Microb Health Dis 2025; 7: e1436

Microbiota in Health and Disease
A Journal of the European Helicobacter & Microbiota Study Group

EPIDEMIOLOGY OF *HELICOBACTER PYLORI*

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Abstract – *H. pylori* is associated with the majority of gastric cancer cases globally and is responsible for a large burden of morbidity and mortality from chronic gastritis and peptic ulcer disease. Despite a recent trend in reducing prevalence, it continues to pose a major threat to human health worldwide. With a full understanding of the current prevalence, risk factors, characteristics of the infection, and at-risk populations, we can better target screening and diagnostic strategies to maximize eradication and improve clinical outcomes. In the last year, studies on the prevalence of *H. pylori* infection in different regions have shown that rates are decreasing in many parts of Asia, particularly in urban China, but remain high, ranging from 40% to 80%, across the African continent. Despite differences in these factors by geography, risk factors such as socioeconomic status, hygiene, and diet remain evident and play a crucial role in reducing transmission and reinfection. The prevalence of antimicrobial resistance, particularly multidrug-resistant bacteria, and genetic mutations associated with virulence now approaches a plurality of infections, underlining the importance of ongoing strong local evidence to support eradication therapies and antimicrobial stewardship.

Keywords: Epidemiology, Prevalence, Resistance.

INTRODUCTION

Helicobacter pylori is the first formally recognized bacterial carcinogen, accounting for the majority of gastric cancers worldwide and a cause of significant non-malignant morbidity, including chronic gastritis and peptic ulcer disease. It is considered one of the most successful human pathogens, estimated to affect 50% of the global population[1-3].

With a full understanding of the current prevalence, risk factors, characteristics of the infection, and at-risk populations, we can better target screening and diagnostic strategies to maximize eradication and improve clinical outcomes. In this review, we present the most recent data on the epidemiology of this pathogen, concerning prevalence, and factors associated with higher rates of infection, reinfection, bacterial virulence factors, and clinical antimicrobial resistance.

METHODS

A search was conducted on Medline and PubMed Central using the following search terms: ((*Helicobacter pylori*[Title]) OR (*H. pylori*[Title])) AND ((Prevalence) OR (Recurrence) OR (Reinfection) OR (Epidemiology) OR(Transmission) OR (Family) OR (Outbreak) OR (Cluster)).

419 studies were returned and screened, with 350 excluded after review. A total of 69 studies were included.

PREVALENCE

A systematic review and meta-analysis assessing gastric cancer worldwide examined the global prevalence of *H. pylori*, based on data from the Global Burden of Disease Study and Cancer Incidence, and found a significant decrease in the prevalence of the bacterium[4]. The global prevalence of *H. pylori* in adults has reduced from 52.6% before 1990 to 43.9% in the 2015-2022 period. This study estimated that the global prevalence of *H. pylori* has declined by 15.9% over the last 3 decades in adults, but significantly less in children, where prevalence rates remain as high as 35.1%[4].

ASIA

Multiple cross-sectional studies have assessed the prevalence of *H. pylori* infection in the general population this year (Table 1). In China, while overall prevalence is falling as evidenced by a review that showed a reduction from 63.3% in 1983-1999 to 38.7% from 2015-2019, significant inter-provincial variability is noted with prevalences ranging from 24.3-69.3%[5]. Other studies have endorsed this finding. In the Lianyungang, Guangdong, and Hunan areas, prevalence rates of 25.3%, 25.2% and 25.8% were recorded[6-8]. By contrast, in data from the Gansu and Quanzhou regions, the *H. pylori* prevalence was higher at 38.1% and 52.6%, respectively[9,10]. This disparity between regions within China can be further seen in another review article, including data from 2014 to 2023 and including 152 studies and 763,827 individuals[11]. This study estimated that the prevalence had declined over the previous decade to 42.8%, with the highest rate still observed in Qinghai Province at 60.2%[11]. Other studies have looked at a more heterogeneous group of Chinese subjects. A retrospective study from 5 Chinese military hospitals, including 22,421 active-service members across multiple provinces, demonstrated an overall prevalence of 33.1%[12]. As with all studies of military populations, the age, gender, and overall level of fitness of subjects are major confounding factors. Another large cross-sectional study of 12,902 mainly civilian participants aged 18-60 years across 52 cities in 26 provinces suggested a pooled urban prevalence of 27.1%[13].

