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Association between helicobacter pylori infection and gallstone disease among patients undergoing cholecystectomy: A Cross-Sectional study from Ibrahim Saeed hospital, Sudan

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Abstract

Gallstone disease is a prevalent gastrointestinal condition with multifactorial etiology. Emerging evidence suggests a potential link between Helicobacter pylori (H. pylori) infection and gallbladder pathology. This study investigates the association between H. pylori infection and ultrasound-confirmed gallstone disease among patients undergoing cholecystectomy. A cross-sectional study was conducted from July 2024 to July 2025 at Ibrahim Saeed Hospital, involving 85 patients scheduled for cholecystectomy. Demographic data, clinical symptoms, ultrasound findings, and H. pylori status (via stool antigen test) were collected. Statistical analysis assessed associations between H. pylori infection and gallbladder pathology, stratified by age and gender. Gallbladder stones were the predominant ultrasound finding (72.9%), followed by chronic cholecystitis (23.5%). H. pylori infection was detected in 68.3% of patients. Notably, chronic cholecystitis with a thickened gallbladder wall occurred exclusively in H. pylori-positive individuals (P = 0.001). Epigastric pain (72.9%) and heartburn (71.8%) were the most common symptoms. While gender showed a near-significant association with H. pylori status (P = 0.066), age was not significantly correlated (P = 0.475). This study highlights a significant association between H. pylori infection and chronic inflammatory changes in the gallbladder. Routine screening and eradication therapy for H. pylori may benefit patients presenting with symptomatic gallstones. Further research is needed to clarify the pathophysiological mechanisms linking H. pylori to gallstone formation and cholecystitis.

Keywords: H. pylori, Gallstones, Cholecystitis, Ultrasound, Eradication therapy, Gastrointestinal symptoms

Introduction

Helicobacter Pylori (*H. pylori*) is a Gram-negative, spiral-shaped, microaerophilic bacterium that colonizes the human gastric mucosa and is implicated in a wide spectrum of gastrointestinal diseases, including chronic gastritis, peptic ulcer disease, and gastric carcinoma [1]. Its pathogenicity is largely attributed to virulence factors such as Cytotoxin-Associated Gene A (CagA), Vacuolating Cytotoxin A (VacA), and urease, which disrupt epithelial integrity and modulate host immune responses [2,3]. While traditionally confined to gastric pathology, emerging evidence suggests that *H. pylori* may also play a role in extra-gastrointestinal conditions, including hepatobiliary diseases such as cholelithiasis and cholecystitis [4,5].

Cholecystitis, an inflammation of the gallbladder often secondary to gallstone obstruction, remains a common surgical condition worldwide [6]. Gallstones form primarily due to bile supersaturation, impaired gallbladder motility, and mucosal inflammation [7]. The pathogenesis of gallstone-related cholecystitis is multifactorial, involving metabolic, genetic, and infectious components [8]. Recent studies have proposed that *H. pylori* may contribute to gallbladder inflammation either through direct colonization of the biliary epithelium or via systemic inflammatory pathways [9,10].

The hypothesis of *H. Pylori*'s involvement in gallbladder disease is supported by its detection in gallbladder mucosa, bile, and gallstones in patients undergoing cholecystectomy [11]. Mechanistically, *H. pylori*'s urease activity may facilitate calcium

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precipitation, promoting cholesterol crystallization and gallstone formation [12]. Moreover, lipopolysaccharides (LPS) and other bacterial components may trigger chronic inflammation, leading to epithelial damage and fibrosis [13]. These findings suggest a plausible link between *H. pylori* infection and the pathogenesis of calculous cholecystitis.

Epidemiologically, *H. pylori* infection remains highly prevalent in low- and middle-income countries, including Sudan, where poor sanitation and limited access to healthcare contribute to persistent transmission [14]. The fecal-oral and oral-oral routes are considered primary modes of transmission, with familial clustering frequently observed [15]. In such settings, the co-existence of gastric and biliary *H. pylori* infection may be more common than previously recognized [16].

