was designed with data provided by the Instituto Nacional de Estadí stica y Censo, INDEC (National Institute for Statistics and Census, INDEC) Auto administered questionnaire trained volunteer year 1998 N=1086	Total T 5.14% M 5.98% (CI 3.41-8.55%) F 4.49% (CI 2.61-6.37%)	M/F 1.19:1. Adult > 19
85	Bacallao Méndez 2022	Cuba	Subjects attending three clinics of Plaza de la Revolution Teaching Community Clinic Havana province Simple random sampling from a population of 17097 subjects N=2023	148 4.99%	89 M M 6.3% F 59
86	Del Real 2023	Chile	Félix Bulnes Cerda Hospital, Santiago, Chile, between 2019 and 2020. 1001 randomly selected patients with TC >15 yrs	144 14.4% (95%CI 12.3 - 16.7)	75 F (52.1%) 69 M (47.9%) F 12.7% (95%CI 10.2 - 15.8) M 16.7% (95%CI 13.2 - 20.6) age 56.6 years (SD 15.5).

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87	Persaud 2024	Trinidad and Tobago	online survey (Survey Monkey) Links to the survey were distributed online, in non-health-related communities, and in numerous chat groups representative of the Trinidadian population N =1225 subjects (46.5% M 53.5% F)	205 16.74%	more common East Indian ancestry
88	Noscimento 2024	Brazil	Tertiary hospital Jan 2021 to Dec 2022 electronic medical records inpatients underwent abdominal CT scans (except Urology ward) N=1937	132 6.8%	45% M 55% F
89	Basulto-Martinez 2025	Mexico	ENSANUT probabilistic household validated survey -stratified and clustered, aimed at each of the 32 federal entities in Mexico N=43,070 participants	2018 3.32%	Highest prevalence Yucatan (7.22%) Mexico City (6.15%) Peak age-prevalence was 50-70 years (~ 5%)

Table 5.
Characteristics of included studies on incidence of urinary calculi in Latin America (including South America, Central America and Caribbean) (n = 7) (90-96).

Ref	Author,year	Country	Population	Incidence	Notes
89	Orta-Sibu 2002	Venezuela	14 centers Year 1999 3624 children	7% diagnosed with urolithiasis Approximately 2,5 per 100,000	Venezuela Population < 18 yrs 10,762,520 (Population Pyramid.net)
90	Mora Alvarado 2007	Costa Rica=	29 hospitals in the Costa Rican Social Security System. Year 2001-3	approximately 6000 cases per year 170 cases per 100,000	Costa Rica population 4,008,946-4,138,784 (Population Pyramid.net)
91	Korkes 2012	Brazil	Brasilian Public Health System Database Year 2010 IBGE Instituto Brasileiro de Geografia e Estatística (IBGE). Brazilian population in 2010 185,712,713 inhabitants (70% received health care exclusively through the SUS) (approximately 130 million)	Total admission 69039/190,73 millions = 36.32/100000 0.61% of hospitalizations at the SUS during 2010 Higher in areas with greatest socioeconomic development	49.9% M 50.1%F North 3707/15,8 millions = 23.46/100000 NorthEast 13590/53.07 millions = 25.6/100,000 Central West 8655/14.26 millions = 60.7/100,000 Southeast 31266/ 80.3 millions = 38.9/100,000 South 11821/ 27.30 mil = 43.3/100,000
92	Silva 2016	Brazil	visits for urolithiasis in the 35 municipalities of the Paraiba Valley (between Rio de Janeiro and São Paulo) Approximately 3.3 million inhabitants	1901 visits 31.7/100,00	52.3% F Male 30.7/100,000 Female 32.7/100,000
93	Abreu Junior 2020	Brazil	2010-2015. database Brazilian Ministry of Health DATASUS	8,119 admissions in tropical cities 4,388 admissions in subtropical cities 1,692,660 tropical 2,233,680 subtropical 249.4 ± 27.54 tropical 84.3 ± 4.36 subtropical	M 48.2% F 51.8% tropical cities 52.1% M 47.9% F subtropical cities M to F 0.9 tropical 1.1 subtropical

94	Solano 2025	Colombia	Individual Health Service Provision Records (RIPS), 2010-2024.	1,838,661 urolithiasis-related encounters over 15 years 250/100000	M>F (2.9% vs 2.6%). Colombia population 2010-2024 44,777,318-52,886,364 (Population Pyramid.net)
95	Casanova Pardo 2025	Chile	2020-24 Departamento de Estadística e Información de Salud y el Instituto Nacional de Estadística	29.709 cases 36.09/100000	59.4% M Chile population 2020-2034 19,370,624-19,764,771 (Population Pyramid.net)