Between 2007 and 2017, a school-based screening program in Japan evaluated students aged 16 to 17. Out of 5,178 students screened, only 3.6% tested positive. Over time, the annual positivity rate showed a downward trend, decreasing from 4.7% in the earlier years to 2.8% in the later years of the study. A seroprevalence study of 259 individuals in the Kurdistan region of Iraq revealed that 40.02% were infected[15]. While another study showed that in Palestine, 41.7% were positive[16].

AFRICA

A range of studies from Africa were also reported this year. In North Africa, a population of pediatric patients with dyspepsia in Morocco revealed a prevalence of 80.3%[17]. In an adult population of healthcare workers in Egypt, a cross-sectional study of 200 subjects demonstrated a prevalence of 58.5%[18].

In East Africa, slightly lower prevalences are noted. A meta-analysis of 70 articles from across the region revealed a pooled prevalence of 50.98%, ranging from Sudan in the Northern part of the region at 61.3% to Uganda, further south, at 40.7%[19]. In patients presenting with gastrointestinal complaints, 43-44% of Tanzanian patients tested positive[20,21]. Similarly, in Ethiopia, 39.7% were infected[22].

In the Southern part of the continent in Zambia, a cross-sectional analysis revealed an overall *H. pylori* seroprevalence of 79%. Pediatric infection remains a significant problem here, with more than 75% of the children infected by age 10, confirming the persistence of the fact that most infections occur at a young age[23]. Elsewhere, in the Democratic Republic of Congo, 36.8% of symptomatic pediatric patients were infected[24].

EUROPE

Data from the Salzburg Colon Cancer Prevention Initiative (Sakkopi) cohort, consisting of 5,313 asymptomatic Austrian patients, showed an overall prevalence rate of approximately 18.5%.

TABLE 1. RECENT STUDIES OUTLINING *H. PYLORI* PREVALENCE.

Author	Region	Participants	Period	Test	N	Prevalence
Yang et al[6]	Lianyungang,China	Healthy volunteers	N/A	Stool antigen	221	25.1%
Xian et al[7]	Guangdong, China	Healthy volunteers	2023	String Test/PCR	1,764	25.2%
He et al[8]	Hunan, China	Healthy volunteers	2015-20	Urea Breath Test	23,254	25.8%
Xie et al[9]	Quanzhou, China	Healthy volunteers	2024	String Test/PCR	557	52.6%
Zhou et al[10]	Lanzhou, China	Healthy families	2021-23	Urea Breath Test	519	47%
Xie al[11]	China		2014-23	Multiple	763,827	42.8%
Min et al[12]	China	Military personnel	2020-21	Urea Breath Test	22,421	33.1%
Wang et al[13]	China	Healthy volunteers	2023	String Test/PCR	12,902	27.1%
Okamura et al[14]	Japan	Schoolchildren	2007-17	Urea Breath Test	5,178	3.6%
Naqid et al[15]	Duhok, Iraq	Hospital patients	2018-20	Serology	259	40%
Abdoh et al[16]	Palestine	Symptomatic adults	2016-17	Biopsy	91	41.7%
Kheir et al[17]	Morocco	Symptomatic children	2022-23	Biopsy	132	80.3%
Abdelrahman et al[18]	Aswan, Egypt	Healthcare workers	2021	Serology	200	58.5%
Muhina et al[20]	Casablanca, Tanzania	Symptomatic adults	2022-23	Stool Antigen	380	43.4%
Kibira et al[21]	Dar es Salem, Tanzania	Symptomatic adults	2023	Stool Antigen	393	43.8%
Abadi et al[22]	Tigray, Ethiopia	Hospital patients	2020	Stool Antigen	463	39.7%
Kayamba et al[23]	Zambia	Archival plasma, healthy volunteers	2016	Serology	4,050	79%
Tibasima et al[24]	Goma City, DR Congo	Symptomatic children	2020-22	Stool Antigen	323	36.8%
Klesiewicz et al[25]	Southern Poland	Symptomatic adults	2016-19	Biopsy	130	30.8%
Homan et al[26]	Slovenia	Children & adolescents	2019-22	Stool Antigen	421	10.9%
Prodan et al[27]	Romania	Rural adults	2023	Stool Antigen	708	28.2%
Tallman et al[28]	Peru	Awajun indigenous adults	2013	Serology	212	99.1%
Ducrocq et al[29]	Quebec, Canada	Nunavik Innuits	2017	Stool & Serology	1,299	72.5%
Requena et al[30]	Peru	Symptomatic adults	N/A	Endoscopy	343	63.8%
Kotilea et al[32]	Europe & Middle East	Children with GI diseases	2019-21	Endoscopy	3,890	9%
Ismael et al[32]	Egypt	Children with cerebral Palsy	N/A	Stool Antigen	100	45%

