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Risk factors for *Helicobacter pylori* infection in children with gastrointestinal symptoms in Vietnam

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ABSTRACT

Objectives: To investigate the prevalence and risk factors associated with *Helicobacter pylori* infection in Vietnamese children.

Methods: Children under 16 years old with gastrointestinal symptoms underwent esophagogastroduodenoscopy and *H. pylori* infection was diagnosed using rapid urease test.

Results: A total of 246 children with gastrointestinal symptoms were included. The mean age was 8.4 ± 2.6 years. A total 81.3% tested positive for *H. pylori.* Children infected with *H. pylori* had a lower rate of nausea but a higher rate of lesions in the duodenal bulb and nodular lesions than children without *H. pylori* infection (26.5% vs 45.6%, P <0.01; 40.0% vs 23.9%; P = 0.04; and 68.5% vs 30.3%, P <0.0001, respectively). Compared with children aged under 5 years, children aged 11 years and older were four times more likely to be infected with *H. pylori*, with odds ratio (OR) 3.50, 95% confidence interval (CI) 1.07-11.39, P = 0.04. Washing hands with soap was associated with a reduced risk of *H. pylori* infection by three times (OR 0.35, 95% CI 0.17-0.69, P = 0.002). Children living in a family where members had a history of *H. pylori* infection were nine times more likely to be infected with *H. pylori* (OR 8.87, 95% CI 1.15-68.45, P = 0.04).

Conclusions: The prevalence of *H. pylori* infection in Vietnamese children with gastroenteritis is high. Our results identified several risk factors and emphasize the role of handwashing with soap before eating and after using the toilet in reducing the risk of *H. pylori* infection in children.

Introduction

Helicobacter pylori infection is recognized as one of the most prevalent gastrointestinal bacterial infections worldwide, exerting a significant burden on public health systems, particularly, in low-resource countries such as Vietnam [1,2]. Despite notable progress in medical science and health care infrastructure, *H. pylori* infection persists as a significant challenge, especially in vulnerable populations such as children [3].

The implications of *H. pylori* infection in children transcend the confines of the gastrointestinal tract, exerting profound effects on multiple aspects of health and well-being. Beyond its immediate impact on gastric mucosal integrity, *H. pylori* infection exerts systemic effects that can detrimentally influence nutritional status, growth trajectories, and overall health outcomes in affected children [4]. Chronic infection with *H. pylori* has been implicated in a spectrum of gastrointestinal disorders, ranging from mild gastritis to more severe conditions such as peptic ulcer disease [5]. Furthermore, epidemiologic evidence suggests a potential link between *H. pylori* infection acquired during childhood and the heightened risk of developing gastric adenocarcinoma and mucosa-associated lymphoid tissue lymphoma later in life [6]. These long-term consequences underscore the imperative of addressing *H. pylori* infection in children as a critical public health priority.

In the context of Vietnam, where *H. pylori* infection prevalence rates in children are alarmingly high, understanding the multifaceted risk factors driving transmission and persistence is paramount for designing effective prevention and intervention strategies [7–10]. Socioeconomic status emerges as a key determinant, with disparities in access to health care, sanitation infrastructure, and nutritional resources contributing to differential vulnerability to *H. pylori* infection in Vietnamese

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children [10]. In addition, cultural and behavioral factors, including hygiene practices and dietary habits, play pivotal roles in shaping the epidemiology of *H. pylori* in this population [11]. Poor sanitation practices, inadequate handwashing facilities, and communal living arrangements may facilitate the transmission of *H. pylori* within households and communities [11]. Moreover, dietary factors such as consumption of contaminated food and water sources or cultural practices involving shared meals may serve as vehicles for *H. pylori* transmission. Environmental conditions, including overcrowding and inadequate sanitation facilities, create conducive environments for the persistence of *H. pylori*, perpetuating the cycle of infection within communities [11].