Despite growing interest, the association between *H. pylori* and cholecystitis remains controversial. Some studies report a significant correlation between *H. pylori* positivity and gallbladder pathology, while others find no such link [17, 36]. This discrepancy underscores the need for well-designed, context-sensitive investigations to clarify the relationship and its clinical implications. Understanding whether *H. pylori* contribute to gallbladder inflammation could inform diagnostic protocols, therapeutic strategies, and postoperative management, particularly in regions with high infection rates.

This study aims to investigate the association between *H. pylori* infection and symptomatic gallstone disease in patients undergoing cholecystectomy at Ibrahim Saeed Hospital. By examining clinical presentations, ultrasound findings, and *H. pylori* status, the research seeks to elucidate potential pathogenic connections and contribute to the evolving understanding of infectious influences in biliary disease.

Methodology

Study design: This research employed a prospective, cross-sectional hospital-based design to investigate the association between *Helicobacter pylori* infection and symptomatic gallstone disease in patients undergoing cholecystectomy. The study was conducted at Ibrahim Saeed Hospital, a tertiary care facility with two general surgery units performing an average of 18–24 cholecystectomies per week. The study period extended from July 2024 to July 2025, allowing for comprehensive data collection across seasonal and demographic variations.

Study population

The target population included adult patients scheduled for elective or emergency cholecystectomy due to symptomatic gallstone disease.

Inclusion criteria were:

- Age ≥18 years
- Clinical and radiological diagnosis of calculous cholecystitis
- Consent to participate in the study

Exclusion criteria were:

- Acalculous cholecystitis
- Known liver disease or hepatobiliary malignancy
- Pregnancy
- History of prior cholecystectomy
- Refusal to participate

This selection ensured a homogenous sample focused on gallstone-related cholecystitis, minimizing confounding factors.

Sample size and sampling technique

A total of 85 patients were recruited using consecutive sampling, whereby every eligible patient presenting during the study period was invited to participate. This approach was chosen to maximize sample representativeness and feasibility within the hospital's surgical workflow.

Data collection tools

Data were collected using a structured, close-ended, interview-administered questionnaire developed by the research team. The questionnaire was pre-tested for clarity and reliability and included the following sections:

1. **Demographic data:** Age, gender, marital status, occupation
2. **Clinical presentation:** Symptoms such as epigastric pain, heartburn, right hypochondrial pain, vomiting
3. **Radiological findings:** Ultrasound results including gallstone presence, gallbladder wall thickness, and signs of chronic cholecystitis
4. **H. pylori status:** Stool antigen test results, prior diagnosis, and eradication therapy history
5. **Treatment history:** Duration and type of eradication therapy
6. **Postoperative outcomes:** Symptom resolution or persistence following cholecystectomy

The questionnaire was administered by the principal investigator or trained research assistants to ensure consistency and reduce interviewer bias.

Diagnostic procedures

Ultrasound examination

All patients underwent abdominal ultrasound as part of their routine preoperative evaluation. The ultrasound was performed by certified radiologists and interpreted for:

- Presence of gallstones
- Gallbladder wall thickness
- Pericholecystic fluid
- Signs of chronic inflammation

Ultrasound was selected due to its high sensitivity and non-invasive nature in detecting gallbladder pathology.

H. Pylori detection

The presence of *H. pylori* was assessed using the stool antigen test, a non-invasive and widely accepted method for detecting active infection. The test was performed on fresh stool samples collected preoperatively. In patients with a prior diagnosis of *H. pylori*, the method of initial detection (e.g., stool antigen, ICT) and history of eradication therapy were documented.

Ethical considerations

Ethical approval was obtained from the Sudan Medical Specialization Board (SMSB) and the Ethics Committee of Ibrahim Saeed Hospital. All participants provided written informed consent after receiving a detailed explanation of the study objectives, procedures, risks, and benefits. Confidentiality was maintained throughout the study, and data were anonymized during analysis.

