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Prevalence of Helicobacter pylori infection among children with digestive tract pathology in Ukraine: a systematic review and meta-analysis

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The prevalence of *Helicobacter pylori (H. pylori)* infection varies across populations and geographic regions. However, a comprehensive review of prevalence in Ukraine has not been conducted.
***The objective:* to estimate the pooled prevalence of *H. pylori* among children and to identify factors associated with *H. pylori* infection in Ukraine.**
***Materials and methods*. We performed a search in the databases PubMed, Scopus, Web of Science, and Ukrainian electronic resources including the electronic libraries of the National Academy of Sciences of Ukraine published between 1999–2024. The synthesis included the articles that had information on the prevalence of *H. pylori* among the pediatric population of Ukraine, studies with valid methods for diagnosing *H. pylori*.**
***Results*. The final analysis included 9 publications with a total number of participants of 1,113 children. All articles contained information on the prevalence of *H. pylori* in children with gastroenterological complaints. The overall prevalence of *H. pylori* was 53.22% (95% confidence interval (42.28; 64.02)). Meta-regression analysis did not establish differences in the prevalence of *H. pylori* in children depending on age (p > 0.05), the year of publication (p = 0.713), and the sample size (p = 0.756). When dividing the studies into geographical regions where they were conducted, we established a trend (p=0.06), which indicates that among children from the eastern region of Ukraine, the prevalence of *H. pylori* may be slightly higher.**
***Conclusions*. Our meta-analysis showed that the prevalence of *H. pylori* among children with gastrointestinal complaints in Ukraine is high and exceeds the global and European averages for the general pediatric population. Of course, direct comparison with studies of the general population is less accurate, but our data are relevant in a clinical context. The lack of data on the prevalence of *H. pylori* among the general pediatric population in Ukraine emphasizes the need for further research, in particular taking into account socio-economic and hygiene factors.**
Keywords: *Helicobacter pylori, prevalence, children, digestive tract pathology, systematic review, meta-analysis, Ukraine.*

Поширеність інфекції Helicobacter pylori серед дітей із патологією травного тракту в Україні: систематичний огляд та метааналіз

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Поширеність інфекції *Helicobacter pylori* (*H. pylori*) варіюється залежно від популяції та географічного регіону. Однак комплексний огляд поширеності в Україні не проводили.
Мета дослідження: оцінити загальну поширеність *H. pylori* серед дітей та визначити фактори, пов'язані з інфікуванням *H. pylori* в Україні.
Матеріали та методи. Виконано пошук публікацій у базах даних PubMed, Scopus, Web of Science та українських електронних ресурсах, включно з електронними бібліотеками Національної академії наук України, за період 1999–2024 рр. Синтез включав статті, що містили інформацію про поширеність *H. pylori* серед дитячого населення України, з використанням валідних методів діагностики *H. pylori*.
Результати. Остаточний аналіз включав 9 публікацій із загальною кількістю учасників – 1113 дітей. Усі статті містили інформацію про поширеність *H. pylori* у дітей із гастроентерологічними скаргами. Загальна поширеність *H. pylori* становила 53,22% (95% довірчий інтервал (42,28; 64,02)). Під час проведення метарегресійного аналізу не відзначено відмінностей у поширеності *H. pylori* у дітей залежно від віку (p > 0,05), року публікації (p = 0,713) та розміру вибірки (p = 0,756). При розподілі досліджень за географічними регіонами, де вони проводилися, виявлено тенденцію (p = 0,06), яка вказує на те, що серед дітей зі Східного регіону України поширеність *H. pylori* може бути дещо вищою.
Висновки. Метааналіз показав, що поширеність *H. pylori* серед дітей із гастроентерологічними скаргами в Україні є високою і перевищує середні світові та європейські показники для загальної дитячої популяції. Звичайно, пряме порівняння з дослідженнями загальної популяції є менш точним, але наші дані є релевантними для клінічного контексту. Відсутність даних про поширеність *H. pylori* серед загальної дитячої популяції в Україні наголошує на необхідності подальших досліджень, зокрема з урахуванням соціально-економічних та гігієнічних факторів.
Ключові слова: *Helicobacter pylori, поширеність, діти, патологія травного тракту, систематичний огляд, метааналіз, Україна.*

