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Meta-analysis

Vitamin D deficiency in children with urinary tract infection; a systematic review and meta-analysis

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Abstract

Introduction: Urinary tract infection (UTI) is among the most common bacterial infections in children, and evidently, it is associated with vitamin D deficiency. Accordingly, the present study intended to examine the frequency of vitamin D deficiency in children with UTI.

Materials and Methods: Databases Scopus, PubMed, Embase, Web of Science, Cochrane, and Google Scholar Search Engine were used for articles published until August 1, 2025. Data was analyzed using STATA 14. Tests with *P* values <0.05 were considered statistically significant.

Results: The frequency of vitamin D deficiency in the total population of children with UTI was, in case-control studies, and in cohort studies were 42%, 44%, and 38%, respectively. Furthermore, the rates of vitamin D deficiency in children with UTI aged under 3 years, those aged 3 to 5 years, and children older than 5 years were 21%, 46%, and 71%, respectively. Additionally, vitamin D insufficiency frequency in the total population of children with UTI, in case-control studies, and cross-sectional studies was 30%, 34%, and 22%, respectively. Moreover, the rates of vitamin D insufficiency in children with UTI aged under 3 years and those aged 3 to 5 years were 30% and 33%, respectively. Vitamin D deficiency was observed in 60% of the girls and 42% of the boys with UTI. Approximately 47% of the Asian and 20% of the European children with UTI suffered from vitamin D deficiency, and the frequency of vitamin D insufficiency in Asian and European children with UTI was 34% and 24%, respectively.

Conclusion: Approximately half of the children with UTI suffered from vitamin D deficiency, and one-third of them faced vitamin D insufficiency. The increase in the age of the children added to the percentage of children with vitamin D deficiency or insufficiency. Furthermore, Asian children were at higher risk compared with European children, and females were exposed to higher risks than males.

Registration: This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD420251122224) and Research Registry (UIN: reviewregistry2033) websites.

Keywords: Vitamin D, Children, Child, Urinary tract infection

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Introduction

Vitamin D deficiency has turned into a global concern (1). Moreover, vitamin D deficiency increases the risks of hypocalcemia-induced seizures, respiratory infections, growth disorders (2), bone disorders, diabetes mellitus, inflammatory bowel disease, cardiovascular, and autoimmune diseases (3).

Urinary tract infection (UTI) is one of the most frequent bacterial infections among children (4). Compared with adults, UTIs in children may be associated with acute and chronic complications (5). UTI is correlated with issues including hypertension, proteinuria, growth retardation, and kidney dysfunction (6), as the frequency of transient and permanent kidney injuries caused by UTI was 40% and 5%, respectively (7). On the other hand, *Escherichia coli* is the most common pathogen (80% to 90%) in UTI cases (8).

Considering the risks of chronic kidney disease (CKD), hypertension, and renal scar related to delay in diagnosis and treatment of UTI, early detection of this disease is critical (9,10). Vitamin D affects the level of cathelicidin, an endogenous antimicrobial peptide, and promotes the

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Implication for health policy/practice/research/ medical education

About half of children with urinary tract infection suffer from vitamin D deficiency, and one-third of them face vitamin D insufficiency. An increase in the age of the children adds to the percentage of children with vitamin D deficiency or insufficiency, as children aged over five years old are more exposed to vitamin D deficiency or insufficiency compared with those younger than five years old.

immune system of the bladder wall, and prevents UTI (11). Various studies reported different frequencies of vitamin D deficiency in children with UTI, ranging from 75.6% in study (12) to 4.1% in study (13). Hence, the present study was designed using the systematic review and meta-analysis methods to investigate and provide a general conclusion regarding the vitamin D deficiency in children with UTI.

Materials and Methods

This article was based on Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (14), and its protocol was registered at the websites PROSPERO (International Prospective Register of Systematic Reviews) and Research Registry.

Search strategy

Resource search stage was conducted on the databases Scopus, PubMed, Embase, Web of Science, Cochrane, and Google Scholar Search Engine for studies published by August 1, 2025. No language or time restrictions were considered during the search operation.The Medical Subject Heading (MeSH) keywords and their equivalents were combined using operators (AND, OR). The search strategy in the Embase database was as follows**:** ('urinary tract infection':ab,ti OR uti:ab,ti) AND (children:ab,ti OR child:ab,ti) AND 'vitamin d':ab,ti.