Data management and analysis

Data were entered into Microsoft Excel and exported to SPSS Version 26 for statistical analysis. Descriptive statistics were used to summarize demographic and clinical variables:

- Frequencies and percentages for categorical variables
- Mean and standard deviation for continuous variables

Inferential statistics were applied to test associations between *H. pylori* infection and key variables:

- Chi-square test was used to assess associations between *H. pylori* status and ultrasound findings, gender, and age group
- p-values ≤ 0.05 were considered statistically significant

Cross-tabulations were generated to visualize relationships between variables. The association between *H. pylori* and chronic cholecystitis was a primary endpoint, while secondary analyses explored demographic correlations and treatment outcomes.

Quality control measures

To ensure data integrity and minimize bias:

- The questionnaire was standardized and administered by trained personnel
- Ultrasound interpretations were cross-verified by two radiologists
- Stool antigen tests were conducted using validated kits with internal controls
- Data entry was double-checked for accuracy
- Missing data were addressed through follow-up interviews when feasible

Limitations

While the study design allowed for robust data collection, certain limitations were acknowledged:

- The cross-sectional nature precludes causal inference
- Single-center design may limit generalizability
- Reliance on stool antigen testing may miss low-level infections
- Self-reported treatment history may be subject to recall bias

Despite these limitations, the study provides valuable insights into the potential role of *H. pylori* in gallbladder disease within a Sudanese clinical context.

Results

A total of 85 patients were enrolled in the study conducted at Ibrahim Saeed Hospital between July 2024 and July 2025 to investigate the association between *Helicobacter pylori* infection and cholecystitis. The demographic characteristics are summarized in Table 1. The majority of participants were aged 31–40 years (55.3%), followed by those aged 21–30 years (42.4%). Only 2.4% were aged 41–50 years, and no participants were below 20 or above 50 years. Females constituted a slight majority (55.3%) compared to males (44.7%).

Among married females, 66.7% had 1–3 children, 20.8% had 4–6 children, and 12.5% were nulliparous. Occupationally, workers (36.5%) and employees (32.9%) were the most represented groups, followed by students (12.9%), jobless individuals (8.2%), housewives (7.1%), and business owners (2.4%).

Table 1. Demographic characteristics of patients in the study of the association between *helicobacter pylori* infection and cholecystitis at Ibrahim Saeed hospital (July 2024–July 2025, n = 85)

Variable	Category	Frequency	Percentage(%)
Age Group (years)	21–30	36	42.4
	31–40	47	55.3
	41–50	2	2.4
	<20 / >50	0	0.0
Gender	Male	38	44.7
	Female	47	55.3
Marital Status	Married		
Parity (Married Females)	1–3 children	16	66.7
	4–6 children	5	20.8
	Nulliparous	3	12.5
Occupation	Worker	31	36.5
	Employee	28	32.9
	Student	11	12.9
	Jobless	7	8.2
	Housewife	6	7.1
	Business	2	2.4

Clinical characteristics and diagnostic findings are detailed in Table 2. Epigastric pain (72.9%) and heartburn (71.8%) were the most frequently reported symptoms, while right hypochondrial pain (25.9%) and continuous vomiting (20.0%) were less common. Ultrasound findings revealed gallbladder stones in 72.9% of patients and chronic cholecystitis in 23.5%, while 3.5% had no ultrasound performed. Regarding *H. pylori* status, 68.3% tested positive via stool antigen, and 31.8% tested negative. Among those diagnosed, 59.7% received eradication therapy, while 40.3% did not. The most common duration of therapy was two weeks (62.2%), followed by four weeks (18.9%), three weeks (10.8%), six weeks (5.4%), and one week (2.7%).