Helicobacter pylori (*H. pylori*) is one of the most common pathogens colonizing the human gastric mucosa. It infects more than half of the world's population, causing a wide range of gastrointestinal and extra-gastrointestinal diseases that may progress to serious complications, such as peptic ulcer disease, gastric adenocarcinoma, and MALT (Mucosa-Associated Lymphoid Tissue) lymphoma of the stomach [1]. Unlike the recommendations for adults, pediatric guidelines limit the treatment of *H. pylori* to specific situations. The most recent updated guidelines for children recommend treatment only in children with peptic erosions or ulcers, in children with iron deficiency anemia that does not respond to iron supplements, and in children with a first-degree relative who has tested positive for gastric cancer [2]. *H. pylori* infection among children will always be a subject of interest because of its potential to determine long-term complications and significant morbidity. It is a fact that *H. pylori* may play a role in certain extraintestinal diseases, including unexplained iron deficiency anemia, immune thrombocytopenic purpura, Henoch-Schönlein purpura, bronchial asthma, other allergic diseases, and inflammatory bowel diseases and may require a revision of algorithms for the management of this infection in children [3, 4]. According to one of the most recent meta-analyses, the global prevalence of *H. pylori* among children is 32.4%, but it varies significantly depending on geographic region [5]. At the same time, in low- and middle-income countries, the prevalence of *H. pylori* among children is estimated to be between 60–80%, although most infected individuals remain asymptomatic [6]. Moreover, recent data on global prevalence have shown a decreasing trend in adults to 43.7%, but not in children, where these rates are still as high as 34.4% [7].

The objective of our study was to evaluate, based on the analysis of existing publications, the prevalence of *H. pylori* infection in Ukraine among children and adolescents under 18 years of age, and to identify factors associated with such infection.

MATERIALS AND METHODS

We conducted a systematic review according to the international PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [8].

We used scientific databases focused on gastroenterological topics and studies related to *H. pylori* in the Ukrainian population. The primary sources of information included international databases such as PubMed, Scopus, and Web of Science, as well as Ukrainian resources, including the electronic libraries of the National Academy of Sciences of Ukraine, the electronic archive of scientific papers 'Scientific Periodicals of Ukraine', data from the Ukrainian Medical Journal portal, and literature sources provided by the Vinnitsya Regional Universal Scientific Library named after V. Otamanovsky.

The search for publications was conducted using keywords and combinations, including "*Helicobacter pylori*", "*H. pylori* infection in Ukraine", "gastritis", "peptic ulcer", "dyspepsia", and their English equivalents. Logical operators (AND, OR) were applied to refine search queries. The search period covered works published from 1999 to 2024, aiming to analyze current trends in the prevalence of *H. pylori* and its role in the etiology of gastrointestinal diseases in the Ukrainian population.

At the first stage, 784 scientific publications were identified that met the preliminary search criteria. After analyzing