While the prevalence in Southern Poland was 30.8%[25]. A multicenter prospective cross-sectional study among 421 healthy Slovenian children and adolescents showed an infection rate of 10.9%. Interestingly, in this cohort, no socioeconomic factors were found to be associated with *H. pylori* infection; the only differences were regional[26]. Across 10 villages across Southern Romania, with poor access to healthcare, 28.2% tested positive; however, due to the rural nature of participants, the prevalence in the Romanian population as a whole is thought to be lower[27].

OTHER POPULATIONS

A study of 212 Indigenous Awajún people in the northern Peruvian Amazon demonstrated near ubiquitous seropositivity for *H. pylori* exposure (99.1%)[28]. While seroprevalence was estimated at 72.5% in Nunavik's Inuit population[29]. A second study from Peru assessed altitude and diet on HP disease. This study showed that *H. pylori* infection was commonly found in participants living at high altitudes (86.9%) compared to those at sea level (49.8%)[30].

Special Patient Populations

A systematic review was performed to assess the prevalence of HP with obesity. 472,511 individuals from 208 studies were included. Despite a wide disparity in study design, the global estimation of *H. pylori* prevalence among individuals with obesity was 32.3%, varying by region. Resource-rich, low-/middle-income, developing, and Islamic countries had the highest prevalence, similar to the global prevalence of *H. pylori* in the general population[31].

A retrospective study across 14 countries assessed pediatric patients diagnosed with celiac disease, IBD, and eosinophilic esophagitis. Unfortunately, this study did not compare the group with healthy controls; however, it showed that *H. pylori* prevalence did not differ significantly among diseases (average 9%) but did differ between Europe (4%-5.5%) and the Middle East (26.6%-32%)[32]. In Egypt, a cross-sectional study was performed in pediatric cerebral palsy patients and showed that 45% were positive for *H. pylori*. Associated risk factors identified were similar to the general population in terms of socioeconomic factors, but also with functional status[33].

Parasitic Coinfection

A meta-analysis of studies from Africa reveals a significant prevalence of intestinal parasites and *H. pylori* co-infection in Africans with gastrointestinal symptoms, at 31.03%, with variation between countries (Range, Egypt 39.84% to Ethiopia 5.86%)[34]. Similarly, a study involving hospitalized Lebanese children with gastrointestinal symptoms showed that 6.4% of the patients were infected with intestinal parasitic infections, 5.4% with *H. pylori* infection, and 11.8% were co-infected[35]. A third study of HIV positive patients in Ethiopia showed the prevalence of *H. pylori*, intestinal parasites, and intestinal protozoal infection among HIV positive individuals were 27.6%, 24.4% and 6.5% respectively. The overall prevalence of both intestinal parasites and intestinal protozoal co-infection with H. *pylori* was 20.7%[36]. Although *H. pylori* was significantly associated with parasitic infections in these studies, no specific parasite species was linked. Therefore, while improving hygiene and sanitation is crucial to interrupt the transmission of both *H. pylori* and parasites, opportunistic screening and treatment for *H. pylori* may be advisable when managing parasitic infections in endemic regions.

