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Research Article

Status of *helicobacter pylori* infection and its impact on peptic ulcer disease in high-altitude in Karnali Province

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ABSTRACT

Background & Objectives: *Helicobacter pylori* infection is a major contributor to acid peptic disease (APD) and peptic ulcer disease (PUD) worldwide. However, its prevalence and clinical impact in high-altitude populations remain underexplored. This study assessed the status of *H. pylori* infection and its association with peptic ulcer disease among dyspeptic patients at Karnali Academy of Health Sciences (KAHS).

Materials and Methods: A cross-sectional observational study was conducted at KAHS in Jumla, Nepal (altitude 2,500–3,500 m) over one year (2078/08/01–2079/08/30 BS). A total of 143 adult patients aged 15–75 years with dyspepsia or suspected APD attending the OPD were enrolled using complete enumeration. Patients with prior APD treatment, proton pump inhibitor use, or severe comorbidities were excluded. *H. pylori* infection was diagnosed by blood titer, stool antigen test, or endoscopic biopsy, while peptic ulcers were clinically suspected and confirmed by endoscopy. Socio-demographic data were collected using a structured questionnaire and analysed with descriptive statistics and Chi-square test.

Results: Among 143 participants, 80 (56%) were males and 63 (44%) females, with a mean age of 45 years (15–75 years). *H. pylori* infection was detected in 124 (86.7%) cases: blood titer 39.9%, stool antigen 32.2%, and biopsy 14.7%; 13.3% tested negative. Age-wise distribution showed significant variation in detection methods (χ^2 = 63.154, p = 0.000). Younger patients (15–30 years) were mainly positive by serology, whereas middle-aged groups showed more diverse diagnostic patterns including stool antigen and biopsy.

Conclusions: There was a high prevalence of *H. pylori* infection among dyspeptic patients in high-altitude regions. Age significantly influences detection methods and possibly disease severity, highlighting the need for context-specific diagnostic strategies and targeted management.

Keywords: Dyspepsia, Endoscopy, Helicobacter pylori, High-altitude, Infection prevalence, Karnali, Peptic ulcer.

INTRODUCTION

Helicobacter pylori (*H. pylori*) is a gram-negative, microaerophilic bacterium that colonizes the gastric mucosa and is a major etiological agent of chronic gastritis, peptic ulcer disease (PUD), gastric mucosa-associated lymphoid tissue (MALT) lymphoma, and gastric carcinoma. Globally, more than 50% of the population is infected, although prevalence varies by geographic region, age, socioeconomic status, and environmental conditions.

In Nepal, *H. pylori* infection remains an important public health concern, particularly in remote and resource-limited regions where access to diagnostic and treatment facilities is limited. The reported prevalence ranges from 40–70% depending on the population group and diagnostic methods. However, limited information is available regarding the burden of infection in high-altitude populations.
High-altitude environments (≥2,500 m) may influence gastric physiology due to chronic hypoxic stress, which can affect gastric mucosal integrity, immune response, and susceptibility to infection. In addition, poor sanitation, lower socioeconomic conditions, and limited healthcare access in mountainous regions may contribute to persistent infection and delayed diagnosis.

Karnali Academy of Health Sciences (KAHS), located in Jumla in the Karnali Province at an altitude of 2,500–3,500 meters, provides a unique setting to study *H. pylori* epidemiology in high-altitude populations. This study aimed to determine the prevalence of *H. pylori* infection among dyspeptic patients attending KAHS outpatient services, assess its association with endoscopically diagnosed peptic ulcer disease, and analyse age-wise detection patterns using different diagnostic modalities.

MATERIALS AND METHODS

Study Design

An observational cross-sectional study was conducted to determine the prevalence of Helicobacter pylori infection and its association with peptic ulcer disease (PUD) at a specific time point. This design is suitable for resource-limited high-altitude settings and provides preliminary epidemiological insights without longitudinal follow-up.

Study Setting

The study was conducted at Karnali Academy of Health Sciences (KAHS), located in Jumla, Nepal, at an altitude of about 2,500 meters above sea level. The high-altitude environment provides an important ecological context where hypoxia and environmental stressors may influence gastric physiology and microbial colonization, including *H. pylori*.

Sample Size and Sampling

A total of 143 patients were enrolled using a complete enumeration sampling technique, including all eligible patients during the study period. Data were collected over one year from 2078/08/01 to 2079/08/30 BS, allowing seasonal variation in symptoms and healthcare-seeking behaviour to be considered.