PECO elements

Population: Studies that examined the vitamin D deficiency in children with UTI. Exposure: Vitamin D deficiency. Comparison: Healthy children. Outcome: Prevalence of vitamin D deficiency or vitamin D insufficiency in children with UTI.

Inclusion criteria

Studies that examined the prevalence of vitamin D deficiency in children with UTI.

Exclusion criteria

Reviews, Studies that examined the association between vitamin D deficiency and risk of UTIs in children, low-quality studies, studies that lacked sufficient data, studies that did not report our primary outcome and addressed secondary outcomes, duplicate studies, studies without accessible full text.

Quality assessment

Two authors assessed the quality of the studies using the Newcastle-Ottawa scale. On the scale, zero is the lowest score (indicating the lowest quality) and ten is the highest score (indicating the highest quality). Studies scoring less than five were considered low quality and were excluded (15).

Data extraction

Two authors independently extracted data, including age, total number, number of girls, number of boys, country, continent, year, prevalence of vitamin D deficiency in children with UTI, prevalence of vitamin D insufficiency in children with UTI, and first author. Then, using an agreement solution, the two authors addressed the discrepancies.

Statistical analysis

The variances of each study were calculated using the binomial distribution formula. The I^2 index was conducted to assess heterogeneity among studies, and a random-effects model was employed to combine the results. Meta-regression was used for additional analysis. Data analysis was conducted using STATA 14. Meanwhile, tests with *P* values<0.05 were considered statistically significant.

Results

Overall, 250 articles were found in the search stage. Then, 115 duplicate studies were identified and removed. The abstracts were reviewed, and 8 studies without full text were excluded. Out of the remaining 127 studies, 23 articles that lacked the required data for analysis were removed. A total of 104 studies entered the next step and, 93 articles were excluded due to other exclusion criteria, and 11 studies remained (Figure 1).

Table 1 presents the background information of 11 examined observational studies.

Based on the results of the current study, the overall frequency of vitamin D deficiency in children with UTI was (42%, 95% CI: 27%, 57%), in case-control studies was (44%, 95% CI: 29%, 60%), and in cross-sectional studies was (38%, 95% CI: 10%, 66%). Besides, the prevalence of vitamin D deficiency in children with UTI aged under 3 years, those between 3 and 5 years, and children over 5 was (21%, 95% CI: 5%, 37%), (46%, 95% CI: 42%, 51%), and (71%, 95% CI: 62%, 80%), respectively (Figures 2 to 4).

The overall frequency of vitamin D insufficiency in children with UTI was (30%, 95% CI: 24%, 37%), in case-control studies was (34%, 95% CI: 30%, 38%), and in cross-sectional studies was (22%, 95% CI: 9%, 35%). Furthermore, the prevalence of vitamin D insufficiency in children with UTI aged under 3 years and those between 3 and 5 years was (30%, 95% CI: 19%, 41%), and (33%, 95% CI: 26%, 39%), respectively (Figures 5 to 7).

Vitamin D deficiency was observed in 60% of the female and 42% of the male children with UTI. Besides, 47% of