FACTORS IMPACTING PREVALENCE

The above studies are near ubiquitous in identifying geography, age, and male gender as risk factors for developing *H. pylori* infection[6,7,10,13,15,21,23,28,29,37]. Similarly, education level and occupation[8,13,15,19,22-24,35,36,38,39], access to clean water[19,21,23,24,29,35,36], overcrowding/large family size[10,15,29,35,39], washing food before eating[9,35], and keeping animals at home[24,36] were also associated with infection. Lifestyle choices such as smoking[13,15,22], tea and coffee[8,13], and obesity are also positively correlated. Smoking is a well-established risk factor, but second-hand exposure carries a similar risk to smoking[40]. In Quanzhou, eating takeaway foods was a protective factor against infection, although this may relate to economic status associated with disposable income, or urban living, rather than being a true protective factor, as most infections occur in early childhood, as explained before[9]. Sleep and exercise were not found to be factors associated with *H. pylori* infection[8]. Two studies published conflicting data regarding the incidence of *H. pylori* and HIV coinfection[22,23]. Overall, it can be summarized that these recent studies confirm that factors pertaining to infancy are generally those most influential on infection, rather than adult habits.

A study of US adults aged 20 years and older who had undergone dietary surveys and *H. pylori* testing, suggested that increased solid fats and cheese were protective factors against HP infection, while refined grains and added sugars were risk factors[41]. The same group also published data suggesting an inverse correlation between dietary riboflavin and *H. pylori* infection[42]. The strength of these data is limited by the lack of information on dietary patterns at the time of infection during childhood. However, factors such as regional differences and seasonal dietary habits may warrant further investigation.

H. pylori in the Oral Cavity

While methods of transmission of *H. pylori* remain poorly described, recently, the oral cavity, as a potential route of human-human transmission, and its potential role as a bacterial reservoir implicated in cases of reinfection, has become a topic of interest once more.

362 Chinese patients with dyspepsia who underwent UBT for gastric assessment, *H. pylori* antigen test of the mouth, and dental assessment showed that 72.1% were oral *H. pylori*-infected, and 60.77% were gastric *H. pylori*-infected. While concordance between these test results was not reported upon, dental hygiene scores demonstrated a direct, statistically significant connection between oral *H. pylori* positivity[43]. A review of this topic concluded that despite heterogeneous study designs, geographic locations, oral sampling locations, and diagnostic methods, there is no general consensus that oral HP does correlate with gastric infection. Further high-quality evidence is required to confirm this observation[44].

In a US study assessing 119 tonsillectomy samples from an adult population, *H. pylori* was identified in 72.1% of the patients[45]. A similar survey from Czechia, of patient who underwent tonsillar tumour or stone removal, showed that *H. pylori* was identified in 68.3% of samples. Saliva samples from a healthy control group revealed a prevalence of only 17.5%[46]. In low-prevalence countries, the high incidence of *H. pylori* in patients undergoing tonsillar surgery suggests that *H. pylori* may be a contributing factor for tonsillar pathology. A study on the decayed milk teeth of 170 children extracted from 54 children in Germany. *H. pylori* DNA was detected in both plaque and root canal samples by PCR; live bacteria could only be cultivated from 28 root canals, none from plaque. Therefore, 16.5% of the teeth were positive for live *H. pylori*[47].

HOUSEHOLDS

An assessment of 173 families (519 individuals) in Gansu Province, China, showed that in 51.4% of families, at least one member was infected, in 13.3%, all members were infected, while only 32.3% of families had no infections. A larger living area was found to be an independent protective factor for *H. pylori* infection in households[10]. Another family-based study in Jiangxi, China, again showed a noticeable clustering effect within family groups. All family members were infected in 9.34% of households. Infected parents were a significant risk factor for infected children, suggesting vertical transmission remains a problem in China[39].

A simulation model incorporating data on *H. pylori* infection and gastric cancer, based on family samples from 29 provinces in China, demonstrated that family-based *H. pylori* screening is both cost-effective per patient treated and leads to a higher overall eradication rate. These findings suggest that such a model could be valuable as regions transition to a screen-and-treat strategy[48].