Prevalence data of European studies compared by geographical macro-region

A total of 21 studies from Southern/Mediterranean/ Balkan Europe (hereafter 'Southern Europe') and 14 studies from Central/Northern Europe (hereafter 'Northern Europe') were included in this analysis. Random-effects models using the Freeman-Tukey double-arcsine transformation produced a pooled prevalence of kidney stones of 7.03% (95% CI, 5.14% to 9.18%) for Southern Europe and 7.52% (95% CI, 4.50% to 11.24%) for Northern Europe after back-transformation to the proportion scale. The overall prevalence assessed by pooling all European studies was 7.20% (95% CI, 5.55% to 9.05%). Individual study estimates of kidney stone prevalence varied substantially. Between-study heterogeneity was deemed as "considerable" either globally (I^2 = 99.86%, $p < 0.0001$) or within each macro-region (Northern Europe: I^2 = 99.85%, $p < 0.0001$, Southern Europe: I^2 =99.79%, $p < 0.0001$).To formally assess regional differences within Europe, studies were combined in a meta-regression model with the geographic macro-region as a moderator. The region coefficient was negative (-0.0082) and statistically non-significant (p = 0.8187), indicating that the prevalence of kidney stones was not detectably different in Northern compared with Southern Europe. A forest plot visually illustrates the distribution of study-level estimates and the pooled effects for each region (Figure 2). Publication bias assessed with the Egger's test showed significant funnel plot asymmetry (***Supplementary Materials Figure 1***) when all European studies were considered (p = 0.0373), but non-significant asymmetry was found when studies were divided by macro-region (Northern Europe, p = 0.6673; Southern Europe, p = 0.1222).

Prevalence data of European studies compared by study time (pre-2000 vs 2000 and later)

All studies performed in Europe were separated according to the publication date. A total of 17 studies published before year 2000 (pre-2000) and 18 studies published in year 2000 and later (2000+) were included in the analysis.

Prevalence data were elaborated using the Freeman-Tukey transformation. After back-transformation, random-effects models produced a pooled prevalence of kidney stones of 7.37% (95% CI, 4.53% to 10.81%) for studies published before year 2000, and 7.11% (95% CI, 5.31% to 9.15%) for studies published in 2000 and later (Figure 3).

Individual study estimates of kidney stone prevalence varied substantially within each period. Between-study heterogeneity was deemed as "considerable" either for the global data pool (I^2 = 99.86%, $p < 0.0001$) or in both subgroups (Pre-2000, I^2 = 99.79%, $p < 0.0001$; 2000+, I^2 = 99.81%, $p < 0.0001$).

When studies were combined in a meta-regression model with year 2000 as a moderator, the regression coefficient was negative (-0.0038) and statistically non-significant (p = 0.8187), indicating that the prevalence of kidney stones was not detectably different depending on the study publication date. A forest plot shows the distribution of study-level estimates and the pooled effects for each period considered (Figure 3).

Publication bias assessed with the Egger's test indicates significant funnel plot asymmetry for studies published before year 2000 (p = 0.004), but non-significant (or borderline-significant) asymmetry is found for studies published from year 2000 (p = 0.052) (***Supplementary Materials Figure 1***).

Sensitivity analysis

As the prevalence of kidney stones in Ukraine (36%; 95% CI, 27% to 46%) was a major outlier, we performed sensitivity analysis by excluding the Kurennaia 1992 study. The overall prevalence assessed by pooling all European studies (Ukraine excluded) was 6.75% (95% CI, 5.34% to 8.30%; I^2 = 99.82; $p < 0.0001$). Metanalysis performed according to macro-regions resulted in a pooled prevalence equal to 6.31% (95% CI, 4.30% to 8.68%; I^2, 99.71; $p < 0.0001$) for Northern Europe. The meta-regression coefficient was 0.0147. (P = 0.6392), showing that the difference between macro-regions remained non-significant. Exclusion of the 1992 Ukrainian study from metanalysis between studies performed before 2000 or in 2000 and beyond, resulted in a pooled prevalence equal to 6.36% (95% CI, 4.23% to 8.87%; I^2, 99.71; $p < 0.0001$) for studies performed before year 2000. The meta-regression coefficient was 0.0751 (p = 0.6146).

Studies on incidence in Europe

Forty-two studies reported on incidence in 15 European countries. Incidence was evaluated in children in Croatia (n = 1), Iceland (n = 2), and UK (n = 1). In adults it was evaluated in Denmark (n = 1), France (n = 1), Germany (n = 3),Greece (n = 1),Kosovo (n = 1), Iceland (n = 2), Ireland (n = 1), Italy (n = 4), Norway (n = 1),Poland (n = 1), Russia (n = 2), Spain (n = 7), Sweden (n = 3),Switzerland (n = 1), UK (n = 9),

Incidence in pediatric series in Iceland in 2006 was 5.6 and 6.3 per 100,000 children less than 18 and 16 years of age