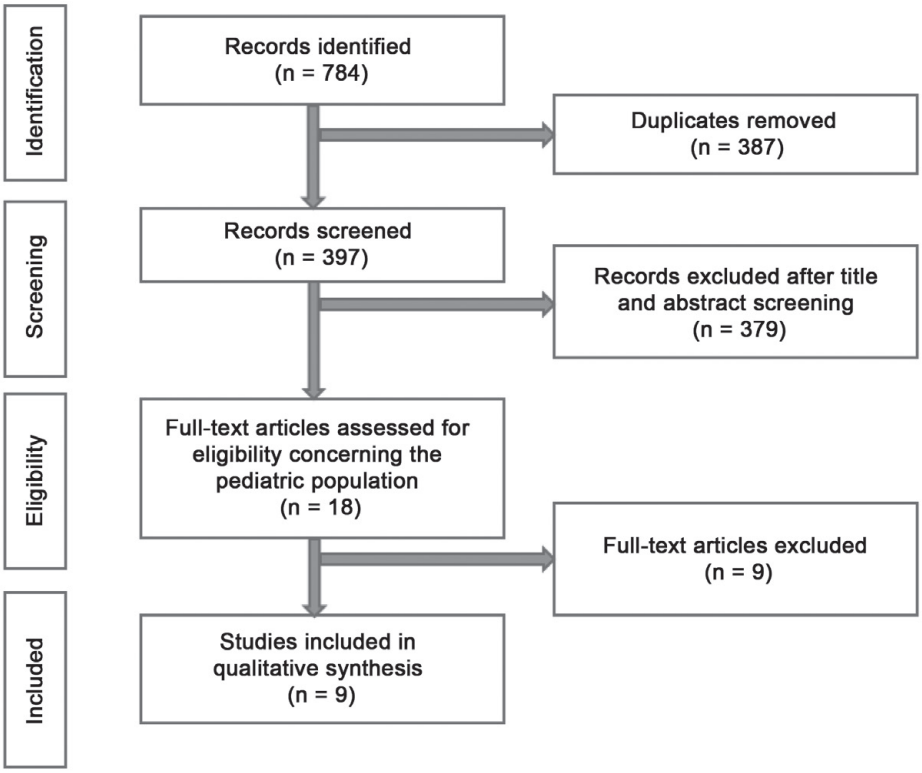

Fig. 1. PRISMA flow diagram of articles included in the meta-analysis

the titles and abstracts, 397 papers were selected for full-text review and assessment for eligibility. As a result of the final full-text analysis, only 18 studies related to the pediatric population. Following additional expert review and assessment of methodological quality, 9 studies involving children were finally included in the synthesis of results (Fig. 1).

Statistical Analysis

The meta-analysis was conducted using MedCalc software (version 23.2.1). Heterogeneity between studies was assessed using the Q test (Cochran's Q), which tests the null hypothesis of homogeneity of effects, and the I^2 index, which reflects the percentage of variation between studies not explained by random error. A random-effects model was applied for the analysis.

Sensitivity analysis was performed using the leave-one-out method, where each study was sequentially excluded from the meta-analysis to assess its impact on the overall result and the level of heterogeneity. After exclusion of individual studies, II values and the overall effect estimate were compared to determine the stability of the meta-analysis results. To test for publication bias, we used Begg's rank correlation test and Egger's regression. To assess the impact of potential moderators (covariates) on *H. pylori* prevalence in children, meta-regression models were constructed using the metafor package in R. Separate moderators included: year of the study, sample size, geographic region, and age category. In models involving regional or age covariates, categorical variables were coded as factors with a specified reference level. Specifically, for region, the central region was the reference level; for age, the reference category was "children of all age groups". Model coefficients (β) are interpreted as the change in average effect relative to the reference category. Moderators were entered separately to avoid overfitting due to the small number of studies (k = 9). Each model used the random-effects level (method = 'REML' (Restricted (or Residual) Maximum Likelihood)). Statistical significance of moderators was assessed based on z-values, p-values, and confidence intervals. Results for categorical covariates were presented relative to the reference level, allowing for comparison between groups. A result was considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION

Search Results and Study Characteristics

Nine publications meeting the search criteria were included in the analysis, and their characteristics are presented in Table 1.

For example, in 2015, O. Y. Abaturov et al. studied endoscopic changes in the gastric mucosa of 115 children aged 8 to 17 years diagnosed with chronic gastritis, who were treated in the gastroenterology department of the Municipal Children's Clinical Hospital No. 1 in Dnipro [9]. A rapid urease test was performed during upper endoscopy. As a result, 74 children tested positive (64.3%) and 41 (35.7%) negative.

In a study by S. A. Ali conducted at Kyiv City Children's Clinical Hospital No. 3, 122 children aged 6–17 years were examined. Of these, 60 children (49.2%) with functional dyspepsia had concurrent *H. pylori* infection, confirmed by rapid urease testing and CagA (Cytotoxin-associated gene A) antibody analysis [10].

