J Renal Inj Prev. 2023; 12(4): e32160.

https://journalrip.com doi: 10.34172/jrip.2023.32160

Journal of Renal Injury Prevention

A systematic review and meta-analysis of prevalence of urinary tract infection in childhood

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ARTICLE INFO

Article Type:
Review

Article History:
Received: 10 November 2022
Accepted: 1 January 2023
Published online: 9 February 2023

Keywords:
Urinary tract infections
UTI
Children
Prevalence

ABSTRACT

Introduction: Urinary tract infection (UTI) is considered as one of the most important causes of fever and hospitalization in children. The present study was conducted with the aim of investigating the prevalence of UTIs in children through meta-analysis.
Methods: This meta-analysis study was conducted on individuals aged >18 years. In order to retrieve the studied, the following domestic and foreign databases were searched: PubMed, Scopus, Web of Science, and Cochrane. The obtained data were analyzed in STATA version 14 at the significance level of P<0.05.
Results: In 36 studies with 78212 samples published between 2000 and 2021, the prevalence of UTIs in children was reported at 15% (95% CI: 13%, 17%). It was 16% in girls (95% CI: 12%, 19%) and 10% in boys (95% CI: 7%, 13%). The most common cause of UTI in children was Escherichia coli with 58% (95% CI: 46%, 69%). The least common prevalence was reported in the UK with 6% (95% CI: 5%, 6%) and the USA with 6% (95% CI: 5%, 8%) and the highest prevalence was reported in Iraq with 43% (95% CI 39%, 48%).
Conclusion: Approximately one out of 10 people suffers UTI and this rate is increasing over time and the prevalence of UTIs in girls is about 1.5 times higher than that in boys.
Registration: This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD42021290886, https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021290886).

Review

Implication for health policy/practice/research/medical education:
Almost one out of 10 people suffers a childhood urinary tract infection (UTI). The prevalence of UTI in girls is about 1.5 times higher than that of boys. Therefore, gender is a risk factor for childhood UTI and girls are more prone to UTI compared to boys.
Please cite this paper as: Jamshidbeigi T, Adibi A, Hashemipour SMA, Sarokhani D, Hasanpour Dehkordi A, Fakhri M, Alaienezhad S. A systematic review and meta-analysis of prevalence of urinary tract infection in childhood. J Renal Inj Prev. 2023; 12(4): e32160. doi: 10.34172/jrip.2023.32160.

Introduction

In a urinary tract infection (UTI), one or more parts of the urinary system, such as the ureter, kidney, or bladder, are infected (1). UTI is the second most common bacterial disease in children (after upper respiratory tract infections) and the most common bacterial infection that affects humans (2). The global prevalence of pediatric UTI is about 2%-20% (3).

In infected children, a UTI manifests with nonspecific symptoms, which causes confusion in diagnosis. Thus, high prevalence of UTIs in children without diagnosis and lack of proper treatment is a cause of clinical and general concern. Abdominal pain/suprapubic pain, vomiting, and fever along with chills are common symptoms of upper and lower UTIs that usually appear only after the age of 5 years (4). Internationally known definitions refer

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to the calendar age in specifying the boundary between childhood and adulthood, which often refers to the age of 18 as childhood. Therefore, the age range studied in our meta-analysis study was 0 to 18 years old. In this definition, childhood is divided into three categories, including early childhood (<6 years), middle childhood (6-12 years), old childhood (12-18 years) (5). Due to high prevalence of UTIs in childhood and its dangerous complications, as well as the different results of published studies in this area, it is necessary to conduct a systematic review and meta-analysis.

Methods

Study protocol

The present study is a systematic review and meta-analysis examining the prevalence of UTIs in childhood.

Study population

The study population was all under 18 years old and no gender or race restrictions were imposed on them.

Primary outcome

The main outcome of this study was prevalence of UTIs in childhood.

Secondary outcome

The secondary outcomes include prevalence of UTIs in girls and boys, and prevalence organisms of UTIs in childhood.