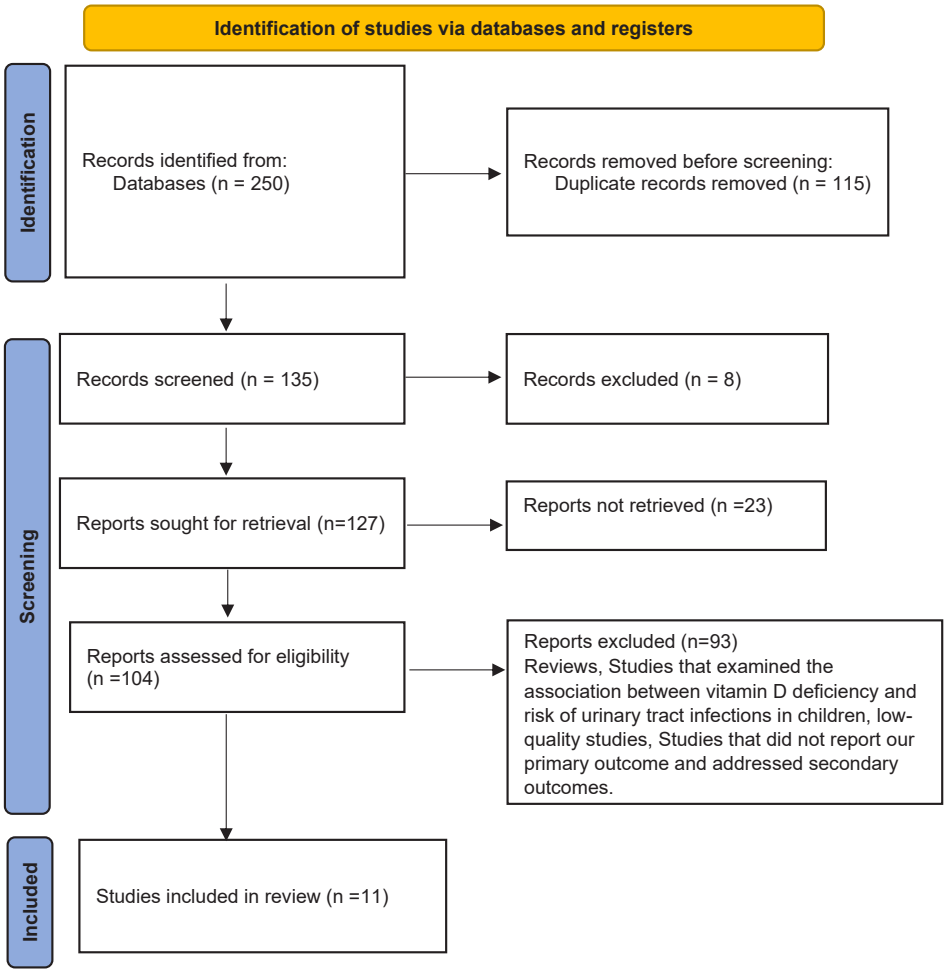

Figure 1. The PRISMA flow chart of study selection.

the Asian and 20% of the European children with UTI suffered from vitamin D deficiency. Additionally, the prevalence of vitamin D insufficiency in children with UTI in Asia and Europe was 34% and 24%, respectively (Table 2).

The meta-regression plot indicated a significant relationship between the 'prevalence of vitamin D deficiency in children with UTI' and the 'publication year of the studies' (*P* value = 0.009). In other words, the prevalence of vitamin D deficiency in children with UTI has increased over the past years (Figure 8).

Vitamin D deficiency in children

Discussion

The prevalence of vitamin D deficiency in children with UTI was reported to be 42% in general, 60% in female children, 42% in males, 47% in Asians, and 20% in European children. The frequency of vitamin D deficiency among children with UTI in children aged less than 3, those aged 3 to 5 years, and those over 5 years was 21%, 46%, and 71%, respectively. On the other hand, the prevalence of vitamin D insufficiency in children with UTI was reported to be 30% in general, 34% in Asia, 24% in Europe, 30% in children less than 3, and 33% in those aged between 3 and 5.

In a meta-analysis by Deng et al, results showed that vitamin D deficiency was associated with increased risk of UTI (OR=3.01, 95% CI = 2.31-3.91) (1). In a meta-analysis by Gan et al, findings indicated that children with UTI had lower vitamin D levels than the control group. Low vitamin D levels significantly increased the risk of UTI in children (24). In another meta-analysis by Li et al investigating the relationship between the serum level of vitamin D and the risk of UTI in children, the serum level of vitamin D in children with UTI was lower than that of healthy children. Consequently, there was a significant negative association between the serum vitamin D levels and the risk of UTI in children (25). Based on the results of a meta-analysis by Gao et al aiming to examine the effects of vitamins A, C, D, and zinc on UTI in children, findings demonstrated that vitamin D administration reduced the risk of UTI and shortened the duration of symptoms (26). The results of the previous meta-analyses matched the findings of the current meta-analysis, with the difference that the previous meta-analyses investigated the risk of UTI in children with low vitamin D levels; however, the