In 2013, V. I. Bobrova et al. investigated the effect of smoking on chronic gastroduodenal pathology in adolescents aged 12–17 years [11]. Among 136 children, 79 (58.1%) were found to be infected with *H. pylori*. The study showed a stronger association between infection and pathology in smokers.

In 2023, Yu. V. Karpushenko et al. conducted a study among 256 children aged 6–18 years with gastrointestinal complaints [12]. Of these, some had allergic comorbidities, while others did not. Overall, 145 children (56.6%) were found to be infected with *H. pylori*.

Table 1

List and characteristics of studies included in the meta-analysis

Author, Year	Region of Ukraine	Study Subjects	Diagnostic Methods for *H. pylori*	Sample Size	Prevalence of *H. pylori* (%)
O. Y. Abaturov et al., 2015	Eastern	Children aged 8–17 with chronic gastritis	Rapid urease test	115	64.4
S. A. Ali, 2018	Central	Children aged 6–17 with functional dyspepsia	UBT, serological tests	122	49.2
V. I. Bobrova et al., 2010	Central	Children aged 12–17 with chronic gastroduodenal pathology	Serological and histological methods	136	58.1
Y. V. Karpushenko et al., 2023	Eastern	Children aged 6–18 with GI complaints	Rapid urease or histological method	256	56.6
O. V. Nikolaieva et al., 2008	Eastern	Children aged 9–14 with GERD	Serological and histological methods	57	70.2
S. D. Saltanova, 2012	Central	Children aged 6–14 with chronic gastroduodenal disease	UBT and histological methods, UBT, stool antigen, serology	102	48
T. V. Sorokman et al., 2016	Western	Children aged 7–18 with gastroduodenal diseases	Serological and histological methods	106	67.9
O. V. Tyazhka et al., 2008	Central	Children aged 5–17 with chronic organic / functional gastroduodenal pathology	Serological and histological methods	126	15.9
Ye. I. Rubtsova et al., 2005	Western	Children aged 3–18, including symptomatic and healthy	Serological and histological methods	93	52.7

Notes: UBT – Urea Breath Test; GI – Gastrointestinal; GERD – Gastroesophageal Reflux Disease.

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In 2008, O. V. Nikolaieva et al. studied gastroesophageal reflux disease (GERD) in children aged 9–14 years [13]. Among 57 children, 40 (70.2%) had *H. pylori* infection. No differences in gastric and duodenal mucosal morphology were observed depending on infection status, although erosive esophagitis was more common in infected individuals.

In 2012, S. D. Saltanova conducted a comparative study on the diagnostic effectiveness of C^{13} urea breath test (UBT), stool antigen testing, and serological methods for primary *H. pylori* diagnosis in children [14]. Among 102 patients, 49 children (48%) were found to be infected.

A 2016 study by T. V. Sorokman et al. examined immunological characteristics of *H. pylori*-associated gastroduodenal pathology in 106 children aged 7–18 years [15]. They were divided into two groups: 72 children (67.9%) tested positive for *H. pylori*, and 34 were negative.

A study by O. V. Tyazhka et al. found that among 126 children with chronic gastroduodenal pathology, *H. pylori* infection was identified in 11 of 60 children in the traditional therapy group and in 9 of 66 children in the systemic enzyme therapy group – an overall prevalence of 15.9% [16].

In 2005, Y. I. Rubtsova et al. studied the relationship between *H. pylori* infection and the development of various gastroduodenal lesions in children and adolescents [17]. Among 93 examined subjects, 49 (52.7%) were infected.

Thus, *H. pylori* prevalence among children in the included studies ranged from 15.9% to 70.2%.

Overall H. pylori Prevalence in Children

The total sample included in the meta-analysis comprised 1,113 children, among whom the prevalence of *H. pylori* infection was 53.22% (Fig. 2).

Heterogeneity analysis using Cochran's Q test and I^2 indicated high variability among studies (Cochran's Q test – $p < 0.0001$; $I^2 = 92.69\%$). Therefore, a random-effects model was used to calculate overall prevalence.