VIRULENCE FACTORS

Bacterial virulence factors such as cagA and vacA, in isolation and combination, have been implicated in increased gastric inflammation, more aggressive disease phenotypes, and increased rates of progression to gastric cancer. Similar to both *H. pylori* prevalence and resistance patterns, these genetic virulence genes vary in prevalence around the world.

In the US, the prevalence of cagA strains was compared across different ethnic groups. Evidence of *cagA* was present in 62% of all patients and was more frequently found in patients with intestinal metaplasia (77% *vs.* 56%). In the US, Black patients were 2 times more likely to be cagA positive than White patients (82% *vs.* 36%)[49]. In Southern Poland, 60% of infections involved cagA-positive strains[25].

In Shandong, 87.36% of the strains carried cagA, however, no significant differences were observed among the different clinical outcomes[50]. A meta-analysis of 24 studies from eight Indo-Pacific countries (Bhutan, India, Indonesia, Malaysia, Myanmar, Singapore, Thailand, Vietnam) was included. Overall, pooled prevalence of cagA positivity in *H. pylori*-infected patients was 83% (Range: Bhutan 100% – India 60%)[51].

Data from North Brazil showed cagA and the vacA-s1m1 allelic combination were seen in 84% and 77% of isolates, respectively; however, there was no correlation with endoscopic findings[52]. Conversely, in Assam, India, the prevalence of cagA and vacA-s1m1 was 88.5%, and was associated with intestinal metaplasia and high bacterial density scores[53]. Similarly, in Vietnam, cagA and vacA were detected in 77.6% and 100% of cases, respectively. Notably, cagA with vacA s1m1 was present in 44.9%. Statistically significant associations were found between virulent combinations and gastric cancer[54]. In Egypt, 60.0 % of the isolates were positive for the cagA gene, and 80.0% had the vacA-s1 type. A significant association was found between metronidazole resistance and the presence of both genotypes[55].

RESISTANCE PATTERNS

Although differences exist in assessing the prevalence of resistance strains of *H. pylori*, particularly due to patient selection, and tests used, several studies have documented good levels of concordance between genotypic resistance and phenotypic resistance[56,57].

Analysis of a curated global genome dataset of 4,067 *H. pylori* isolates from 76 countries found that the prevalence of genotypic resistance to amoxicillin and metronidazole was >15% across all five continents, resistance to levofloxacin was >15% on all continents except for Oceania, and resistance to clarithromycin was >15% in Asia, Europe, and Oceania, with a trend towards increased resistance over time[58]. A meta-analysis of 63 studies involving 15,953 individuals was included, comprising data from 28 countries across five WHO regions. The primary pooled resistance rates were: metronidazole 35.3%, clarithromycin 32.6%, tetracycline 2.1%, levofloxacin 13.2%, and amoxicillin 4.8%. Rising antibiotic resistance was detected in all WHO regions[59].

Throughout China, antibiotic resistance rates are high but vary by region. Resistance to clarithromycin (15.4-49.2%), levofloxacin (10.7%-44.6) and double-resistance to levofloxacin and clarithromycin (14.29-40%) are common[6,7,9,56,60,61]. Rates for metronidazole resistance are also high at 45.8%-93.6%, while amoxicillin, furazolidone, and tetracycline remain generally low at 1%-2.3%, 0%-1.4%, and 0%-0.7%, respectively[56,60,61]. Resistance to metronidazole and clarithromycin in particular had increased from 2019 to 2022[61]. A large multicenter cross-sectional study of 1,776 urban Chinese patients showed an average resistance rate of 50.83% for clarithromycin and 47.17% for levofloxacin, with women and residents in the northeast regions showing higher resistance rates[37].