Search strategy

In this systematic review, the international databases of PubMed, Scopus, Web of Science, Cochrane, and the Google Scholar search engine were searched. The articles up to 15.02.2021 were included and the search process was performed using the following keywords: "Urinary Tract Infections, UTI, Children, Prevalence" using their English equivalents mapped in the MeSH (Medical Subject Headings). In addition, their combinations were searched in English language databases using the "AND" and "OR" operators. Search strategy in PubMed: (((Urinary Tract Infections [Title/Abstract]) OR (UTI [Title/Abstract])) AND (Children [Title/Abstract])) AND (Prevalence [Title/Abstract]).

Inclusion criteria

All studies that examined the prevalence of UTIs in childhood (<18 year) were included in the study.

Exclusion criteria

Studies with non-randomized sample selection, studies that examined the prevalence of recurrence of UTIs, studies with incomplete information, studies whose full text was not available, studies which were not of the desired quality, Studies examining the prevalence of risk factors for UTIs.

Qualitative evaluation

The researchers examined the quality of articles using the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist (6), a well-known international standard checklist for qualitative evaluation of articles. This checklist consists of 22 different sections and covers different parts of a report including sampling, variable measurement, statistical analysis, confounding modifications, validity, and reliability of used tools and study objectives. The score range for this checklist is between 0 and 44, and articles scoring <15.5 were excluded from the study.

Extracting data

To minimize bias in reports and errors in data collection, two researchers extracted data from studies independently. These researchers entered the extracted data into a checklist consisting of researcher's name, year, sample size, number of girls and boys, prevalence of UTIs in childhood, prevalence of organisms of UTIs in childhood. Another researcher examined the extracted data to resolve any discrepancies .In case that in one of the initial articles or studies, the required data were not reported, an email was sent to the corresponding author inquiring him/her to send them.

Statistical analysis

In this study, the variances of each study were calculated using the binomial distribution formula. The heterogeneity evaluation was done by Q-Cochran test and I^2 index. Considering the high heterogeneity of the studies, a random effects model was used to estimate the point prevalence with 95% CI. The data were analyzed in STATA software 14 and a P value <0.05 was considered significant. Meta-regression was used to investigate the relationship between the prevalence of UTIs in childhood with year of publication of the study.

Results

Literature research

In the early stages, 515 articles were found from the above-mentioned databases, among which 235 overlapping studies were excluded by reviewing the study titles. The abstracts of the remaining 280 articles were reviewed, and out of this number, 179 articles were removed according to the exclusion criteria. Out of the remaining 101 articles, 65 articles were excluded due to their incomplete information or lack of full text. Finally, 36 articles reached the quality evaluation stage, all of which had good quality and entered the meta-analysis process (Figure 1).

Characteristics of studies

A summary of the information extracted from the reviewed articles is given in Table 1.

In 36 studies conducted on 78212 samples and published between 2000 and 2021, the prevalence of UTIs