Inclusion and Exclusion Criteria

Adult patients aged 15–75 years attending the OPD with dyspepsia or abdominal pain suggestive of acid peptic disease (APD) were included. Patients with prior APD treatment, those using proton pump inhibitors (PPI), and patients with severe comorbid conditions were excluded to reduce diagnostic bias and confounding.

Data Collection Methods

Patients with dyspepsia underwent upper gastrointestinal endoscopy for direct visualization and confirmation of peptic ulcers. *H. pylori* detection was performed using blood titer (serology) for antibody detection, stool antigen test for active infection, and endoscopic biopsy for histological confirmation. A structured questionnaire was used to collect socio-demographic information.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Committee of Karnali Academy of Health Sciences (IRC Ref: 079/080/36). Informed consent, confidentiality, and data protection were maintained.

Statistical Methods

Descriptive statistics, including frequencies and percentages, were used to describe patient demographics, prevalence of *H. pylori* by detection method, and peptic ulcer occurrence. The Chi-square (χ^2) test was applied to assess associations between categorical variables, particularly age group and method of *H. pylori* detection, and possibly *H. pylori* status with peptic ulcer presence. A p-value <0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS Statistics 21.

RESULTS

Socio-demographic factors are important in understanding the risk and prevalence of Helicobacter pylori infection and its association with peptic ulcer disease (PUD) in high-altitude settings. Most participants were 31–45 years (41.3%), followed by 46–65 years (33.6%) and 16–30 years (25.2%). This adult distribution is relevant as *H. pylori* infection acquired in childhood often manifests clinically in adulthood. Males constituted 56%, suggesting possible behavioural and occupational influences on infection and PUD risk. Secondary education was reported by 54.5%, while 25.2% had only primary education, which may influence hygiene practices and health-seeking behaviour. Low socioeconomic status (54.5%) and low income (66.4%) were common, factors associated with overcrowding, poor sanitation, and higher *H. pylori* transmission. The majority were Brahman (35.7%) and Chettri (28%), which may reflect differences in dietary habits and healthcare access. Most participants were married (58%), where household transmission may occur. Agriculture was the main occupation (58%), indicating a rural background with possible exposure to contaminated water and limited healthcare access as shown in Table 1.

Table 2 finding detect that Irregular food habits were reported by 84 (58.7%) participants, a known risk factor for peptic ulcer disease (PUD) due to increased gastric acid and reduced mucosal protection. Only 35 (24.5%) had regular food habits. Erosions were observed in 51 (55.9%) participants, most commonly in the duodenum 29 (20.3%), followed by the stomach 22 (15.4%) and combined involvement 19 (13.3%). Endoscopy was normal in 63 (44.1%) participants, while 80 (56%) had ulcers.

Table 1: Socio-demographic Characteristics of Participants

Age	**Frequency (N)**	**Percent (%)**
16-30	36	25.2
31-45	59	41.3
46-55	30	21.0
56-65	18	12.6
Sex		
Male	80	56
Female	63	44
Education		
Primary	36	25.2
Secondary	78	54.5
Tertiary	29	20.3
Socioeconomic status		
Low	78	54.5
Medium	47	32.9
High	18	12.6
Ethnicity		
Brahman	51	35.7
Chettri	40	28.0
Baise	31	21.7
Sudra	21	14.7
Income		
low	95	66.4
Medium	36	25.2
High	12	8.4
Marital History		
Unmarried	42	29.4
Married	83	58.0
Divorced	6	4.2
Separation	12	8.4
Occupation		
Agriculture	83	58
Office work	36	25.2
Business	12	8.4
Not working	12	8.4

Table 2: Clinical manifestations of participants (N=143)

Food Habit	Frequency(N)	Percent (%)
Irregular food Habit	84	58.7
Regular Food Habit	35	24.5
Endoscopic Erosions		
Erosions in Esophagus	10	7.0
Eros. Stomach	22	15.4
Eros. Duodenum	29	20.3
Stomach and Duodenum	19	13.3
Normal	63	44.1
Ulcers		
Erosions in Esophagus	10	7.0
Eros. Stomach	22	15.4
Eros. Duodenum	29	20.3
Stomach/ Duodenum	19	13.3
Normal	63	44.1
Malignancy		
Malignancy Esophagus	2	1.4
Malig. Stomach	4	2.8
Normal	137	95.8
Location of ulcer in Stomach		
Antrum	51	35.7
Body	7	4.9
Fundus	6	4.2
No Ulcer	79	55.2
Location of ulcer in Duodenum		
Bulb	65	45.5
1st Part	18	12.6
No ulcer	60	42.0
H. Pylori Detection Method		
Blood titer	57	39.9
Stool Antigen	46	32.2
Biopsy	21	14.7
Negative	19	13.3
Location of Ulcers in Esophagus		
Ulcer Upper	35	24.5
Ulcer Mid	36	25.2
Ulcer lower	12	8.4
Normal	60	42.0