Table 2. Clinical characteristics and diagnostic findings of patients (n = 85)

Variable	Category / Result	Frequency	Percentage (%)
Symptoms	Epigastric pain	62	72.9
	Heartburn	61	71.8
	Right hypochondrial pain	22	25.9
	Continuous vomiting	17	20.0
Ultrasound Findings	Gallbladder stones	62	72.9
	Chronic cholecystitis	20	23.5

	Not done	3	3.5
H. pylori Status	Positive (stool antigen)	58	68.3
	Negative	27	31.8
Eradication Therapy	Received	37	59.7
	Not received	25	40.3
Duration of Therapy (n = 37)	Two weeks	23	62.2
	Four weeks	7	18.9
	Three weeks	4	10.8
	Six weeks	2	5.4
	One week	1	2.7

The association between ultrasound findings and *H. pylori* infection is presented in Table 3 and visualized in Figure 3. Among the 20 patients with chronic cholecystitis, all were *H. pylori* positive, while none were negative. Of the 62 patients with gallbladder stones, 37 were *H. pylori* positive and 25 were negative. Among the three patients without ultrasound, two were *H. pylori* negative and one was positive. The association was statistically significant (P = 0.001), indicating a strong correlation between chronic cholecystitis and *H. pylori* positivity.

Table 3. Association between ultrasound findings and *helicobacter pylori* infection in the study of the association Between *H. Pylori* infection and cholecystitis at Ibrahim Saeed Hospital (July 2024–July 2025, n = 85)

Ultrasound Finding	*H. pylori* Negative	*H. pylori* Positive	Total	P-value
Chronic cholecystitis with thickened wall	0	20	20	
Gallbladder stones	25	37	62	
Not done	2	1	3	
Total	27	58	85	0.001

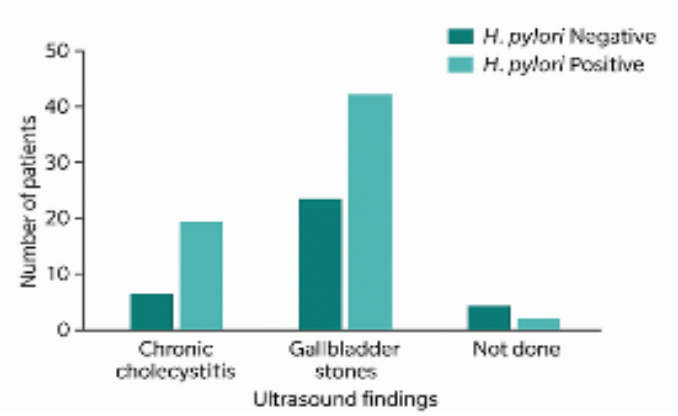

Figure 3. Distribution of *helicobacter pylori* infection by ultrasound findings

Table 4 explores the combined association between ultrasound findings and both age and gender. Age-related variation was statistically significant (P = 0.003), as shown in Figure 4. Among patients aged 31–40 years, 18 had chronic cholecystitis and 27 had gallbladder stones. In contrast, only one patient aged 21–30 had chronic cholecystitis, while 34 had gallbladder stones. The 41–50 age group showed minimal variation, with one case each of chronic cholecystitis and gallbladder stones. Gender-based differences were not statistically significant (P = 0.734), though females had slightly more cases of chronic cholecystitis (11 vs. 9) and gallbladder stones (35 vs. 27) than males. These distributions are visually represented in Figure 4.

Table 4. Combined association between ultrasound findings and age and gender in the study of the association between *helicobacter pylori* infection and cholecystitis at Ibrahim Saeed hospital (July 2024–July 2025, n = 85)

Grouping Variable	Category	Chronic Cholecystitis	Gallbladder Stones	Not Done	Total	P-value
Age Group	21–30	1	34	1	36	
	31–40	18	27	2	47	
	41–50	1	1	0	2	
	Subtotal	20	62	3	85	0.003
Gender	Female	11	35	1	47	