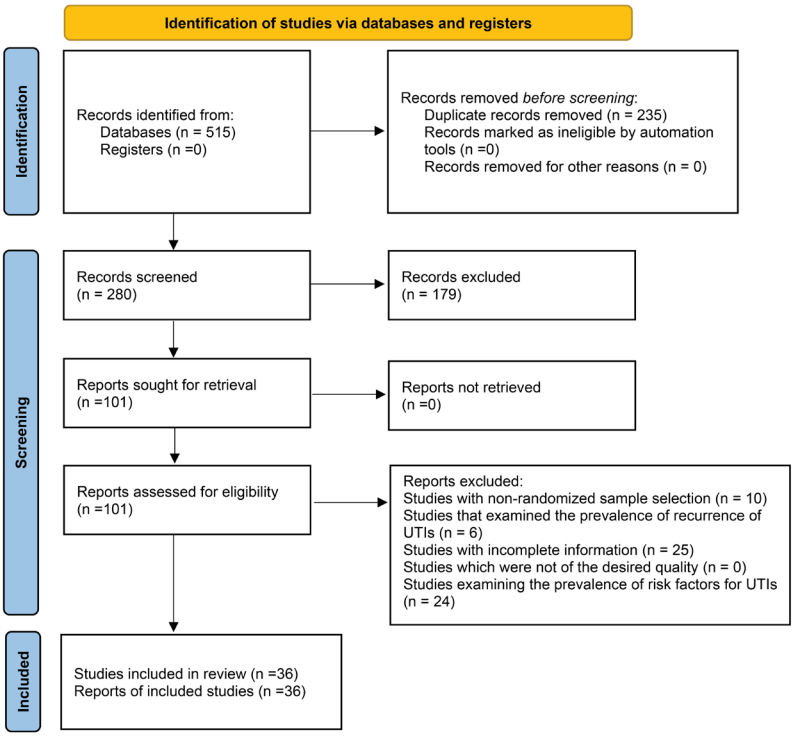

Figure 1. Flowchart of entering studies into the process of systematic review and meta-analysis.

in children (under 18 years) was reported at 15% (95% CI: 13%, 17%) (Figure 2).

Analysis of subgroups

The prevalence of UTIs was 16% in girls (95% CI: 12%, 19%) and 10% in boys (95% CI: 7%, 13%). Regarding organisms of childhood UTIs, the lowest and highest prevalence was related to *Citrobacter* with 2% (95% CI: 1%, 3%) and *Escherichia coli* with 58% (95% CI: 46%, 69%), respectively. The list of countries where only one study was conducted is not included in Table 2.

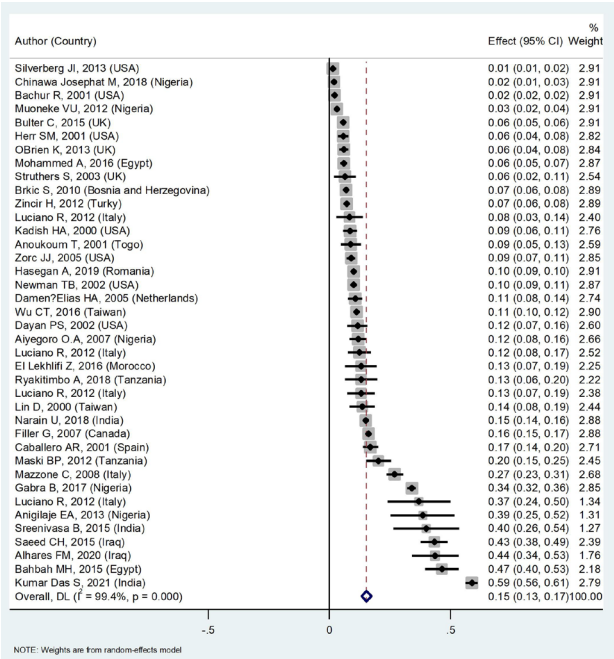

Figure 2. Prevalence of urinary tract infection in childhood and 95% CI.

Additional analysis

Figure 3 shows that the prevalence of UTIs in childhood has increased during the years 2000 to 2021 and this relationship is statistically significant ($P = 0.012$).

Discussion

The prevalence of childhood UTIs in the present study was estimated at 15%. The results of the study by Hasegan et al on people under the age of 18 also showed that the prevalence of UTIs in a population of 15389 was 9% (9). In a study by Bulter et al (18), in a sample of 6079 people aged below five years, the prevalence of UTI was reported at 5%. In a study Carried out by Wu CT on 5470 children aged below three years, the prevalence of UTIs was reported at 11.3% (15). The prevalence of childhood UTIs in the above-mentioned studies is lower than the prevalence of UTIs in the present meta-analysis (15%). In the study by Filler et al (31) in Canada on 3422 people with a mean age of 9.6 years, its prevalence was reported to be 16.1%. One of the reasons for this difference in its prevalence may be related to difference in sample size and studied age group.

Regarding childhood UTIs, the prevalence of the studied organisms varied from 2% to 58%. Consistent with the results of the present study, the most common organism was *Escherichia coli* in the studies conducted by Kumar et al (7) in India, Alhares et al (8) in Iraq, Mohammed et al