Table 3 depicts that mostly blood titer 29 (82.9%); stool antigen 6 (17.1%); no biopsy or negatives—suggesting early or mild infection. Stool antigen highest 48.2%, followed by blood titer 25% and biopsy 21.4%; negatives 5.4%, indicating more active infection and increased diagnostic evaluation. Balanced distribution; biopsy 26.7% and negatives 26.7% highest, suggesting chronic or complicated PUD and some non–Helicobacter pylori ulcers. Blood titer 38.5% and negatives 38.5% highest; low biopsy positivity, suggesting declining infection or other ulcer causes (e.g., NSAIDs).

Mainly stool antigen 44.4% and negatives 33.3%; no biopsy detection. Younger patients show mainly serological positivity, middle-aged groups show active infection (stool/biopsy), and older adults show mixed or declining prevalence with increasing negative cases after 45 years. Age-specific diagnostic strategies may be useful non-invasive tests for young and elderly, biopsy for symptomatic middle-aged patients. χ^2 = 63.154, p = 0.000, indicating a significant association between age group and method of *H. pylori* detection.

Table 4 indicated that overall infection rate (~87%) of Helicobacter pylori was observed higher among patients with peptic ulcer symptoms in high-altitude settings, indicating a strong association with PUD. Hypoxia-related mucosal damage and altered immunity may increase susceptibility to infection and ulceration.

Most diagnoses were made using non-invasive tests (blood and stool), which are cost-effective but less definitive than biopsy; the lower biopsy rate may reflect limited endoscopic access in high-altitude areas.
The ~87% positivity is epidemiologically high; comparison with low-altitude national data and consideration of altitude-related factors (oxygen level, diet, socioeconomic status) are important.

These findings highlight the need for screening programs, improved diagnostic access, and health education on hygiene, food safety, and treatment adherence in remote high-altitude populations.

Table: 3 Helicobacter pylori Detection Method

Age	Blood Titer	Stool Antigen	Biopsy	Negative H Pylori	Chi square	p-value
16-30	29(82.9%)	6(17.1%)	0%	0%	63.154[a]	0.000
31-45	14(25.0%)	27(48.2)	12(21.4%)	3 (5.4%)		
46-55	7 (23.3)	7(23.3%)	8(26.7%)	8(26.7%)		
56-65	5(38.5%)	2(15.4%)	1(7.7%)	5(38.5%)		
66-75	2(22.2%)	4(44.4%)	0%	3(33.3%)		
Total	57 (39.9%	46(32.2%)	21(14.7%)	19(13.3%)		

Table 4: Overall infection rate of Helicobacter pylori

H pylori Detection Method	Frequency
Blood titer	57 (39.9%)
Stool Antigen	46 (32.2%)
Biopsy	21(14.7)
Negative	19(13.3)
Total	143 (100%)

Table 5: Ulcers with H pylori Detection Method

Ulcers	Blood titer	Stool Antigen	Biopsy	Negative	Like hood	P Valu e
Ulcer esophagus	2(18.2%)	6(54.5%)	0%	3(27.3%)	21.627	0.042
Ulcer Stomach	18(50.0%)	6(16.7%)	7(19.4%)	5(13.9%)		
Ulcer Duodenum	7(41.2%)	5(29.4%)	4(23.5%)	1(5.9%)		
ulcers 1&2	1(12.5%)	6(75.0%)	0%	1(12.5%)		
Normal	29(40.8%)	23(32.4%)	10(14.1%)	9(12.7%)		
Total	57(39.9%)	46(32.2%)	21(14.7%)	19(13.3%)		

In table 5, The Likelihood Ratio Chi-square value of 21.627 and a p-value of 0.042 indicates a statistically significant association between ulcer type and the H. pylori detection method at the 5% significance level.

DISCUSSION

This demographic breakdown highlights that *H. pylori* infection and its peptic ulcer complications in high-altitude settings are more prevalent among younger, married, low-income individuals with limited education, predominantly engaged in agriculture, and from marginalized ethnic and socioeconomic backgrounds. These findings underscore the need for targeted public health interventions, improved sanitation, awareness programs, and accessible diagnostic and treatment services, particularly in rural and high-altitude regions. *Helicobacter pylori* infection and its impact on peptic ulcer disease are significantly influenced by socio-demographic factors in high-altitude settings. The infection is more prevalent among middle-aged, low-income males with limited education, particularly those involved in agriculture. Public health strategies should target these at-risk groups with improved sanitation, awareness campaigns, and accessible screening and treatment services, especially in remote high-altitude communities.