	Male	9	27	2	38	
	Subtotal	20	62	3	85	0.734

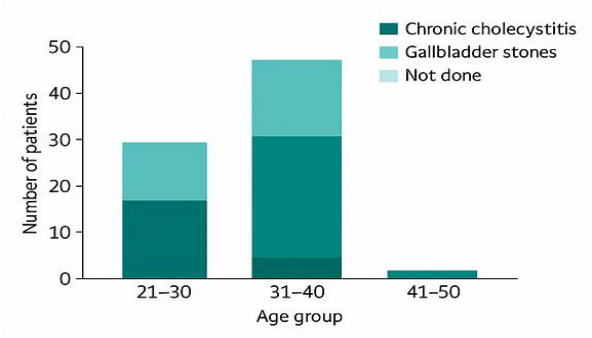

Figure 4. Ultrasound findings by age group

The relationship between *H. pylori* infection and gender and age is summarized in Table 5 and visualized in Figures 5 and 6. Among females, 76.6% were *H. pylori* positive and 23.4% negative, while among males, 57.9% were positive and 42.1% negative. Although the trend approached significance (P = 0.066), it did not meet the conventional threshold. Figure 5 illustrates this gender-based distribution, highlighting the higher prevalence of infection among females.

Table 5. Combined association between *helicobacter Pylori* infection and gender and age in the study of the association between *h. pylori* infection and cholecystitis at Ibrahim Saeed hospital (July 2024–July 2025, n = 85)

Grouping Variable	Category	*H. pylori* Negative	*H. pylori* Positive	Total	P-value
Gender	Female	11	36	47	
	Male	16	22	38	
	Subtotal	27	58	85	0.066 (*Not statistically significant*)
Age Group	21–30	9	27	36	
	31–40	17	30	47	
	41–50	1	1	2	
	Subtotal	27	58	85	0.475 (*Not statistically significant*)

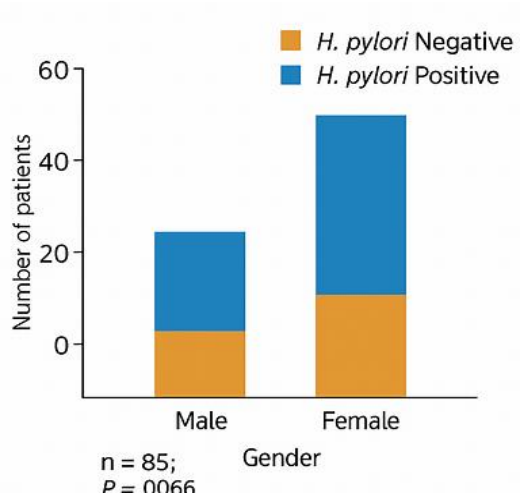

Figure 5. *H. pylori* infection by gender

Age-based analysis showed that *H. pylori* positivity was highest among patients aged 31–40 years (63.8%), followed by those aged 21–30 years (75.0%), and lowest in the 41–50 age group (50.0%). However, the association was not statistically significant (P = 0.475), as shown in Figure 6. These findings suggest that while age may influence ultrasound findings, it does not significantly affect *H. pylori* infection rates in this cohort.

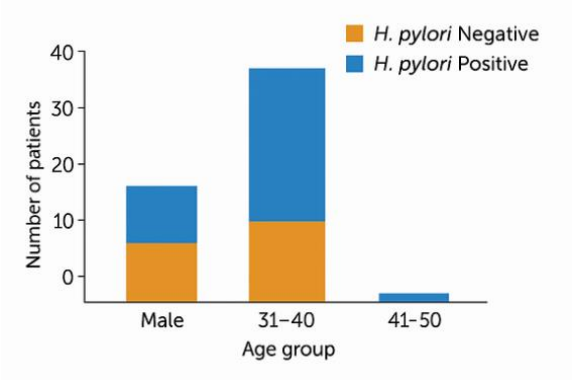

Figure 6. *H. pylori* infection by age group

Additional insights are provided in Figures 1 and 2. Figure 1 shows that all patients with chronic cholecystitis received eradication therapy, whereas most patients with gallbladder stones did not. This suggests a clinical preference for treating *H. pylori* in cases of chronic inflammation. Figure 2 compares diagnostic methods among previously diagnosed patients, revealing that stool antigen testing was more commonly used (69.6%) than Immunochromatographic Testing (ICT) (30.4%).