Table 1. Specifications of the reviewed articles

First Author	Year of publication	Country	Age range (y)	Sample size	No. of girls	No. of boys	Prevalence of UTI (%)	Prevalence of UTI in girls (%)	Prevalence of UTI in boys (%)
Kumar Das (7)	2021	India	0-14	1492	813	679	58.7		
Alhares (8)	2020	Iraq	1.5-10	101	33	68	43.6	14.9	28.7
Hasegan (9)	2019	Romania	0-18	15389			9.9		
Narain (10)	2018	India	<18	2880			15		
Chinawa Josephat (11)	2018	Nigeria	<18	2942	1306	1636	2		
Ryakitimbo (12)	2018	Tanzania	3-8	99	41	58	13.1		
Gabra (13)	2017	Nigeria	0-14	2658			34		
Mohammed (14)	2016	Egypt	6-12	1000	448	552	6	11.4	1.6
Wu (15)	2016	Taiwan	0-3	5470	2564	2906	11.3	11.2	11.4
El Lekhlifi (16)	2016	Morocco	0-15	104	23	81	13		
Bahbah (17)	2015	Egypt	1-15	200	109	91	46.5		
Bulter (18)	2015	UK	0-5	6079			5.6		
Saeed (19)	2015	Iraq	0-15	300	171	129	43.3	53.2	30.2
Sreenivasa (20)	2015	India	0-12	50	20	30	40	24	16
Anigilaje (21)	2013	Nigeria	2-15	52	22	30	38.5	15.4	23
Silverberg (22)	2013	USA	0-17	9417			1.4		
O'Brien (23)	2013	UK	<5	597	284	313	5.9	6.7	5.1
Zincir (24)	2012	Turkey	6-13	2511	1244	1267	7.1	10.1	4.1
Msaki (25)	2012	Tanzania	0-5	231	126	105	20.3	26.9	12.4
Luciano (26)	2012	Italy	<1	54			37		
Luciano (26)	2012	Italy	1-4	137			13.1		
Luciano (26)	2012	Italy	5-9	186			12.4		

Table 1. Continued

First Author	Year of publication	Country	Age range (y)	Sample size	No. of girls	No. of boys	Prevalence of UTI (%)	Prevalence of UTI in girls (%)	Prevalence of UTI in boys (%)
Luciano (26)	2012	Italy	10-14	97			8.3		
Muoneke (27)	2012	Nigeria	<18	3625			3		
Brkic (28)	2010	Bosnia and Herzegovina	0-6	2118	1021	1097	7	11.2	4.5
Mazzone (29)	2008	Italy	<18	606			27		
Aiyegoro (30)	2007	Nigeria	5-18	301	124	177	11.9	22.4	4.6
Filler (31)	2007	Canada	9.6	3422			16.1		
Zorc (32)	2005	USA	<1	1005			9		
Damen-Elias (33)	2005	Netherlands	<18	396			10.6		
Struthers (34)	2003	UK	<6	110			6.4		
Newman (35)	2002	USA	<1	1608	798	868	10	13	7
Dayan (36)	2002	USA	<1	232			11.6	18.4	5.1
Herr (37)	2001	USA	<1	434			5.7		
Bachur (38)	2001	USA	<2	11089			2.1	2.9	1.5
Anoukoum (39)	2001	Togo	<18	175	108	67	8.9		
Caballero (40)	2001	Spain	<18	511	300	211	17		
Kadish (41)	2000	USA	<1	372			8.6		
Lin (42)	2000	Taiwan	<1	162	68	94	13.6	5.9	19.1

Table 2. Prevalence of urinary tract infection and its organisms in childhood separately based on studied subgroups

Subgroups		Prevalence (%)	Lower limited (%)	Upper limited (%)	I^2(%)	*P* value
Prevalence of UTI	Total	15	13	17	99.4	<0.001
Prevalence of UTI by sex	Boys	10	7	13	95.1	<0.001
	Girls	16	12	19	97.8	<0.001
Prevalence of organisms	*Citrobacter*	2	1	3	92.3	<0.001
	Enterococcus spp	3	2	4	88.3	<0.001
	Enterobacter spp	4	2	5	95.6	<0.001
	Pseudomonas aeruginosa	5	3	8	98.1	<0.001
	Proteus	6	5	7	95.5	<0.001
	Klebsiella pneumoniae	11	8	14	98.8	<0.001
	Staphylococcus aureus	14	7	21	99	<0.001
	Streptococcus species	14	13	15	0	0.470
	Streptococcus faecalis	23	6	53	98.7	<0.001
	Escherichia coli	58	46	69	99.9	<0.001
Prevalence of UTI by countries	UK	6	5	6	0	0.906
	USA	6	5	8	97.6	<0.001
	Taiwan	11	11	12	0	0.399
	Nigeria	16	8	24	99.7	<0.001
	Tanzania	17	10	24	64.3	0.094
	Italy	19	10	28	92.5	<0.001
	Egypt	26	0	66	99.2	<0.001
	India	38	3	73	99.8	<0.001
	Iraq	43	39	48	0	0.958