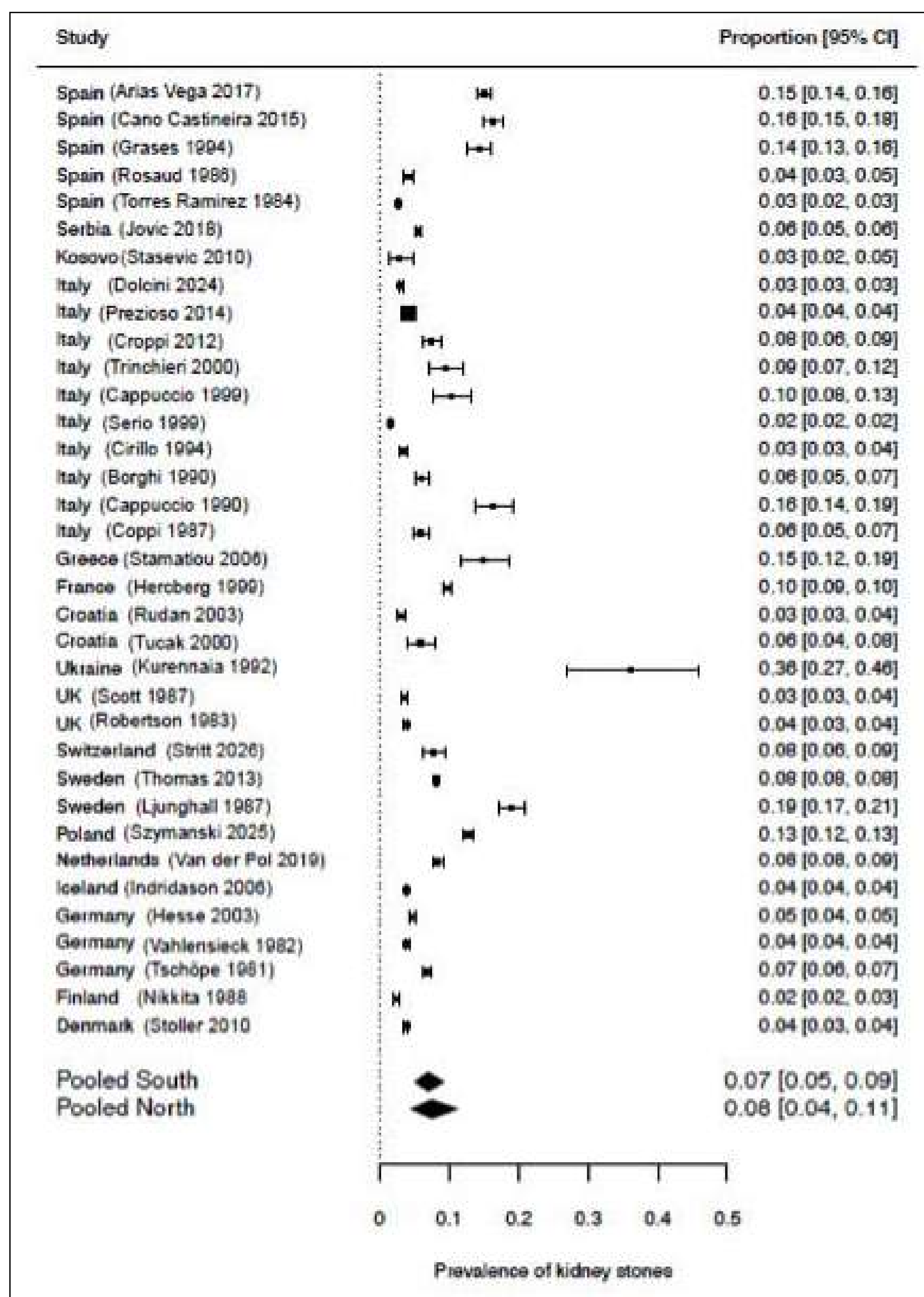

Figure 2.
Forest plot of kidney stone prevalence in Europe, divided by macro-regions.

Forest plot showing prevalence estimates (rounded to the second decimal) extracted from population-based studies across European countries. Individual study prevalences (proportions) are displayed as squares with 95% confidence intervals, weighted by inverse variance. A random-effects model using the Freeman–Tukey transformation was applied, and all values shown are back-transformed to the original proportion scale. Diamonds represent the pooled prevalences for Northern/central Europe ('North' in the plot) and Southern/Mediterranean/Balkan Europe ('South' in the plot) macro-regions, derived from separate random-effects models, spanning between their 95% confidence interval boundaries.