Table 1. Summarized information of the studies

Author, year	Country	Type of study	Duration of study	Total number	Number of girls	Number of boys	Mean age (year)	Prevalence of deficiency vitamin D	Prevalence of insufficiency vitamin D
Abd Elfatah AM, 2024 (12)	Egypt	Case-control	NR	45	23	22	5.05	75.6	NR
Cetiner GM, 2024 (16)	Turkey	Case-control	NR	60	55	5	7.3	66.7	NR
Babar M, 2022 (17)	Pakistan	Cross-sectional	from July 2019 to March 2020	172	40	132	3.46	45.9	NR
Chidambaram S, 2022 (18)	India	Case-control	from October 2018 to February 2021	82	45	37	2.36	41.5	31.7
Muntean C, 2021 (19)	Romania	Case-control	NR	59	34	25	3.95	37.3	32.2
Qadir S, 2021 (20)	Pakistan	Cross-sectional	from July 2019 to March 2020	170	40	130	3.46	45.9	NR
Qazaryan KS, 2020 (21)	Iraq	Case-control	NR	130	95	35	4.58	51.5	33
Georgieva V, 2019 (13)	Sweden	Cross-sectional	between March 2012 and October 2016	120	59	61	<3	4.1	16.6
Abdul Ghani MF, 2019 (22)	Iraq	Cross-sectional	between November 2017 to February 2018	50	NR	NR	<5	58	30
Shalaby SA, 2018 (5)	Egypt	Case-control	from January 2015 to December 2015	50	30	20	0.98	20	38
Yang J, 2016 (23)	China	Case-control	between August 2014 and July 2015	132	62	70	≤1	20.4	35.6

NR: Not reported.

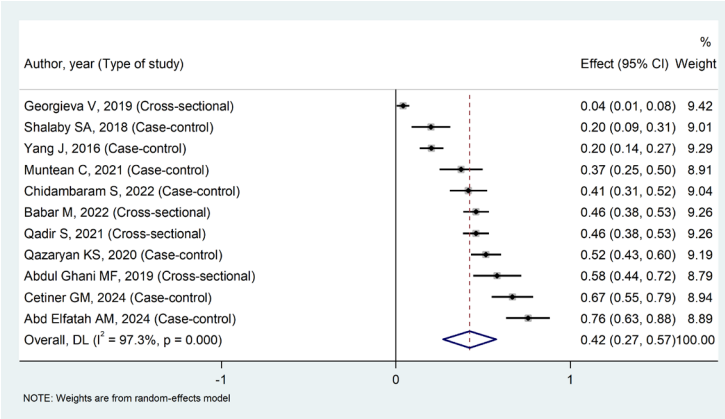

Figure 2. Forest plot showing deficiency of vitamin-D in children with UTI.

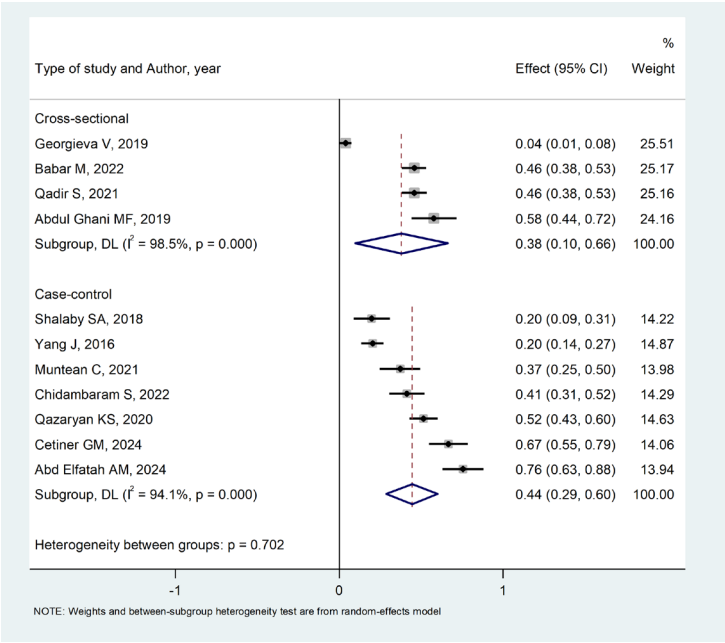

Figure 3. Forest plot showing deficiency of vitamin D in children with UTI by design.