A comprehensive understanding of these interconnected risk factors is essential for devising targeted interventions aimed at mitigating the burden of *H. pylori* infection in Vietnamese children. By addressing underlying determinants, such as socioeconomic inequalities, promoting improved hygiene practices, fostering dietary diversification, and enhancing access to clean water and sanitation facilities, we can effectively curb the transmission and adverse health outcomes associated with *H. pylori* infection in this vulnerable population.

This study aims to investigate the prevalence and risk factors associated with *H. pylori* infection in Vietnamese children, providing insights into the epidemiology of the infection and informing public health initiatives aimed at reducing its prevalence and associated complications.

Materials and methods

Study design and location

This cross-sectional study was conducted between January and May 2024 at the Thai Binh Pediatric Hospital, Thai Binh Province, Vietnam.

Thai Binh is a coastal province located in the eastern part of the Red River Delta in the northern part of the country. It lies approximately 110 kilometers from Hanoi, the capital of Vietnam. The province covers an area of 1586 km^2, with approximately two million inhabitants [12]. Thai Binh Pediatric Hospital, located in the central part of Thai Binh, is a first-class medical facility for ill children aged under 16 years of the province and some surrounding areas. The hospital has nearly 600 beds distributed across 17 distinct medical departments. However, the number of beds is insufficient to accommodate the high patient volume, resulting in overcrowding in most departments, except for the neonatal unit, with about 2000 hospitalized patients and 10,000 consultations per month [13].

Sample size

The sample size formula for a cross-sectional study was used to calculate the sample size, with $Z_{1-\alpha/2} = 1.96$ for a 95% confidence interval (CI) and a margin of error of 5% (d = 0.05). According to a previous study, the estimated rate of children infected with *H. pylori* was 80.0% [14]. The minimum sample size needed was 246 children.

Inclusion criteria

Children aged under 16 years with a variety of gastrointestinal symptoms (chronic gastritis, persistent nausea/vomiting, chronic bowel disorders, suspicion of gastroesophageal reflux disease, dyspepsia, or melena) who underwent upper endoscopy with biopsy were included in the study. Children having used antibiotics or proton pump inhibitors within 2 weeks before endoscopy, those who underwent esophagogastroduodenoscopy as interventional endoscopy (ulcer perforation, bleeding control, or foreign body removal); those not tested for *H. pylori*, or having esophageal burns, or esophageal damage due to other causes; or children who had endoscopy as re-examination after treatment were excluded from this study.

Esophagogastroduodenoscopy and H. pylori test

Each patient underwent an esophagogastroduodenoscopy, with detailed documentation of macroscopic findings for the esophagus, gastric corpus, gastric antrum, and duodenum. Endoscopic lesions were classified according to severity, from erythema and nodularity to erosion and ulceration, especially when gastric and duodenal lesions were present, following the Minimal Standard Terminology for Digestive Endoscopy [15]. Two biopsies of the gastric mucosa were taken from the edges of ulcers or areas with suspected *H. pylori* infection (characterized by slipping, lumpy mucosa) for rapid urease test (HAMESCO Vietnam Company Limited, Hanoi, Vietnam) and histopathologic analysis using the Updated Sydney Classification [16].

Data collection

Demographics, epidemiologic, clinical features; esophagogastroduodenoscopy; and *H. pylori* tests results were collected using a standardized questionnaire by clinical doctors.

Statistical analysis

Stata 17.0 software was used for statistical analysis. Categorical variables are presented as percentages, whereas continuous variables are presented as median and interquartile. Our main outcome was the presence of *H. pylori* in pediatric children with gastroenteritis. Unadjusted associations between multiple independent factors and the presence of *H. pylori*. The results are presented by odds ratios (ORs) with 95% CIs. Variables with $P < 0.20$ in the univariate analysis were introduced in the multivariate model. Logistic regression was used to estimate a factor's adjusted OR of the outcome. $P < 0.05$ was considered to be statistically significant.