In our study results indicate that *H. pylori* infection is most prevalent among individuals aged 31–45 years, aligning with studies that report peak infection during economically productive years due to occupational stress and lifestyle [1]. A male predominance (56%) suggests gender-linked behavioral factors such as smoking, alcohol use, and delayed healthcare seeking [7].

Individuals with secondary education (54.5%) were most affected, emphasizing the need for educational interventions to promote hygiene and early treatment seeking [8].

The infection disproportionately affects those from low socioeconomic (54.5%) and low-income (66.4%) backgrounds. Poor sanitation, overcrowding, and limited access to clean water are key risk factors in such populations [9]).

The dominant ethnic groups affected—Brahman and Chettri may reflect regional population structures or differences in dietary and hygienic [10]. Finally, agricultural workers (58%) were the most affected, possibly due to their rural lifestyle, limited sanitation, and exposure to contaminated water.

This study revealed a high prevalence of Helicobacter pylori infection (86.7%) among dyspeptic patients attending the outpatient clinic of Karnali Academy of Health Sciences (KAHS), a high-altitude center in Jumla, Nepal. The most common diagnostic method was blood titer (39.9%), followed by stool antigen (32.2%) and biopsy (14.7%). A statistically significant association was observed between H. pylori detection method and patient age ($\chi^2 = 63.154$, $p < 0.001$), indicating that diagnostic approaches and infection status vary with age groups.

Our findings are consistent with previous studies conducted in Nepal, where H. pylori prevalence among symptomatic patients ranged from 50% to 80% depending on the setting and diagnostic tool used [4], [11]. The overall infection rate in this study is notably high, likely due to a combination of factors inherent to high-altitude regions, such as poor sanitation, limited healthcare access, frequent use of untreated water sources, and nutritional deficiencies.

A significant finding in our study is the age-specific variation in H. pylori detection patterns. Younger patients (16–30 years) showed high seropositivity (82.9%) without biopsy-confirmed cases, suggesting either early or past infection stages, or low endoscopic suspicion. In contrast, middle-aged groups (31–55 years) had a more diverse detection pattern, including biopsy and stool antigen positivity, indicating increased clinical suspicion and diagnostic workup due to more severe or persistent symptoms. Older patients (≥56 years) had higher rates of negative results or non-invasive diagnosis, which may reflect either lower bacterial colonization, prior clearance, or the presence of non-H. Pylori ulcers (e.g., NSAID-induced)

The use of multiple diagnostic tools enhanced the validity of the infection status. While serology is accessible and widely used, it may detect past rather than current infections [12]. Stool antigen testing and biopsy provide better specificity for active infection, but resource constraints often limit their use in remote settings like Jumla. Higher infection rates among married individuals (58%) may be due to household transmission, [13].

High-altitude physiology may also contribute to gastric mucosal vulnerability. Hypoxia has been shown to reduce mucosal blood flow and bicarbonate secretion, impairing mucosal defense and possibly facilitating H. pylori colonization and ulcer formation [5]. This suggests that the high-altitude environment itself may enhance the pathogenesis of H. pylori-related peptic ulcers.

Clinically, endoscopy confirmed a high burden of peptic ulcer disease among H. pylori-positive patients, aligning with global evidence that H. pylori is the principal cause of duodenal and gastric ulcers [1], [13]. Early diagnosis and targeted eradication therapy are critical, especially in such settings where reinfection risk is high and access to advanced care is limited.

The majority (58.7%) reported *irregular food habits*, which is a known risk factor for peptic ulcer disease (PUD). Irregular meals can disrupt gastric acid secretion cycles, leading to mucosal damage and increasing the risk of *H. pylori* colonization and ulceration [14].

Duodenal erosions (20.3%) are more prevalent than gastric (15.4%) or oesophageal erosions, suggesting a predominance of duodenal ulcer disease, which is classically associated with *H. pylori* infection [15].The ulcer table mirrors the erosion data, with highest frequency in the duodenum (20.3%), followed by stomach (15.4%) and combined stomach/duodenum (13.3%). This reaffirms that duodenal ulcers are predominant. Gastric malignancy was present in 2.8% of cases. Although relatively low, this finding underscores the importance of monitoring chronic gastritis, especially in high-risk populations and high-altitude areas, where hypoxia may play a carcinogenic role [16]. Most gastric ulcers were located in the antrum (35.7%), a classic site for *H. pylori*-induced gastritis and ulceration. This correlates with increased acid production and reduced mucosal protection [17].