High heterogeneity prompted further investigation. Leave-one-out sensitivity analysis revealed that exclusion of one study (O. V. Tyazhka et al., 2008) significantly reduced heterogeneity (Table 2).

In particular, after excluding this study from the analysis, the value of I^2 decreased from 92.69% to 63.13%, which indicates that this study has a significant impact on the variability of the results. The rather low values (15.87%) of *H. pylori* infection among the cohort of children in the study are noteworthy; it is difficult to clearly explain the reason for such a significant difference from other studies. This may be due to the methodology of patient selection, since, as indicated by the authors, half of the cohort of children had chronic gastroduodenal pathology of allergic origin.

We also conducted a statistical analysis to assess publication bias. Begg's correlation test did not reveal a statistically significant correlation between standard error and study effect ($p = 0.53$), indicating no publication bias. Egger's regression results similarly did not indicate bias ($p = 0.81$). The funnel plot symmetry suggested the absence of publication bias among studies included in this

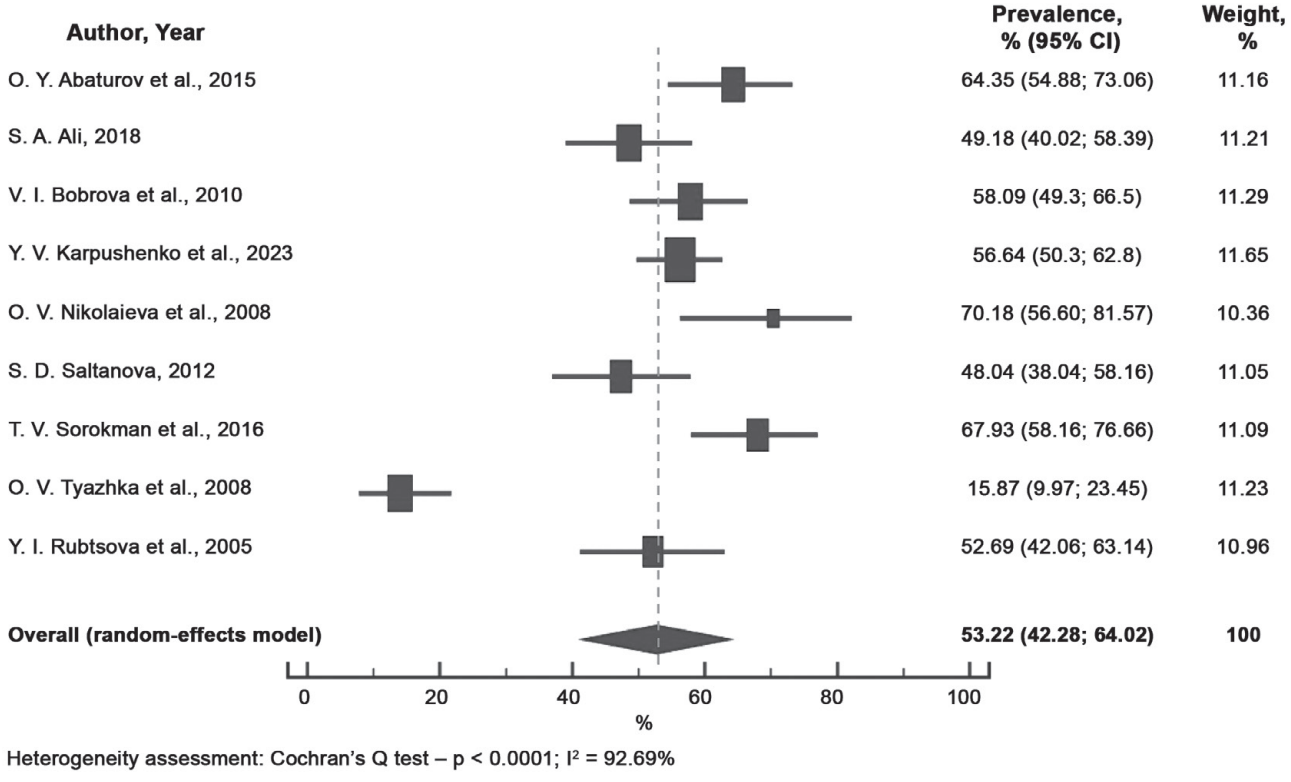

Fig. 2. Meta-analysis of *H. pylori* prevalence among children with gastrointestinal pathology

Note: CI – Confidence Interval.