with variation of rate along time being 3.7/100,000 in 1985-1989,11.0/100,000 in 1995-2004 and 8.7/100,000 in 2010-2013; in Croatia incidence was 6.5/100,000 children under 18 years and in UK 1.77/100,000 person-years (57, 61, 70).
The annual incidence rates expressed as the number of cases per 100,000 inhabitants and calculated based on the data from the retrieved studies varied greatly between different countries and between studies conducted in the same country: Denmark 55.5, France 15.6, Germany 540-1470, Greece 2843, Kosovo 16.8, Iceland 138-562 (M) 108-197 (F), Ireland 99, Italy 158-2614, Norway 200, Poland 127, Russian Federation 23.8-205, Spain 56.7-1255, Sweden 140-500, Switzerland 1445, UK 28-175 (49-79).
These large differences do not reflect the real geographical differences related to lifestyle and climate but are evidently a result of the broad differences in study design and the specificity of some populations under examination. For this reason, only a narrative review of these incidence results is possible, as they cannot be quantitatively compared due to methodological differences.
Nine studies have been conducted in the *United Kingdom* (UK) in the general population. Most of these studies evaluated the number of annual hospitalizations for urolithiasis-related diagnoses over various time periods. The initial data, dating back to 1980, are based on hospital case registers, including outpatients and inpatients, and from Hospital Activity Analysis (52). These yielded an annual registration rate (22/100,000 population), which appears to underestimate the incidence of the dis-

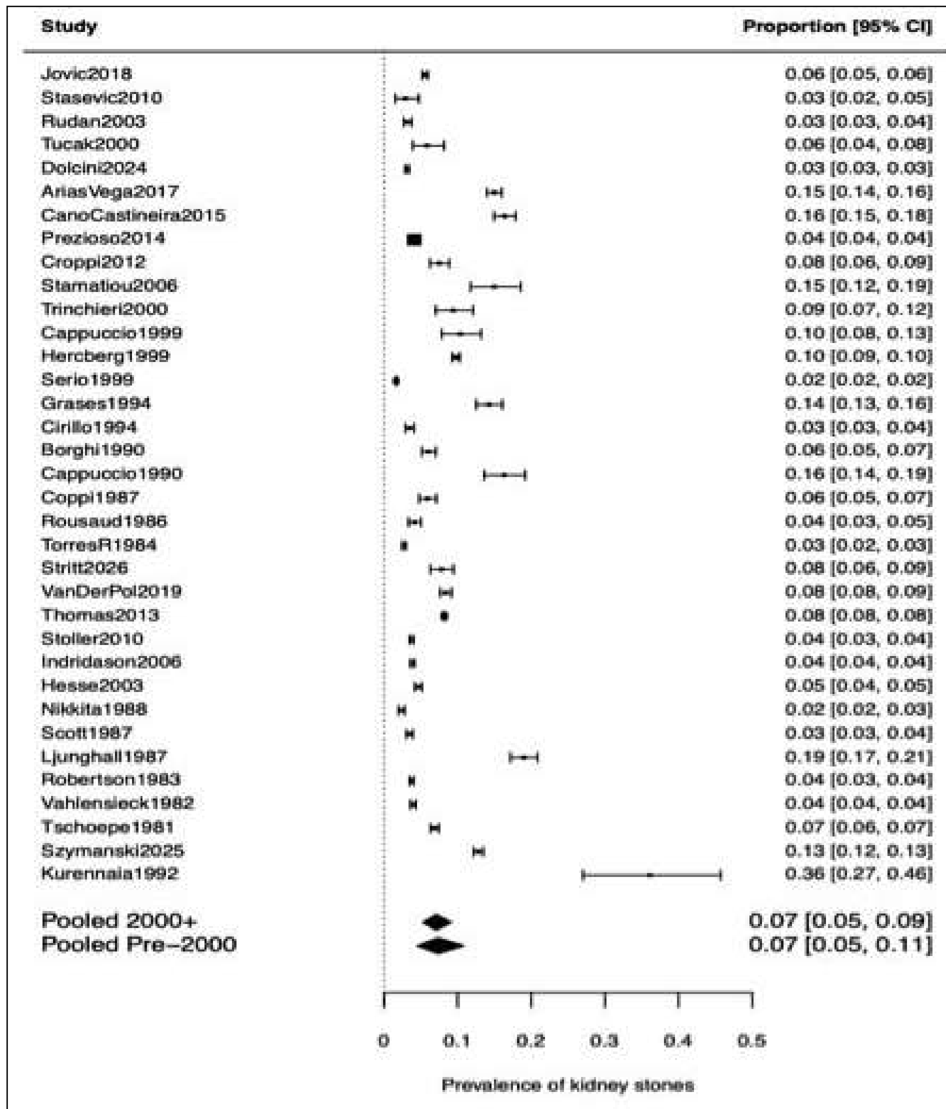

Figure 3.
Forest plot of kidney stone prevalence assessed before year 2000 or in year 2000 and later.