In North India, a study assessed 58 isolates showing high resistance across a wide range of antibiotics: clarithromycin 17.2%, metronidazole 39.6%, levofloxacin 70.7%, cefixime 41.3%, amoxicillin 20.7%, tetracycline 20.7%, and rifabutin 17.2. Out of 58 *H. pylori* strains, only 3 were pan-susceptible. 21.8% strains had single-drug resistance, 30.9% dual resistance, 20% triple resistance, and 27.3% multidrug resistance. Again, resistance rates in females were higher than males[62]. In Palestine, Metronidazole and Clarithromycin demonstrated resistance rates of 100% and 47.4%, while rates were lower for Ciprofloxacin, Levofloxacin, and Amoxicillin, with resistance rates of 0%, 0%, and 18.4%, respectively[16].

By gene analysis, metronidazole, fluoroquinolone, clarithromycin, and tetracycline were found to be 68%, 32.1%, 28.4%, and 11.1%, respectively[63].

Vietnam genotypic resistance to clarithromycin and levofloxacin was evident in 81.3% and 53.6% of the patients, respectively, and dual resistance was observed in 48.2%[64].

In Japanese schoolchildren, the resistance rate of *H. pylori* to clarithromycin was 41.1%[14]. In Morocco, *H. pylori* resistance to metronidazole was high (70.8%)[17].

A systematic review encompassing 297 Latin American children and adolescents across six studies reported the following antibiotic resistance rates: clarithromycin resistance ranged from 8.0% to 26.7%, metronidazole from 1.9% to 40.2%, and amoxicillin from 0% to 10.4%. No resistance to tetracycline was detected, while levofloxacin resistance was observed at 2.8%[65]. A small Colombian study, however, also demonstrated resistance to these common antibiotics, while all assessed strains were susceptible to tetracycline and amoxicillin[66].

In Europe, data from Italy and Poland suggest resistance rates of 14.3%-36.7% for clarithromycin, 23-33% for metronidazole, and 11.4%-22.1% for levofloxacin. Dual clarithromycin-metronidazole resistance in the Italian cohort was 17.4%, and triple resistance in 9%[25,67].

REINFECTION

Rates of *H. pylori* reinfection and recrudescence are generally considered to be low; however, data from many regions of the world on this topic remain scarce. A cross-sectional study was conducted on the prevalence of HP infection in 81,754 people who underwent physical examination across China from March 2010 to December 2019. The 1-year overall recurrence rate was 3.86%, with a statistically significant difference between genders (2.82% in males and 5.44% in females)[68].

A review article comprising 30 articles (encompassing 1,915 participants) was conducted on this topic. The *H. pylori* annual recurrence rate in Asian children was higher than that in Europe (17% *vs.* 6%) and higher in developing countries than in developed countries (18% *vs.* 5%). Overall, *H. pylori* recrudescence and re-infection rates were 6% and 10%, respectively, and their recurrence was inversely correlated with Human Development Index[69]. The relatively high recurrence rates in these pediatric populations raise questions regarding the optimal age to begin population-wide screening, if such programs are to become more widespread in the near future. A high recrudescence rate in children would also raise questions about whether ongoing surveillance is required to ensure persistence of cure, as the transmission factors that make pediatric infection common likely persist throughout childhood.

CONCLUSIONS

Although prevalence rates of *H. pylori* infection have decreased globally over recent years, large disparities between WHO regions, as well as within countries, remain. The factors associated with higher rates of infection remain constant: lower socioeconomic conditions, sanitation, and access to healthcare, and combating these.

Of note, both levels of antibiotic resistance and more virulent bacterial strains continue to pose a major threat to treatment efforts, with multi-drug resistance reaching very high levels, and virulent strains of the bacteria becoming dominant in some communities. However, clinical resistance to tetracyclines remains low in most areas, supporting the choice of tetracycline-containing bismuth quadruple therapy as the first-line therapy of choice.

Conflict of Interest

The authors declare no conflicts of interest.

Authors' Contribution

CC performed the original literature search and data extraction, prepared the draft manuscript and edited the final manuscript. AOC provided additional literature search, supervision and edits and corrections to the final manuscript.

AI Disclosure

No generative AI or AI-assisted technologies were used during the writing or development of this manuscript.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments

Not applicable.

Data Availability

All data supporting the findings of this study are included within the article and/or its supplementary materials.

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