Results

Socio-demographic characteristics of population

A total of 246 children undergoing upper endoscopy with biopsy for a variety of gastrointestinal symptoms were included, with a mean age of 8.4 ± 2.6 years (minimum = 2 and maximum = 16 years). The majority of participants were aged 5-10 years, accounting for 67.1% of participants, followed by those aged ≥11 years (20.7%). A proportion of 12.2% of children were aged under 5 years. A total of 52.8% of patients were male, and the sex ratio male/female was 1.1. The majority of children (83.7%) lived in rural areas.

Clinical features, results of esophagogastroduodenoscopy, and prevalence of H. pylori infection

All participants had abdominal pain. Vomiting and nausea were two other common clinical symptoms in children with gastroduodenal inflammation, accounting for 45.1% and 30.1%, respectively. No child had symptoms of gastrointestinal bleeding and melena. A total of 81.3% (200 of 246) children tested positive for *H. pylori*.

Children negative for *H. pylori* had a higher proportion of nausea than children who tested positive for *H. pylori* (45.6% vs 26.5%, $P < 0.01$) (Table 1).

The antrum and body of the stomach were the two most common anatomic sites with lesions detected through upper gastrointestinal endoscopy, accounting for 99.2% and 77.6%, respectively. The pylorus and duodenum were the two least common injury locations, with a prevalence of 0.8% and 0.4%, respectively (Table 2). Children infected with *H. pylori* had a higher rate of lesions in the duodenal bulb than children without *H. pylori* infection (40.0% vs 23.9%, $P = 0.04$) (Table 2).

The endoscopy of the upper digestive tract showed that most ill children (98.8%) had signs of congestive erosive lesions. Nodular lesions

Table 1
Clinical feature of included patients.

Clinical presentation	*Helicobacter pylori*–negative		*H. pylori*–positive		Total		*P*-value
	n	%	n	%	n	%	
Abdominal pain	46	100	200	100	246	100	1.0
Abdominal bloating	1	2.2	5	2.5	6	2.4	0.90
Nausea	21	45.6	53	26.5	74	30.1	0.01
Vomiting	23	50.0	88	44.0	111	45.1	0.46
Anorexia	1	2.2	4	2.0	5	2.0	1.0
Diarrhea	2	4.4	5	2.5	7	2.9	0.62
Constipation	1	2.2	6	3.0	7	2.8	1.0
Melena	0	0	0	0	0	0	-

Table 2
Results of esophagogastroduodenoscopy.

Endoscopic findings	*Helicobacter pylori*–negative		*H. pylori*–positive		Total		*P*-value
	n	%	n	%	n	%	
Locations of lesion							
Esophagus	6	13.0	19	9.5	25	10.2	0.43
Gastric corpus	27	58.7	146	73.4	173	70.6	0.07
Gastric antrum	45	97.8	199	99.5	244	99.2	0.34
Pylorus	0	0	2	1.0	2	0.8	1.0
Duodenal bulb	11	23.9	80	40.0	91	37.0	0.04
Duodenum	0	0	1	0.5	1	0.4	1.0
Type of lesion							
Nodules	14	30.3	137	68.5	151	61.4	<0.0001
Flat erosion	1	2.2	7	3.5	8	3.2	1.0
Congestion	45	97.8	198	99.0	243	98.8	0.46
Ulcer	0	0	1	0.5	1	0.4	1.0
Pseudomembrane	1	2.2	14	7.0	15	6.1	0.32
Bleeding	1	2.2	0	0	1	0.4	0.19
Histologic findings							
Chronic inflammation							
Mild	37	80.4	104	52.0	141	57.3	0.001
Moderate	9	19.6	95	47.5	104	42.3	
Severe	0	0	1	0.5	1	0.4	
Polymorph nuclear cell activity							
Absent	31	67.4	93	46.5	124	50.4	0.01
Present	15	32.6	107	53.5	122	49.6	

accounted for 61.4% of cases. Children infected with *H. pylori* had a higher rate of nodular lesions than children without *H. pylori* infection (68.5% vs 30.3%, P <0.0001) (Table 2).