(14) in Egypt, Msaki et al (25) in Tanzania, and Mazzone et al (29) in Italy.

In the present meta-analysis, we concluded that the prevalence of UTIs was 16% in girls and 10% in boys. The results of the study by Alhares et al in Iraq showed that the prevalence of UTIs in 101 children aged 1.5 to 10 years was 43.6% (14.9% for girls and 28.9% for boys). In Nigeria, Anigilaje et al (21) evaluated 52 children aged 2 to 15 years. The prevalence of UTI in girls 15.4% and in boys 23% were. In both of above-mentioned studies, the prevalence of UTI in girls was lower than that in boys, which is inconsistent with the results of the present meta-analysis. In another study by Msaki et al (25) in Tanzania on 231 children aged below 5 years, the prevalence of UTIs was 26.9% in girls and 12.4% in boys which is consistent with the results of our research.

Conclusion

Almost one out of 10 people suffers a childhood UTI. The prevalence of UTIs in girls is about 1.5 times higher than that of boys. Therefore, gender is a risk factor for childhood UTI and girls are more prone to UTIs compared to boys. Since the prevalence of UTI in developed countries is lower than in developing countries, it is possible that the prevalence of UTI in children is related to per capita income and public health development.

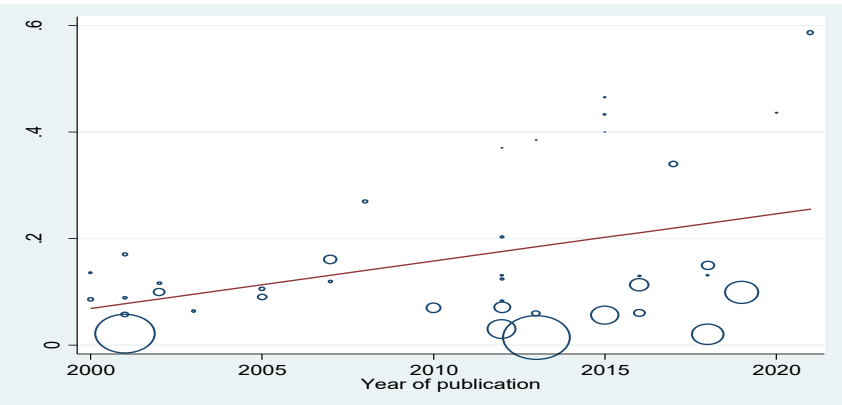

Figure 3. Meta-regression chart of the relationship between the prevalence of UTIs in childhood and year of publication of studies.

Limitations of the study

(A) Since the reviewed studies expressed the age of subjects as age range and the expressed time intervals overlapped with each other, we could not present the prevalence of UTI separately based on age groups. B) Lack of reporting the prevalence of symptoms of childhood UTIs such as fever and dysuria in the reviewed articles.

Acknowledgments

The authors wish to thank all the researchers whose studies were used in this meta-analysis. The authors would like to thank Abbas Moghimbeigi for guidance and editing of manuscript registration on the PROSPERO website.

Authors' contribution

Conceptualization: Tayebe Jamshidbeigi, Diana Sarokhani, Amir Adibi, Shakiba Alaienezhad and Moloud Fakhri.
Methodology: Diana Sarokhani and Ali Hasanpour Dehkordi.
Formal analysis: Diana Sarokhani and Moloud Fakhri.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Conflicts of interest

The authors declare no conflicts of interest, financial or otherwise.

Ethical issues

This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (International Prospective Register of Systematic Reviews) website (ID: CRD42021290886, https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021290886). Besides, ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

Funding/Support

None.

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