Forest plot showing prevalence estimates (rounded to the second decimal) extracted from population-based studies across European countries. The first author of the study and the publication year for each individual study are listed. Individual study prevalences (proportions) are displayed as squares with 95% confidence intervals, weighted by inverse variance. A random-effects model using the Freeman-Tukey transformation was applied, and all values shown are back-transformed to the original proportion scale. Diamonds represent the pooled prevalences for studies published before year 2000 ('Pre-2000' in the plot) and for studies published in year 2000 and later ('2000+' in the plot). Pooled prevalence data, spanning between their 95% confidence interval boundaries, are derived from separate random-effects models.

ease. The introduction of electronic registers allowed a more accurate assessment of the incidence, which has been estimated by *Hospital Episode Statistics* (HES) as increasing from 110/100,000 in 2003-4 to 160/100,000 in 2013-14, before stabilizing at around 140/100,000 in subsequent years (59, 64, 85, 66, 75) The total number of cases was reported as 83,050 in 2009-10, 93,039 in 2013-14, and 88,632 in 2019-20.
Another statistical approach in UK has been to consider the incidence of stone disease in a cohort under observation for other purposes. *Turney et al.* (63) considered the 51,336 participants in the Oxford arm of the European Prospective Investigation into Cancer and Nutrition, using data from Hospital Episode Statistics in England and Scottish Morbidity Records to demonstrate that in the cohort, 303 participants attended hospital with a new kidney stone episode during the follow-up period. A similar design was adopted by *Littlejohns et al.* (72), who considered the 439,072 participants in the UK Biobank study who had 2,057 hospital admissions for urinary stones during a 6.1-year follow-up. *Zhang et al.* (79) used the same dataset at a longer interval of follow up. The incidence values that can be calculated based on these numbers are lower (< 100 per 100,000) than those derived from previous statistics.
In Spain (53-56), estimated incidence values derived from studies conducted in hospitals that collected patients from well-defined geographical areas produced fairly homogeneous incidence values ranging from 250 to 510/100,000. Conversely, the study by *Sáenz-Medina et al.* (76), which relied on the *minimum basic dataset* (MBDS), supported by the Health and Social Services Ministry of the Spanish Government, estimated significantly a lower incidence value (56.7 per 100,000).
Furthermore, studies based on the follow-up of populations in Spain (22.67), intercepted a higher number of stone episodes, leading to a much higher estimates of the annual incidence of 500-1,200/100,000.
A very low incidence rate of 15,6 per 100,000 have been described in France in a study based on a small series of patients referred to an outpatient stone clinic of a hospital serving a population of approximately 250,000, which may not have identified all patients with stones (51). In Kosovo (63) and in a Caucasian republic of the Russian Federation (69), low incidence rates of urolithiasis (< 30

per 100,000) can be estimated on local or government records of urolithiasis-related admissions.
In Sweden (16,23), incidence values have ranged between 140 and 500/100,000, based on two specific studies assessing the incidence of stone formation and a larger study assessing the effects of cadmium exposure.
In Italy, the incidence of kidney stones has been estimated at homogeneous values (158-400/100,000) in three studies (17, 21 ,58), while much higher values were reported by *Rendina et al.* (71), who studied a selected population of women > 40 years with idiopathic osteoporosis.
In Germany, relatively high incidence values were described in two studies (620 and 540/100,000) (14, 15) and significantly higher in a third study, at 1470/100,000 (18). All these studies were based on the follow-up of relatively large cohorts of subjects (7,000-10,000 subjects).
Two studies in Iceland relied on a search of computerized databases of all major hospitals and medical imaging centers in Reykjavik and in Iceland to identify radiologic and surgical procedure codes indicative of kidney stones (20, 60). The estimated incidence values were 562/197 and 138/108, respectively.
A relatively low incidence rate can be estimated in a population of firefighters in Denmark (around 115x100,000) (78) and slightly higher rates have been observed in Norway (200x100,000), Ireland (184.5x100.000 in M and100.2 in F), Russia (205.4x100,000) and Poland (150 x 100,000) (59, 73, 74, 77).
Finally, higher rates have been reported in Switzerland (24) and Greece (19). Both studies estimated incidence directly through population follow-up. The Swiss study found 49 new cases out of 1128 and the Greek study 12 new cases out of 422 that means incidence rates of 4,343x100,000 and 2843x100,000 respectively.

Studies on prevalence in Latin America

Ten studies (79-88) reported data on the prevalence of urolithiasis in Latin America: two in Mexico (80,89), three in Cuba (82,83,85), and one each in Argentina (82), Bolivia (81), Brazil (88), Chile (86), and Trinidad and Tobago (87). Prevalence values ranged between 1.3% and 16.74%. The study with the lowest prevalence of 1.3% was conducted in Bolivia (81), as part of a population-based educational study that selected apparently healthy, asymptomatic subjects with abnormal urinalysis and urinary sediment findings. Only 700 subjects were included in the final evaluation. The highest values were observed in Trinidad and Tobago (87), where a prevalence of 16.74% was estimated. This may be an overestimation because the study was based on an e-mailed questionnaire, which may have aroused greater interest in responding in subjects with stones. A study conducted in Chile (86) reported a prevalence of 14.4%, estimated by the detection of stones in a series of patients undergoing CT scans, which may be biased by inclusion of patients undergoing the scan for stone-related symptoms. A similar study in Brazil (88) showed a 6.8% prevalence of stones in a series of patients undergoing CT scans after exclusion of patients referred by urology ward.
Other studies demonstrated a prevalence ranging from 2.52% to 5.5%, with slightly higher values in men, white subjects and subjects > 50 years of age.
Random-effects models using the Freeman-Tukey transformation produced a pooled prevalence of kidney stones of 6.02% (95% CI, 3.58% to 9.03%) (Figure 4). Between-study heterogeneity was deemed as "considerable" (I^2 = 99.09%, p < 0.0001). Publication bias assessed with the Egger's test does not indicate the presence of significant asymmetry (p = 0.32).