According to the Updated Sydney Classification [16], the histologic analysis showed that children who tested positive for *H. pylori* had higher rate of moderate and severe chronic inflammation than those who tested negative. The proportions were 47.5% vs 19.6% and 0.5% vs 0%, respectively. In addition, the presence of polymorph nuclear cell activity was higher in patients who tested positive for *H. pylori* than those who tested negative (53.5% vs 32.6%).

Risk factors for H. pylori infection in children with gastrointestinal symptoms

The Supplementary Tables S1-S4 and Table 3 show the results of univariate and multivariate analysis of risk factor for *H. pylori* infection.

Compared with children under 5 years, children aged 11 years and older were four times more likely to be infected with *H. pylori*, with OR 3.50, 95% CI 1.07-11.39, P = 0.04. Children aged 5-10 years also had a higher tendency to be infected with *H. pylori* than children under 5 years, with OR 2.36, 95% CI 0.96-5.76, P = 0.06. Washing hands with soap reduced the risk of *H. pylori* infection by three times, with OR 0.35, 95% CI 0.17-0.69, P = 0.002. Children living in a family where members had a history of *H. pylori* infection were nine times more likely to be infected with *H. pylori*, with OR 8.87, 95% CI 1.15-68.45, P = 0.04 (Table 3).

Table 3
Risk factors for *Helicobacter pylori* infection among children with gastroenteritis symptoms: multivariate analysis.

Risk factor	Adjusted odds ratio (95% confidence interval)	*P*-value
Age		
≤5 years	Reference	
5-10 years	2.36 (0.96-5.76)	0.06
≥11 years	3.50 (1.07-11.39)	0.04
Number of children in the family		
≤2	2.23 (0.81-6.15)	0.12
≥3		
Washing hands with soap or alcohol before eating and after using the restroom		
No	0.35 (0.17-0.69)	0.002
Yes		
Family member with a history of *H. pylori* infection		
No	8.87 (1.15-68.45)	0.04
Yes		

Discussion

Our results showed a high proportion of *H. pylori* infection in children with gastrointestinal symptoms. This is a warning signal about the widespread presence of this bacterium in the child population, especially in areas with poor hygiene and high exposure to infection sources.

Gastroenteritis in children not only causes uncomfortable symptoms but can also impact their overall growth and health. If not diagnosed and treated promptly, *H. pylori* can lead to serious complications such as stomach ulcers and even stomach cancer in adulthood. Therefore, addressing this issue early in life is crucial to prevent potential health problems and enhance the quality of life for children [17].

In areas with high infection rates, implementing preventive measures and screening programs for children can help reduce the spread of this bacterium. Moreover, raising awareness about personal hygiene and health care among children and their caregivers can play a significant role in reducing infection risk and strengthening the immune system against *H. pylori* [18].

Analyzing the influence of age on the risk for *H. pylori* infection in children is a key part of our research. Our study showed that children aged 11 years and older have a higher risk of *H. pylori* infection than those aged under 5 years—a noteworthy and alarming statistic. Although not statistically significant, children aged 5-10 years also tended to have a higher infection rate than younger ones.

The increased risk of *H. pylori* infection with age may reflect several factors. Older children often have more exposure to infection sources, including contact with adults in the family or friends. In addition, dietary habits and lifestyles may change with age, affecting the digestive system and the body's ability to resist to this bacterium [10,11,19–22].

Our findings underscore the importance of applying age-appropriate preventive and intervention measures for children. Educational strategies and advice on personal hygiene and eating habits should be tailored to different age groups, ensuring that children's living and daily environments are clean and safe. This also suggests the need for further research to better understand the relationship between age and *H. pylori* infection risk, providing a basis for developing more effective intervention strategies.