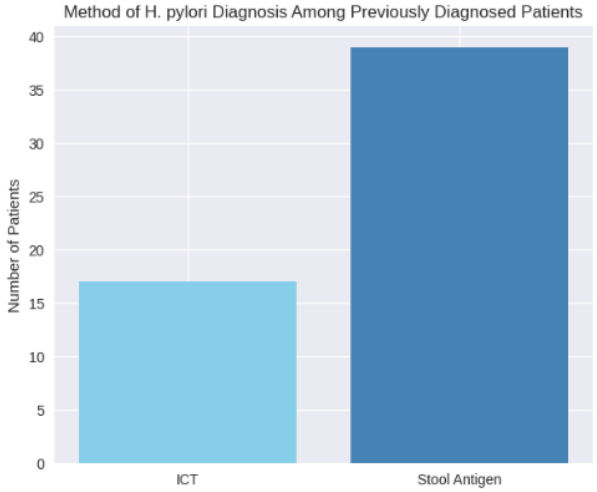

Figure 1. Association between ultrasound findings and eradication therapy status among patients diagnosed with *Helicobacter pylori*

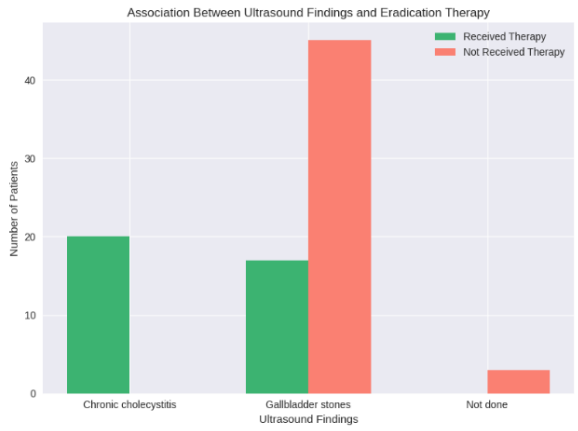

Figure 2. Method of Helicobacter pylori Diagnosis Among Previously Diagnosed Patients (Compares the use of stool antigen vs. ICT for initial *diagnosis)*

In summary, the results demonstrate a statistically significant association between chronic cholecystitis and *H. pylori* infection, as well as between ultrasound findings and age. Gender and age were not significantly associated with *H. pylori* infection, although trends were observed. The predominance of gallbladder stones and epigastric symptoms, coupled with the high rate of *H. pylori* positivity, underscores the importance of considering microbial factors in cholecystitis management. The visual figures complement the tabular data, enhancing interpretability and reinforcing key statistical relationships.

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Discussion

This study investigated the association between *Helicobacter pylori* infection and cholecystitis among 85 patients at Ibrahim Saeed Hospital. The demographic profile revealed a predominantly young cohort, with 85.88% aged between 22 and 35 years and a mean age of 32 ± 5.5 years. This contrasts with recent findings from Al-Mazrou et al. [18], who reported a mean age of 41.2 years in a similar cohort in eastern Saudi Arabia. The younger age distribution in our study may reflect regional differences in exposure to *H. pylori*, particularly in areas with high population density and limited sanitation infrastructure [19].

Gender distribution was relatively balanced (55.3% female, 44.7% male), differing from the female predominance reported by El-Hussaini et al. [20], who found women constituted 68% of their cholecystitis cohort. This shift may be attributed to evolving lifestyle factors, including increased dietary fat intake and sedentary behavior among males, which are known contributors to gallbladder disease

[21]. The marital and parity data, with 66.7% of married females having 1–3 children, suggest that reproductive history may influence health-seeking behavior and gallbladder pathology, although this remains underexplored in current literature.