Studies on incidence in Latin America

The incidence was assessed in seven studies (89-95). One study was limited to the pediatric population with an estimated incidence of 2.3 cases/year/100,000 inhabitants (89). The other studies reported incidence values ranging from 31 to 250 cases/year/100,000.
The variability depends on the different methodologies used and the socioeconomic and climatic characteristics of the different areas in which the study was conducted.

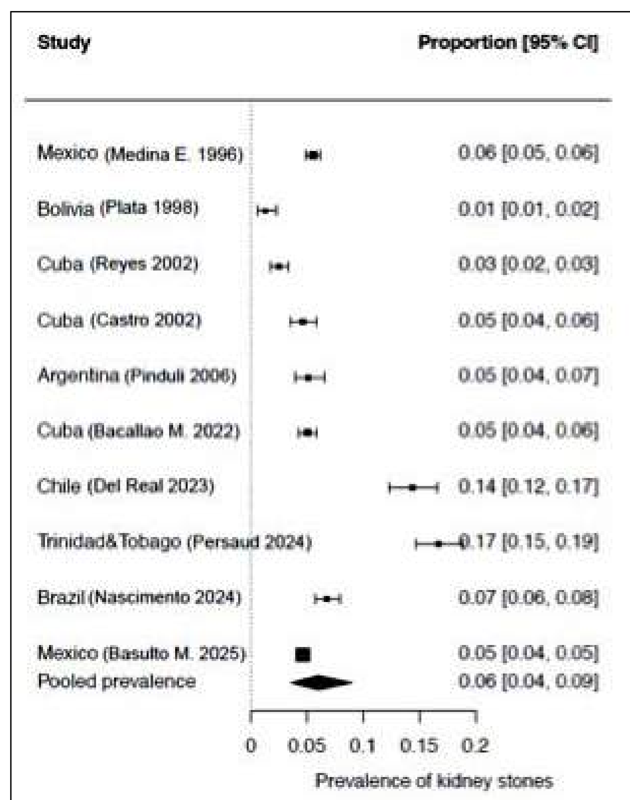

Figure 4.
Forest plot of kidney stone prevalence in Latin American countries.

Forest plot showing prevalence estimates (rounded to the second decimal) extracted from population-based studies across countries from Southern America and the Caribbeans. Individual study prevalences (proportions) are displayed as squares with 95% confidence intervals, weighted by inverse variance. All values shown are back-transformed from Freeman-Tukey transformation to the original proportion scale. Diamonds represent the pooled prevalence spanning between its 95% confidence interval boundaries.

M to F ratio

In the vast majority of studies in Europe, prevalence and incidence rates have been higher in men than in women, although the male-to-female ratio has decreased from values of 2.7:1 in the 1980s (50) to values closer or equal to 1:1 in more recent years (43).

Incidence rates of urolithiasis have been shown to be slightly higher in females in Brazil (91, 92), particularly in subtropical regions (93), while the males still had higher rates in the subtropical regions of Brazil, in Colombia (94), and in Chile (95). Prevalence has also been shown to be slightly higher in females in Brazil (88) Mexico (80, 89) and Trinidad and Tobago (87) while it was higher in males in other countries as Cuba (82, 83, 85), Argentina (84), and Chile (86).

Quality assessment

Each study was evaluated across the nine JBI domains, with scoring item-by-item and an overall quality percentage.

Supplementary tables present the full JBI appraisal matrix for 35 prevalence and 42 incidence studies (11 studies assessed both prevalence and incidence and were scored two times) in Europe and for 10 prevalence and 7 incidence studies in Latin America.

The tables show for each of the 84 studies: item by item scoring (Y/N), a total JBI score (0-9) and a rounded percentage score.

For the 35 prevalence studies in Europe (11 studies evaluating both prevalence and incidence + 24 evaluating prevalence alone): 10 studies scored 9/9, 18 studies 8/9, 6 studies 7/9 and one study 5/9.

For the 42 incidence studies in Europe (11 studies evaluating both prevalence and incidence, 31 evaluating incidence alone): 10 studies scored 9/9, 18 studies 8/9, 6 studies 7/9 and 1 study 5/9.