The positive impact of handwashing with soap in reducing the risk of *H. pylori* infection is a highlight of our research. Our results showed that this simple habit can significantly reduce the risk of *H. pylori* infection. This is a significant finding because it indicates that basic preventive measures can have a substantial positive impact on improving community health. Handwashing with soap is not only a basic hygiene practice but also a simple and effective method to eliminate bacteria and prevent the spread of infectious diseases. By removing bacteria from the skin surface, regular handwashing can reduce the risk of infection not only for oneself but also for others in the community [11,18].

Emphasizing the role of handwashing with soap in reducing the risk of *H. pylori* infection contributes to the creation of exemplary and easily applicable preventive strategies in the community. By enhancing education and developing personal hygiene programs, we can raise awareness and encourage community action in maintaining health and preventing diseases. However, ensuring the effectiveness of handwashing with soap requires proper and consistent implementation. Therefore, regular education and reminders are needed to promote this habit.

Our study also showed a strong link between living in a household with a person previously infected with *H. pylori* and the risk of *H. pylori* infection in children. This is an important finding regarding the role of environmental factors and exposure in the transmission of *H. pylori* within the community. This result highlights the importance of the relationship between exposure to individuals infected with *H. pylori* and the risk of infection within the family. Families are often the primary environment for children's exposure, where they interact with other members and share living spaces and daily items [11,23,24]. Therefore, having a family member previously infected with *H. pylori* can create favorable conditions for the bacterium to spread in the living environment.

In addition, the relationship between living in a household with a previously infected person and the risk of infection in children may reflect genetic susceptibility to the bacterium and exposure opportunities through shared behaviors and habits within the family [11,23,24]. Family members may share eating habits, living environments, and personal hygiene practices, creating a setting that increases the risk of *H. pylori* infection for children [25].

From this result, we can see that diagnosing and treating *H. pylori* is not only an individual issue but also a community concern. There should be educational and counseling programs not only for infected individuals but also for their families and the community. Education about personal hygiene, healthy eating habits, and preventive measures within the family can help reduce the risk of transmission and protect public health.

Our study has some limitations. Because this is a single-center study conducted on a modest number of patients, our results may not be representative of all pediatric patients in Vietnam. However, to the best of our knowledge, this is one of the largest studies in which pediatric patients underwent esophagogastroduodenoscopy and were diagnosed with *H. pylori* infection using the rapid urease test in the country, whereas previous studies diagnosed *H. pylori* using monoclonal enzyme-immunoassay stool antigen test [8,19,26]. Moreover, due to economic constraints, we did not perform *H. pylori* bacterial culture to determine antibiotic resistance. Finally, all patients in this study were treated with proton pump inhibitors and *H. pylori* eradication regimens by antibiotics when having an indication for peptic ulcer, refractory iron deficiency anemia, or family history of one parent having stomach cancer; however, we did not include a long-term follow-up of patients to evaluate the treatment outcomes.

Conclusion

Our study has shown that a large proportion of children with gastrointestinal symptoms are infected with *H. pylori*. Our results also indicate several risk factors on which to base a targeted prevention strategy and emphasize the role of handwashing with soap before eating and after using the toilet in reducing the risk of *H. pylori* infection in children.

Declaration of competing interest

The authors have no competing interests to declare.

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Ethics statement

The protocol was approved by the Thai Binh University of Medicine and Pharmacy (January 2, 2024; reference No. 09). The study was performed according to the good clinical practices recommended by the Declaration of Helsinki and its amendments. All guardians of the participants provided their verbal informed consent.

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Author contributions

Conceptualization: PG, TLD, VTH. Data curation: CANL, KLD, DMB, KDL, KLD, TKN. Formal analysis: CANL, KLD, KDL, PG, VTH, TLD. Investigation: CANL, KLD, TLD. Methodology: CANL, KLD, PG, TLD, VTH. Software: TLD, VTH. Validation: CANL, KLD, DMB, KDL, KLD, TKN, PG, TLD, VTH. Visualization: TLD, VTH. Writing - original draft: CANL, KLD, TLD. Writing - review & editing: CANL, KLD, DMB, KDL, KLD, TKN, PG, TLD, VTH.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author (TLD) upon reasonable request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijregi.2024.100426.