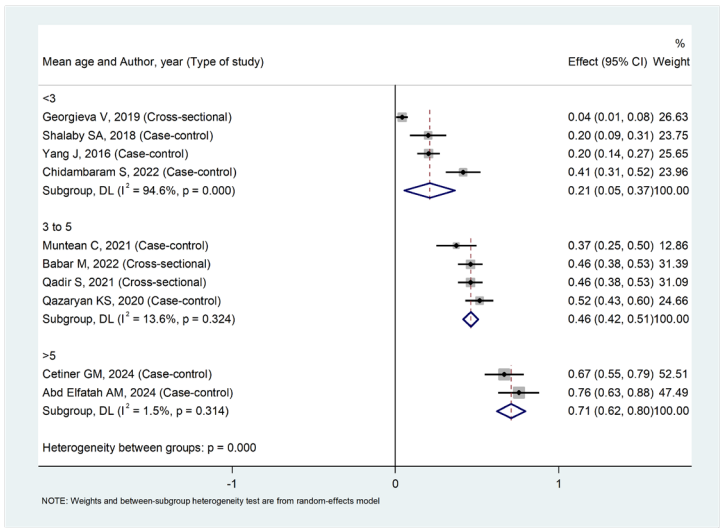

Figure 4. Forest plot showing deficiency of vitamin D in children with UTI by mean age.

present study examined the prevalence of vitamin D deficiency or insufficiency in children with UTI.

In a cross-sectional study by Georgieva et al on 120 children younger than 3 years in Sweden, results demonstrated that vitamin D deficiency and insufficiency was common (21%) in children with UTI (13), which was consistent with our results as in the current study, we combined cross-sectional studies and concluded that the prevalence of vitamin D deficiency or insufficiency in children with UTI was higher than healthy children.

In a case-control study by Chidambaram et al on 82 children with UTI and 82 healthy children in India, 41.5% of the children with UTI and 2.2% of the children in the control group had vitamin D deficiency (18). In another case-control research by Shalaby et al on 100 children in Egypt, findings revealed insufficient vitamin D levels

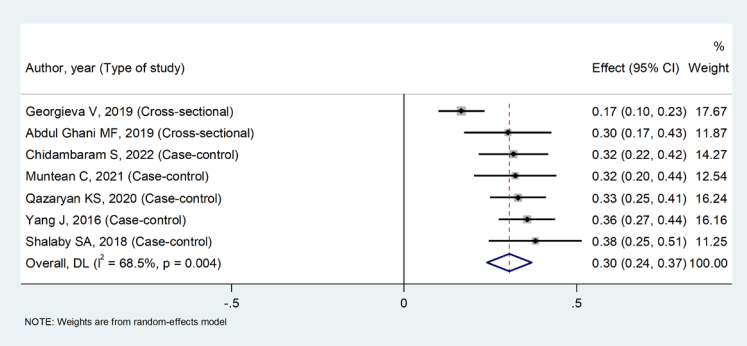

Figure 5. Forest plot showing insufficiency of vitamin D in children with UTI.

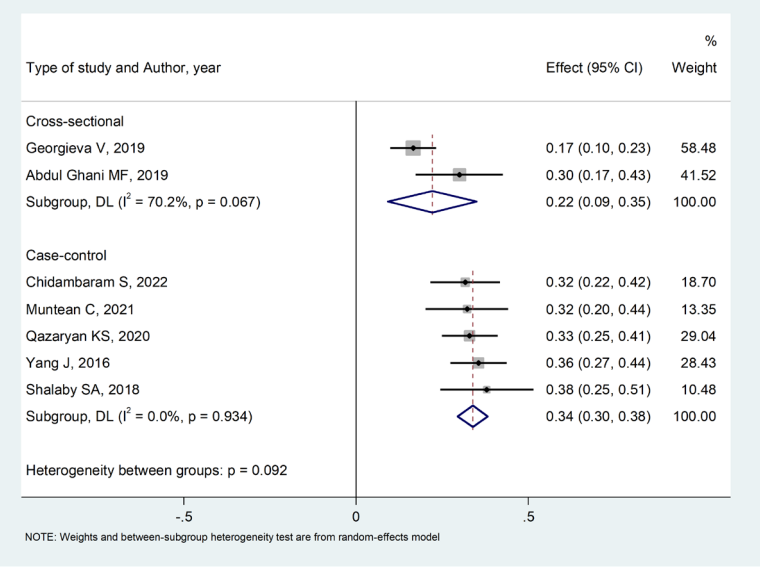

Figure 6. Forest plot showing insufficiency of vitamin D in children with UTI by design.