For the 10 prevalence studies in Latin America 4 studies scored 9/9, 4 studies 8/9, one study scored 7/9 ed one 6/9.

For the 7 incidence studies 4 scored 9/9 and 3 scored 8/9.

Lower scores were mainly due to issues in sampling methods and sample size justification. Most studies scored between 7 and 9 out of 9, indicating generally good methodological quality.

Discussion

Historical notes

The presence of stones in the urinary tract has been known since ancient times. Ancient Greek and Roman physicians described the symptoms of urinary lithiasis in the lower and upper urinary tracts. Surgery for bladder stones has been described since then, and the technique of lithotomy with the related dedicated instruments was widespread between the XVI and XVIII centuries in numerous European countries.

In the first half of the XIX century, bladder lithotomy was one of the most performed surgical procedures in hospitals in England (97) and throughout the rest of Europe (98). In fact, at that time, primary bladder stones (not associated with stasis and bladder neck obstruction) were relatively common in adults and children. Stones were composed of 50% of ammonium urate, which formed the core of the stone, while the remaining part was calcium oxalate. Between 1829 and 1830, *Yelloly* (99) collected the first epidemiological data on the incidence of hospitalizations for urolithiasis in Great Britain reporting an overall incidence in Great Britain of 1 case per 100,000 inhabitants per year, lower rates in Scotland and Ireland, with a higher incidence in rural districts. The incidence of bladder stones gradually declined because of improved socioeconomic conditions and the development of healthcare, although it was still described in some areas of Europe in the first half of the XX century. At the same time, an increase in the incidence of upper urinary tract stones began to be described in some northern European countries as a consequence of increased food intake and change of lifestyle. These stones manifested with painful colic symptoms followed by stone passage. The introduction of radiological diagnostics allowed for easier and more frequent diagnosis of upper urinary tract stones. The phenomenon gradually became increasingly important, so much so that it was referred to as the "*stone wave.*"

In the Oslo population the annual incidence of symptomatic renal stones in the population rose from 118 cases/year per 100,000 in 1940 to 300 cases/year in 1960 (100) and similar observations were made in other Scandinavian countries such as Sweden (101) and Finland (102), and subsequently in many other Western European countries (103).

Historical data on the epidemiology of urolithiasis in Latin America are much scarcer, although some reports suggest a trend similar to that observed in Europe with a time lag of a few decades. In 1944, *Davalos* (104) reported having learned during his stay in Ecuador that bladder stones had been more frequent forty years earlier, at the beginning of the twentieth century, but that they had subsequently progressively decreased in association with an increase in stones of the upper urinary tract that had previously been very rare. *Judd and Meyers* (105) report the statistics of the Chief Health Officer of the Panama Canal, who showed a relatively high incidence of urinary stones in 1942 of 181.8 cases/year/100,000.

Over the past 50 years, several epidemiological studies have been conducted to evaluate the prevalence and incidence of urinary stones in both Europe and Latin America.

Prevalence of urolithiasis in Europe

Numerous studies evaluated the prevalence of urolithiasis in cohorts of subjects residing in European countries. These studies vary in design, making comparisons somewhat difficult. Most studies are based on interviews (in person or by telephone) with participants recruited using various criteria. Some studies have investigated entire populations residing in a defined geographic area (village, city, county, island, town). Other studies have randomly selected a cohort representative of a larger population (town, country). Other studies have involved GPs who evaluated the entire cohort of patients they care for. Some studies have evaluated workers within a company or a public service who undergo periodic health checks. Finally, other studies have evaluated cohorts of subjects already under study with longitudinal follow-ups for other purposes (cancer incidence, effect of vitamin prophylaxis, twin studies). The sample size varies greatly, but

only in a few cases it was below the minimum estimate required to calculate prevalence/incidence.

Some studies had shown that the prevalence of urolithiasis was still increasing in Central and Southern European countries (16, 17) between the early 1980s and the late 1990s as a consequence of changing lifestyle.

This trend, however, appears to have slowed over the last 20 years. In fact, pooled prevalence did not vary between studies conducted between 1981 and 2000 and those conducted after 2000. On the other hand, regional variations also appear to have diminished because of the homogenization of economic conditions and lifestyles across European countries, also as a result of the unification processes of the European Union.

Across the included studies, we observed high heterogeneity in reported kidney stone prevalence, with (I^2) values approaching 100%. This indicates that the variance between studies is a dominant factor, likely reflecting substantial differences in the diagnostic methods, in the time periods, in the environmental exposures, and in the genetic, ethnic, social, or educational characteristics of the various study populations. Importantly, this heterogeneity was pronounced even after applying variance-stabilizing transformations and conducting subgroup analyses. The persistence of such high variability suggests that pooled prevalence estimates should be interpreted cautiously, as they likely represent a broad aggregation of fundamentally heterogeneous elements.