References

[1] Quach DT, Mai BH, Tran MK, Dao LV, Tran HV, Vu KT, et al. Vietnam Association of gastroenterology (VNAGE) consensus on the management of Helicobacter pylori infection. *Front Med (Lausanne)* 2022;**9**:1065045. doi:10.3389/fmed.2022.1065045.

[2] Salih BA. Helicobacter pylori infection in developing countries: the burden for how long? *Saudi J Gastroenterol* 2009;**15**:201–7. doi:10.4103/1319-3767.54743.

[3] Yuan C, Adeloye D, Luk TT, Huang L, He Y, Xu Y, et al. The global prevalence of and factors associated with Helicobacter pylori infection in children: a systematic review and meta-analysis. *Lancet Child Adolesc Health* 2022;**6**:185–94. doi:10.1016/S2352-4642(21)00400-4.

[4] Nguyen J, Kotilea K, Bontems P, Miendje Deyi VY. Helicobacter pylori infections in children. *Antibiotics (Basel)* 2023;**12**:1440. doi:10.3390/antibiotics12091440.

[5] Sun Q, Yuan C, Zhou S, Lu J, Zeng M, Cai X, et al. Helicobacter pylori infection: a dynamic process from diagnosis to treatment. *Front Cell Infect Microbiol* 2023;**13**:1257817. doi:10.3389/fcimb.2023.1257817.

[6] Reyes VE. Helicobacter pylori and its role in gastric cancer. *Microorganisms* 2023;**11**:1312. doi:10.3390/microorganisms11051312.

[7] Nguyen TVH, Bengtsson C, Yin L, Nguyen GK, Hoang TTH, Phung DC, et al. Eradication of Helicobacter pylori in children in Vietnam in relation to antibiotic resistance. *Helicobacter* 2012;**17**:319–25. doi:10.1111/j.1523-5378.2012.00950.x.

[8] Che TH, Nguyen TC, Ngo DTT, Nguyen HT, Vo KT, Ngo XM, et al. High prevalence of Helicobacter pylori infection among school-aged children in Ho Chi Minh City, Vietnam. *Int J Public Health* 2022;**67**:1605354. doi:10.3389/ijph.2022.1605354.

[9] Nguyen VB, Nguyen GK, Phung DC, Okrainec K, Raymond J, Dupond C, et al. Intra-familial transmission of Helicobacter pylori infection in children of households with multiple generations in Vietnam. *Eur J Epidemiol* 2006;**21**:459–63. doi:10.1007/s10654-006-9016-y.

[10] Nguyen TVH, Bengtsson C, Nguyen GK, Yin L, Hoang TTH, Phung DC, et al. Age as risk factor for Helicobacter pylori recurrence in children in Vietnam. *Helicobacter* 2012;**17**:452–7. doi:10.1111/j.1523-5378.2012.00968.x.

[11] Che TH, Nguyen TC, Vu VNT, Nguyen HT, Hoang DTP, Ngo XM, et al. Factors associated with Helicobacter pylori infection among school-aged children from a high prevalence area in Vietnam. *Int J Public Health* 2023;**68**:1605908. doi:10.3389/ijph.2023.1605908.

[12] City population. Thái Bình Province in Vietnam, https://www.citypopulation.de/en/vietnam/prov/admin/; 2020 [accessed 09 August 2020].

[13] Pham TD, Hoang VT, Dao TL, Tran XD, Phi DL, To MM, et al. Morbidity and mortality patterns in children admitted to hospital in Thai Binh, Vietnam: a five-year descriptive study with a focus on infectious diseases. *J Epidemiol Glob Health* 2021;**11**:69–75. doi:10.2991/jegh.k.200723.001.