The duodenal bulb was the most frequent site (45.5%) for ulcers, consistent with classical *H. pylori*-associated duodenal ulcer disease [18].

Serological testing (blood titer) was the most common method (39.9%), but it may detect past infections rather than active ones. Stool antigen is more reliable for current infection, but biopsy remains the gold standard. A combination of non-invasive (stool antigen) and invasive (biopsy with rapid urease test) methods improves diagnostic accuracy [19].

Esophageal ulcers were mostly in the upper and mid portions (49.7% combined). These may relate more to pill-induced or reflux-associated esophagitis than *H. pylori*, which is less commonly implicated in esophageal disease [*20].*

In table 5, we evaluates the prevalence of Helicobacter pylori infection across various ulcer types using four diagnostic methods—blood titer, stool antigen, biopsy, and negative results—and assesses the statistical significance using likelihood ratio and p-value.

This is various ulcer group with a statistically significant association between detection method and diagnosis of ulcers (p = 0.042). Over half of esophageal ulcer cases tested positive via stool antigen (active infection marker), suggesting a potential link between H. pylori and esophageal mucosal irritation, even though H. pylori rarely colonize the esophagus directly. Absence of biopsy-positive cases is expected due to the esophageal mucosa being a non-preferred colonization site for H. pylori. Likely causes include reflux disease or NSAID use, with H. pylori potentially acting as an aggravating factor [20].

Half of stomach ulcer cases were positive on blood antibody tests, indicating a high burden of past or ongoing H. pylori exposure. Biopsy positivity (19.4%) confirms mucosal involvement, consistent with known H. pylori tropism for gastric epithelium. Gastric ulcers are a classic manifestation of H. pylori-associated gastritis and ulceration, especially in the antrum [16].

Duodenal ulcers show strong associations with all three positive H. pylori tests: Blood titer (41.2%) – suggesting chronic exposure. Stool antigen (29.4%) – current infection. Biopsy (23.5%) direct mucosal colonization. Only 5.9% were negative, reinforcing the well-documented link between H. pylori and duodenal ulcer disease. Particularly in high-altitude regions, environmental stressors like hypoxia may exacerbate mucosal susceptibility [1].

Ulcers in stomach and duodenum indicated that stool antigen positivity was remarkably high (75%), indicating active, possibly severe infection. The low detection via biopsy may reflect challenges in obtaining representative tissue from both stomach and duodenum during endoscopy. These patients may have more aggressive or recurrent forms of peptic ulcer disease. The small sample size may explain the absence of statistical significance despite a strong clinical signal [9]

A high proportion of asymptomatic individuals (86.3%) were H. pylori-positive, either via serology, stool, or biopsy and only 12.7% had negative H pylori test. This supports the understanding that many H. pylori carriers remain clinically silent, but still at risk of future complications if untreated. Routine screening and eradication in high-prevalence settings may be justified to prevent ulcers and malignancies [12].

Blood titer was the most frequently positive method but may overestimate active infection. Stool antigen proved highly sensitive, especially for combined and esophageal ulcers. Biopsy, though less frequently positive, remains the most specific test, detecting actual colonization. The 13.7% negative rate likely reflects non-H. Pylori ulcers (e.g., NSAID-induced, stress-related). [20].

Helicobacter Pylori (H-pylori) infection is widely known to be the cause of APD, and PUD, especially in developing countries where the main route of entry is fecal-oral. The H-Pylori infection is acquired mainly in childhood and is closely associated with health and socio-economic conditions including sanitary conditions. It has been found that living at a higher altitude is associated with a higher H-Pylori infection rate, which is the leading risk factor for gastritis [21, 22].

The present study provides baseline data. Nepal has diverse terrain from near sea level to the world’s highest peak of Mt. Everest. Most of the settlement in Nepal are in mountain area with mostly in high altitude area, so we have to do further epidemiological studies with the inclusion of wider areas from different altitudes to study the presentation and outcome of APDs. Studies have shown that acute high-altitude exposure is associated with delayed gastric emptying [23, 24]. High *Helicobacter pylori* prevalence was noted among dyspeptic patients in high-altitude regions. Age influenced detection methods and may affect disease severity, emphasizing the need for tailored diagnostic and management approaches.

CONCLUSIONS

A high prevalence of *Helicobacter pylori* infection was observed among dyspeptic patients in high-altitude regions. Age significantly affected detection methods and may also influence disease severity, underscoring the need for context-specific diagnostic approaches and targeted management strategies.

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