To explore whether geographic or temporal factors contributed to this variability, we performed meta-regressions comparing studies from Mediterranean/Balkan countries with studies from Central and Northern European countries, as well as studies conducted before or after year 2000. Neither analysis identified statistically significant differences, and prevalence estimates showed substantial overlap across both regional and temporal categories.

These findings indicate that the adopted classifications alone are insufficient to explain the heterogeneity observed across studies. At the same time, the consistency of our results across multiple analytic approaches highlights the robustness of our methodology and suggests that more granular, standardized covariates – such as diagnostic modality, climate variables, or ethnic/social/demographic structure – may be required in future research to better account for the complex factors shaping kidney stone prevalence. The main difficulty will probably reside in the markedly different covariates, namely in the diverse descriptors of each single population in each national report, in the absence of a standardized reporting modality.

Incidence of urolithiasis in Europe

Incidence studies are largely based on electronic registries of urinary stone-related surgeries or hospital admissions, which have become available over the past 20-30 years for many countries or for individual hospitals or hospital consortia. The incidence rate is calculated based on the size of a country's population covered by the national health system or on the number of inhabitants of smaller geographical areas who exclusively refer to a specific health service.

The hospital admission rate in the UK, regardless of the study of *Power et al.* which was prior to the computerization of hospital records, has been estimated by Hospital Episode Statistics to vary over the last 15 years between 110 and 160x100,000 based on a number of cases per year between 83,000 and 93,000 out of a general population of 63,000,000 to 67,000,000.

Similar hospitalization rates were observed in Ireland (102.1-184.5/100,000 in men, 43.5-100.2 in women), Russia (176.7 in 2005, 205.4 in 2019) and Iceland (108 x100,000 in 1995-89 and138 x100,000 in 2005-08), but lower rates were reported in Kosovo and Dagestan. Slightly higher rates were found by some studies in Spain, when evaluating the admission rate to referral hospitals of a specific area, with rates between 266 and 510x100,000.

Other studies have measured incidences directly through systematic follow-up of a cohort of patients monitored for the onset of symptomatic stone events, although no studies have systematically investigated the presence of stones with periodic imaging examinations. These studies include health screening for early diagnosis of diseases or follow-ups of primary care physicians. They are more comprehensive because they can include cases treated conservatively on outpatient basis or cases of asymptomatic stones diagnosed through imaging performed for periodic checkups or for the study of other diseases. In these studies, the incidence was estimated at values close to or greater than 1,000 cases/year x 100,000 inhabitants. These values are higher than the hospital admission rates which tend to underestimate the true incidence of the disease. They are compatible with the global age-standardized incidence rate of the Global Burden of Disease study which was reported to be 1450 per 100,000 in 2000 and 1240 per 100,000 in 2020. Particularly, the GBD age-standardized incidence rates for Central Europe were 1420/100,000 in 2000 and 1040 in 2020 (2).

Declarations

Ethical approval and consent for participate: *Not applicable. This study is a systematic review based exclusively on previously published data and does not involve human participants or identifiable personal information.*

Consent for publication: *Not applicable.*

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In pediatric populations, we have only incidence rates assessed by hospital admissions that range between 1.8 and 6.5 cases per 100,000 which are significantly lower than the global GBD study incidence rates per 100 000 children which were in reported to be 77.92 in 1990 and 77.64 in 2021 (4).
Hospitalization rates in Latin America are even lower than those reported in Europe, with values mostly below 100 per 100,000 inhabitants, which can be explained both by a lower prevalence of the disease and by lower access to health services. These values are much lower than the global age-standardized incidence rates of the GBD study, which for Latin America are 1790 per 100,000 in 2000 and 1970 per 100,000 in 2021 (2).
Finally, it should be noted that in Europe urolithiasis is still more frequent in males, although the male-to-female ratio tends to decrease. Conversely, this trend seems more evident in Latin America where the disease rates in both sexes have been shown to be equal or slightly higher in females in many studies. This finding reproduces what was described by the GBD study which in 2021 observed an increase of female urolithiasis in most regions, with a decrease of the global ratio of age-standardized incidence rates for males-to-females from 2.3:1 in 1990 to 2.07:1 in 2021, until reaching a nearly equivalent male-to-female ratio in Tropical Latin America at 1.4:1, in central Europe at 1.06:1, and eastern sub-Saharan Africa at 1.01:1.

Conclusions

In conclusion, this review confirmed that the peak prevalence of urolithiasis has been reached in European countries, where the disease seems to have fairly homogeneous characteristics across their territories, in which economic conditions and lifestyles tend to become uniform. Conversely, we were unable to confirm the trend of an increase in prevalence and incidence values of urolithiasis in Latin American countries, where prevalence and incidence rates are still lower than those observed in Europe. However, it is possible that the traditional sources we used have a longer latency compared to other indicators; thus, demonstrating a change in prevalence and incidence values may require a longer period of time.

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