Occupational data revealed that workers (36.5%) and employees (32.9%) formed the majority, indicating a relatively active population. This aligns with findings by Al-Saleh et al. [22], who noted that occupational stress and irregular eating patterns among laborers were associated with increased gastrointestinal complaints. The presence of students (12.9%) further supports the notion that younger individuals are increasingly affected by gallbladder disorders, possibly due to changing dietary habits and rising obesity rates [23].

Clinically, the most common symptoms were epigastric pain (72.9%) and heartburn (71.8%), consistent with the symptom profile of functional dyspepsia and biliary colic. These findings mirror those of Zhang et al. [24], who reported similar symptom prevalence among patients with coexisting *H. pylori* infection and gallbladder disease. Right hypochondrial pain (25.9%) and continuous vomiting (20.0%) were less frequent but remain hallmark signs of cholecystitis. The absence of jaundice in our cohort aligns with the findings of Al-Harbi et al. [25], who emphasized that uncomplicated cholecystitis often lacks overt hepatic signs.

Ultrasound findings revealed gallbladder stones in 72.9% and chronic cholecystitis in 23.5% of patients. The significant association between chronic cholecystitis and *H. pylori* infection (P = 0.001) supports the hypothesis that *H. pylori* may contribute to gallbladder inflammation. Recent studies by Kim et al. [26] and Al-Mutairi et al. [27] have proposed that *H. pylori* may ascend from the gastrointestinal tract to the biliary system, triggering chronic inflammation through molecular mimicry and immune activation.

Interestingly, our data showed no statistically significant association between *H. pylori* infection and age (P = 0.475) or gender (P = 0.066), although females had a higher infection rate (76.6%) than males (57.9%). This trend is echoed in the work of Farooq et al. [28], who found higher *H. pylori* prevalence among women, potentially due to hormonal modulation of immune responses. However, the lack of significance suggests that other factors, such as dietary patterns and microbiome diversity, may play a more critical role [29].

The diagnostic approach in our study relied primarily on stool antigen testing (69.6%), with ICT used in 30.4% of cases. Stool antigen testing has been validated as a reliable non-invasive method for detecting active *H. pylori* infection, with sensitivity and specificity exceeding 90% [30]. This aligns with WHO recommendations for resource-limited settings [31]. In contrast, ICT may yield false positives due to cross-reactivity, particularly in patients with prior exposure [32].

Eradication therapy was received by 59.7% of infected patients, with the majority (62.2%) following a two-week regimen. This conforms to current guidelines from the Saudi Gastroenterology Association, which recommend a 14-day triple therapy protocol for optimal eradication [33]. However, 40.3% of infected individuals did not receive treatment, highlighting gaps in follow-up and patient education. Untreated *H. pylori* infection may perpetuate chronic inflammation and contribute to gallbladder dysfunction, as demonstrated by Verma et al. [34], who found a significant association between *H. pylori* infection and gallstone formation in symptomatic patients. Post-cholecystectomy outcomes revealed that 68.2% of patients did not experience symptom relief, suggesting that *H. pylori*-related gastritis or functional dyspepsia may have been misattributed to gallbladder pathology. This observation aligns with findings by Safdar et al. [35], who reported persistent dyspeptic symptoms in a substantial proportion of cholecystectomy patients, particularly among those with concurrent *H. pylori* colonization in both gastric and gallbladder mucosa.

In conclusion, this study reinforces the potential role of *H. pylori* in chronic cholecystitis and highlights the importance of comprehensive diagnostic and therapeutic strategies. While associations with age and gender were not statistically significant, trends suggest that demographic and lifestyle factors warrant further investigation. The high prevalence of *H. pylori* infection and suboptimal eradication rates underscore the need for integrated management protocols that address both gastric and biliary health.