[14] Nguyen TC, Tang NLC, Le GKN, Nguyen VT, Nguyen KHG, Che TH, et al. Helicobacter pylori infection and peptic ulcer disease in symptomatic children in Southern Vietnam: A prospective multicenter study. *Healthcare (Basel)* 2023;**11**:1658. doi:10.3390/healthcare11111658.

[15] Delvaux M, Crespi M, Armengol-Miro JR, Hagenmüller F, Teuffel W, Spencer KB, et al. Minimal standard terminology for digestive endoscopy: results of prospective testing and validation in the gaster project. *Endoscopy* 2000;**32**:345–55. doi:10.1055/s-2000-7384.

[16] Dixon MF, Genta RM, Yardley JH, Correa P. Classification and grading of gastritis. The updated Sydney System. International Workshop on the Histopathology of Gastritis, Houston 1994. *Am J Surg Pathol* 1996;**20**:1161–81. doi:10.1097/00000478-199610000-00001.

[17] Pacifico L, Anania C, Osborn JF, Ferraro F, Chiesa C. Consequences of Helicobacter pylori infection in children. *World J Gastroenterol* 2010;**16**:5181–94. doi:10.3748/wjg.v16.i41.5181.

[18] Thorat JV, Tambolkar S, Chitale MM, Biradar V, Jadhav RS. Association of Helicobacter pylori in children with self-hand hygiene, maternal hand hygiene, cooking, and feeding practices. *Cureus* 2024;**16**:e56554. doi:10.7759/cureus.56554.

[19] Nguyen BV, Nguyen KG, Phung CD, Kremp O, Kalach N, Dupont C, et al. Prevalence of and factors associated with Helicobacter pylori infection in children in the north of Vietnam. *Am J Trop Med Hyg* 2006;**74**:536–9. doi:10.4269/ajtmh.2006.74.536.

[20] Aitila P, Mutyaba M, Okeny S, Ndawula Kasule M, Kasule R, Ssedyabane F, et al. Prevalence and risk factors of Helicobacter pylori infection among children aged 1 to 15 years at holy innocents Children's Hospital, Mbarara, south Western Uganda. *J Trop Med* 2019;**2019**:9303072. doi:10.1155/2019/9303072.

[21] Emerenini FC, Nwolisa EC, Iregbu FU, Eke CB, Ikefuna AN. Prevalence and risk factors for Helicobacter pylori infection among children in Owerri. *Nigeria. Niger J Clin Pract* 2021;**24**:1188–93. doi:10.4103/njcp.njcp_687_20.

[22] Moreira ED, Santos RS, Nassri VB, Reis AT, Guerra AL, Alcântara APG, et al. Risk factors for Helicobacter pylori infection in children: is education a main determinant? *Epidemiol Infect* 2004;**132**:327–35. doi:10.1017/s0950268803001572.

[23] Palanduz A, Erdem L, Cetin BD, Ozcan NG. Helicobacter pylori infection in family members of patients with gastroduodenal symptoms. A cross-sectional analytical study. *Sao Paulo Med J* 2018;**136**:222–7. doi:10.1590/1516-3180.2017.0071311217.

[24] Yucel O. Prevention of Helicobacter pylori infection in childhood. *World J Gastroenterol* 2014;**20**:10348–54. doi:10.3748/wjg.v20.i30.10348.

[25] Ding S-Z, Du Y-Q, Lu H, Wang W-H, Cheng H, Chen S-Y, et al. Chinese consensus report on family-based Helicobacter pylori infection control and management (2021 Edition). *Gut* 2022;**71**:238–53. doi:10.1136/gutjnl-2021-325630.

[26] Nguyen TC, Robert A, Pham THA, Vo KH, Le LD, Ma HT, et al. Helicobacter pylori eradication rate using stool antigen test in Vietnamese children: a prospective multicenter study. *JPGN Rep* 2023;**4**:e374. doi:10.1097/PG9.0000000000000374.