Table 2

Results of sensitivity analysis using the leave-one-out method

Excluded Study	Overall *H. pylori* Prevalence After Exclusion (%)	I^2 (%)	95% CI for I^2	p-value
O. Y. Abaturov et al., 2015	51.829	93.14	(88.78; 95.80)	< 0.0001
S. A. Ali, 2018	53.752	93.56	(89.57; 96.03)	
V. I. Bobrova et al., 2010	52.63	93.49	(89.43; 95.99)	
Y. V. Karpushenko et al., 2023	52.82	93.47	(89.39; 95.98)	
O. V. Nikolaieva et al., 2008	51.24	93.11	(88.72; 95.79)	
S. D. Saltanova, 2012	53.88	93.55	(89.54; 96.02)	
T. V. Sorokman et al., 2016	51.37	92.84	(88.23; 95.65)	
Y. I. Rubtsova et al., 2005	53.31	93.6	(89.64; 96.05)	
O. V. Tyazhka et al., 2008	57.99	63.13	(20.76; 82.84)	0.0082

Note: CI – Confidence Interval.

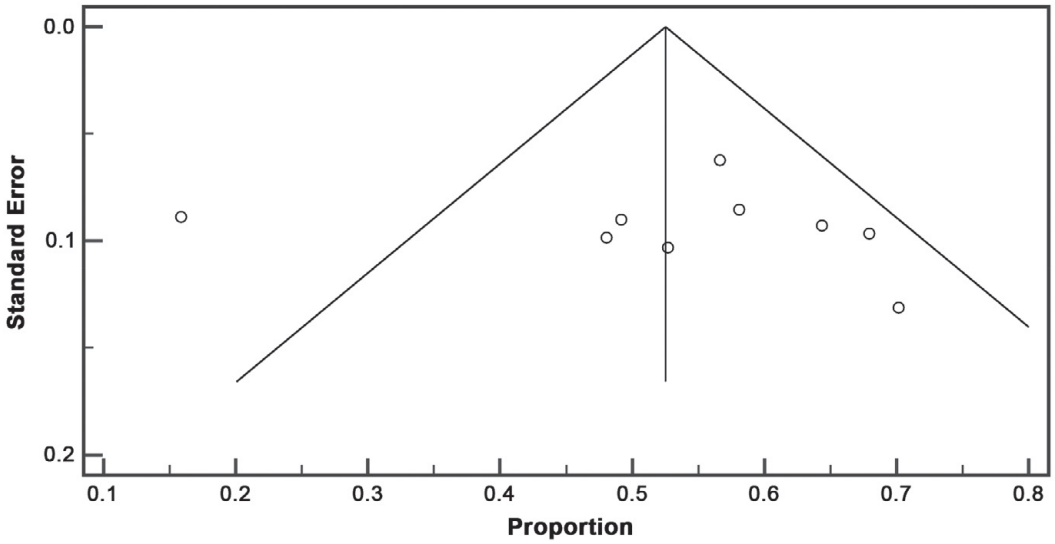

Fig. 3. Assessment of the probability of publication bias

systematic review and meta-analysis, except for one publication, which is described in the previous paragraph about leave-one-out sensitivity analysis (Fig. 3).

Meta-Regression Analysis Results

To investigate factors that might influence the prevalence of *H. pylori* reported in the studies, we conducted meta-regression models with various covariates. All models used the REML method for estimating effects (Table 3).

Year of publication: the model that included publication year showed no statistically significant effect of this factor (p = 0.713), indicating that publication year does not significantly influence the prevalence of *H. pylori* among children in the analyzed studies.