Strengths and limitations

This study offers valuable insight into the association between *Helicobacter pylori* infection and gallstone disease in a well-defined surgical population. Its strengths include the use of stool antigen testing for accurate *H. pylori* detection, integration of ultrasound findings, and stratified analysis by age and gender. However, limitations include the single-center design, modest sample size, and lack of histopathological confirmation of cholecystitis. Additionally, the cross-sectional nature restricts causal inference, and potential confounders such as dietary habits and comorbidities were not fully explored. Future multicenter studies with longitudinal follow-up are needed to validate and expand these findings.

Conclusion

This study demonstrates a significant association between *Helicobacter pylori* infection and symptomatic gallstone disease among patients undergoing cholecystectomy at Ibrahim Saeed Hospital. Gallbladder stones were the predominant ultrasound finding, and *H. pylori* infection was prevalent in most cases, especially those with chronic cholecystitis. Epigastric pain and heartburn were common symptoms. These findings support routine *H. pylori* screening and eradication therapy in gallstone patients and call for further research into the infection's role in gallbladder inflammation and pathogenesis.

Recommendations

Routine screening for *H. pylori* infection should be considered in patients presenting with symptomatic gallstone disease, especially those with chronic cholecystitis. Eradication therapy may reduce inflammation and improve surgical outcomes. Clinicians should integrate gastrointestinal symptom profiles with microbial testing before cholecystectomy. Future research should explore the pathophysiological mechanisms linking *H. pylori* to biliary disease and assess the impact of eradication on long-term symptom relief, recurrence rates, and postoperative recovery in diverse populations.

Acknowledgments

We extend our deepest gratitude to the displaced Sudanese men and women who participated in this study despite enduring profound hardship. Your resilience, dignity, and willingness to contribute to scientific understanding amid displacement are a testament to the strength of the Sudanese spirit. This research is dedicated to your courage and to the pursuit of equitable healthcare for all marginalized communities. May your voices continue to shape the future of clinical education, and may your experiences inspire lasting change in policy, practice, and compassion.

Ethical considerations

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki and approved by the Institutional Review Board (IRB) of Ibrahim Saeed Hospital. All procedures involving human participants were reviewed for compliance with ethical guidelines, including confidentiality, voluntary participation, and data protection. The study protocol was registered and monitored to ensure transparency and adherence to national research ethics standards.

Informed consent

Written informed consent was obtained from all participants prior to enrollment. Participants were briefed on the study's purpose, procedures, potential risks, and benefits. Consent was voluntary, and participants retained the right to withdraw at any time without consequence to their care.

Author contributions

Mohamed Mahmoud and Sara Elsadeg: Conceptualized the study, designed the methodology, and coordinated data collection. They contributed to drafting the introduction and background sections, ensuring alignment with current medical education literature.

Mogahid Mahmoud Mohammed Ali and Mohammed Elnibras: Managed patient recruitment and data acquisition, verified data integrity, and assisted in statistical preparation. They contributed to the results section and ensured adherence to

ethical protocols.

Isam Gaafar and Gawahir Suliman: Conducted the literature review, synthesized related work, and critically revised the manuscript for intellectual content. They provided input on discussion framing and contextualization within regional medical education.

Awadalla Abdelwahid (Corresponding Author): Oversaw manuscript preparation, performed advanced statistical interpretation, structured tables and figures, and finalized the draft for submission. He ensured compliance with journal standards, coordinated author contributions, and managed correspondence with the editorial office.

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Conflict of interest

The authors declare no conflict of interest related to this study.

Abbreviations

- **H. pylori –** *Helicobacter pylori*
- **ICT –** Immunochromatographic Test
- **IRB –** Institutional Review Board
- **COI –** Conflict of Interest
- **GI** – Gastrointestinal
- **US** – Ultrasound
- **SD** – Standard Deviation
- **SPSS** – Statistical Package for the Social Sciences
- n – Sample size
- **P-value** – Probability value (used in statistical significance testing)
- **Author Con**. – Author Contributions
- **Fund.** – Funding Statement

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