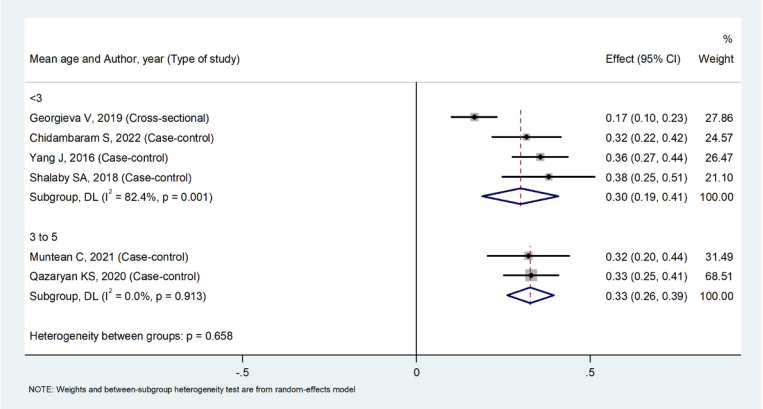

Figure 7. Forest plot showing insufficiency of vitamin D in children with UTI by mean age.

Table 2. Subgroup analysis

Subgroups		Prevalence
Deficiency of vitamin-D	Girls	60% (95% CI: 49%, 71%)
	Boys	42% (95% CI: 36%, 48%)
	Asia	47% (95% CI: 35%, 58%)
	Europe	20% (95% CI: 12%, 53%)
Insufficiency of vitamin-D	Asia	34% (95% CI: 29%, 38%)
	Europe	24% (95% CI: 8%, 39%)

in 38% of the children with UTI and 12% of those in the control group (5). In another case-control study by Muntean et al in Romania, the prevalence of vitamin D insufficiency (32.2%) and deficiency (37.3%) among children with UTI was higher than that of healthy children (19). The results of these studies were consistent with our research, as examined case-control studies demonstrated that vitamin D deficiency or insufficiency in children with UTI was more prevalent than in healthy children.

Conclusion

About half of children with UTI suffer from vitamin D deficiency, and one-third of them face vitamin D insufficiency. An increase in the age of the children adds to the percentage of children with vitamin D deficiency or insufficiency, as children aged over 5 years are more exposed to vitamin D deficiency or insufficiency compared with those younger than 5. Furthermore, among the children with UTI, Asians faced higher risks of vitamin D deficiency or insufficiency than Europeans, and female children were more prone than males. Accordingly, healthcare system policymakers must take note of the role of sex, age, and race in this context.

Limitations of the study

Most studies were conducted in Asia. Merely a few studies had investigated newborn children. Only a limited number of studies reported the prevalence of vitamin D deficiency separately in male and female children.

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Authors' contribution

Conceptualization: Mehrnaz Nazari Rad and Kamran Safa.
Data curation: Sara Ghaseminejad Kermani and Baharak Maddahi.
Formal analysis: Hamid Rastad and Roozbeh Roohinezhad.
Investigation: Leila Ashrafi and Sina Salem Ahim.
Methodology: Hamid Rastad and Leila Ashrafi.
Project management: Baharak Maddahi.
Supervision: Mehrnaz Nazari Rad.
Validation: Roozbeh Roohinezhad and Rasoul Jafari Arismani.
Visualization: Sina Salem Ahim and Rasoul Jafari Arismani.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Conflicts of interest

There are no competing interests.

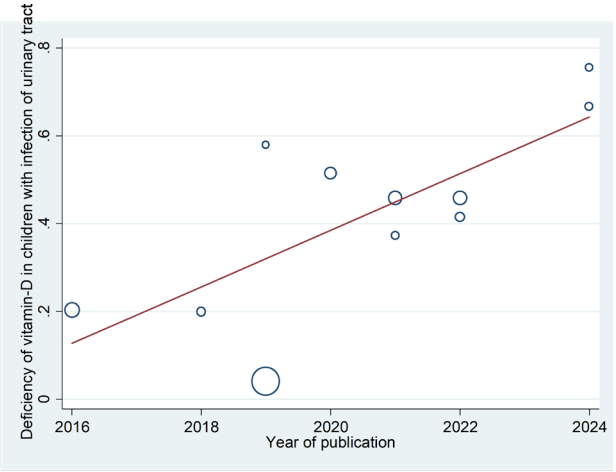

Figure 8. Meta-regression of the association between the prevalence of vitamin D deficiency in children with UTI and the year of publication.

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 with (ID CRD420251122224) and the Research Registry website (Unique Identifying Number [UIN]; reviewregistry2033). Besides, ethical issues (including plagiarism, data fabrication, and double publication) have been completely observed by the author.

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