Sample size: analysis of the "sample size" variable also did not reveal a significant effect (p = 0.756), suggesting no substantial correlation between sample size and *H. pylori* prevalence in the studies.

Geographic region: depending on the region of Ukraine where the study was conducted, all studies were categorized into 3 groups – eastern, western, and central. The central region was selected as the reference category (intercept). Analysis of changes relative to the reference revealed a trend toward higher prevalence in the eastern region (p = 0.0634), though this result did not reach statistical significance (p > 0.05). The result for the western region was also not statistically significant (p = 0.1623).

Age of children: based on age, studies were grouped into 3 categories – "all age groups" (6 studies), "middle age group" (2 studies), and "older age group" (1 study). None of the covariates in this model showed statistically significant influence on the effect. The "all age groups" category was taken as the intercept. Comparisons showed p = 0.603 for older age group and p = 0.719 for middle age group.

Thus, despite evaluating several potential covariates, none were found to significantly impact the prevalence of *H. pylori*. This may suggest that other factors not included in the model may have greater influence, or that the small number of studies limited the ability to detect significant correlations.

A comparative analysis of our meta-analysis results on the prevalence of *H. pylori* infection among children in Ukraine with similar studies from other countries reveals

Table 3

Meta-regression analysis results

Covariate	Model Coefficients (β)	Standard Error	z-value	p-value	95% CI
Year of publication	0.40	1.08	0.37	0.71	(–1.73; 2.53)
Sample size	–0.03	0.11	–0.31	0.76	(–0.26; 0.19)
Eastern region	20.92	11.26	1.86	0.06	(–1.17; 43.01)
Western region	17.93	12.83	1.40	0.16	(–7.22; 43.08)
Middle age group	7.93	15.23	0.52	0.60	(–21.94; 37.80)
Older age group	7.13	19.85	0.36	0.72	(–31.78; 46.04)

Note: CI – Confidence Interval.

both common trends and certain regional peculiarities. In our study, the prevalence of *H. pylori* among children in Ukraine was calculated at 53.2%. It is important to note that all studies included in our meta-analysis examined *H. pylori* infection among children with gastrointestinal symptoms, and therefore, a higher prevalence in this group is logical. However, a systematic review and meta-analysis conducted in 2016 by Torres B. Zabala et al. reported a global prevalence of *H. pylori* in healthy children at 37%, and 39% in children with gastrointestinal symptoms. This means the prevalence in symptomatic children in Ukraine is higher than the global average [18]. It is noteworthy that a recent study reported an 84.5% prevalence of *H. pylori* among Moroccan children and adolescents undergoing endoscopy [19]. In contrast, a similar study conducted by Turkish researchers reported an *H. pylori* prevalence of 31–33% among children with dyspepsia, depending on the diagnostic method used [20]. The above findings indicate considerable variability in the prevalence of this infection among children with dyspeptic symptoms across different regions.

Most currently available reviews and meta-analyses evaluate the overall prevalence of *H. pylori* in pediatric populations rather than among symptomatic children. For example, a 2018 meta-analysis reported an overall prevalence of 32.6% [21]. A large meta-analysis conducted in 2022, which included 193 publications and a sample of 147,000 children, estimated the global prevalence at 32.4% [5]. It also noted that prevalence varies significantly by region: the highest prevalence was found in Southeast Asia (48.6%), Africa (44.2%), and the Eastern Mediterranean (43.6%), compared to Europe (17.2%). Other studies confirm significant variability: for instance, in Ethiopia, prevalence was 48% among children aged 2–4 years and 80% among those over 6 years [22]. A 2016 study in Nepal found prevalence rates of 18.2% in children under 5 years, 14% in boys aged 10–19, and 16% in girls aged 10–19 [23]. Moreover, a meta-analysis from India found that in low- and middle-income countries, *H. pylori* prevalence among children can reach 60–80% [6]. Therefore, our result of 53.22% is high and aligns more with levels observed in Eastern Europe, parts of Asia, Latin America, and Africa, rather than Western Europe or North America.

It is crucial to emphasize that our sample consisted of children with gastrointestinal complaints. The prevalence of *H. pylori* is typically higher in symptomatic children compared to the general pediatric population. This makes direct comparison with general population studies less precise, although our data remain clinically relevant.

Regarding subgroup analysis, some researchers have found that prevalence increases with age. For instance, a 2022 meta-analysis reported an increase from 24.0% at ages 0–6 to 43.5% at ages 13–18 [5, 21]. Recent results from researchers in China also support this trend. According to their data, the infection rate was 8.3% among children aged 6–7 years, compared with 34.7% among those aged 10–11 years [24]. However, our meta-regression did not reveal such a pattern. This might be due to variability in the age ranges of included studies, complicating grouping, or the limited number of studies for such analysis.

We also found no correlation between infection rate and year of publication. However, other sources suggest that more recent publications show declining prevalence. One meta-analysis reported that global prevalence among children decreased from 39.0% before 2000 to 26.0% in studies published from 2010 onwards [5].

Interestingly, in our analysis of regional differences within Ukraine, a trend ($p = 0.06$) suggested slightly higher prevalence in eastern regions. This is consistent with global data showing not only international but also intranational variability [25, 26].

High heterogeneity is a common finding in meta-analyses of *H. pylori* prevalence. For example, an analysis of 224 studies from 71 countries involving nearly 3 million people reported an I^2 of 99.9% [27]. This is attributed to differences in diagnostic methods, age groups, socio-economic conditions, geography, and time periods. Our I^2 of 92.69% is consistent with these global findings. Notably, we identified the main source of heterogeneity – Tyazhka's study – whose exclusion reduced I^2 to 63.13%, though it slightly increased overall prevalence from 53.2% to 57.99%.

Study Limitations

Naturally, the greatest limitation of our meta-analysis is the relatively small number of studies included in the synthesis. Data scarcity remains a major obstacle in this type of research. The lack of data on *H. pylori* prevalence among the general pediatric population in Ukraine forced us to focus only on children with gastrointestinal complaints, as noted in the discussion.

There is an urgent need in Ukraine for further studies aimed at assessing the prevalence of *H. pylori* in the general child population – not only those with symptoms.

Such research should also consider socio-economic and hygiene-related factors, which would be valuable for a better understanding of the infection's epidemiology and the development of effective preventive strategies. Despite evaluating several potential variables, our meta-regression analysis did not identify any factor with a statistically significant impact on *H. pylori* prevalence. This might be due to the influence of other, unaccounted-for factors or, again, due to insufficient data.

CONCLUSIONS

1. The prevalence of *H. pylori* among children with gastrointestinal complaints in Ukraine, according to our meta-analysis (53.2%), is high and exceeds global and European averages for the general pediatric population, approaching levels observed in low- and middle-income countries. Since *H. pylori* prevalence is usually higher among symptomatic children than in the general pediatric population, direct comparison with general population studies is less precise, but our data are highly relevant in the clinical context.

2. We did not identify any statistically significant factors affecting *H. pylori* prevalence among symptomatic children in Ukraine, such as publication year, sample size, age of children, or geographic region – although the latter showed a trend toward higher infection rates in eastern Ukraine.

3. The lack of data on *H. pylori* prevalence in the general pediatric population in Ukraine underscores the need for further research, especially with consideration of socio-economic and hygiene-related factors. Such data are essential for a deeper understanding of the epidemiology of this infection and for the development of effective prevention strategies.

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Authors' contributions. I. H. Paliy – study design, implementation, interpretation and final manuscript correction; O. O. Ksenchyn – statistical analysis, interpretation, and manuscript drafting; D. V. Palii – manuscript writing and translation; A. H. Kapitun – data interpretation and draft review; O. M. Muzychuk – data collection, analysis, interpretation.

Conflict of interest. The authors declare no conflicts of interest.

Data availability. All data generated or analyzed during this study are included in this published article.

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