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Prevalence and Risk Factors for Helicobacter pylori Infection among Gastrointestinal Patients in Dhamar City, Yemen

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Abstract

Background: *Helicobacter pylori (H. pylori)* is a bacterium frequently contracted during childhood and is the primary etiological agent of various gastrointestinal conditions, including gastritis, peptic ulcers, and gastric cancer. The transmission of *H. pylori* predominantly occurs through person-to-person contact, most commonly via oral-oral or fecal-oral pathways. Its acquisition and persistence are strongly affected by various environmental and socioeconomic conditions. This study aimed to determine the prevalence of *H. pylori* infection and evaluate its association with multiple risk factors among individuals presenting with gastrointestinal disorders in Dhamar, Yemen.

Methods: This cross-sectional study was conducted between January to December 2022. *H. pylori* infection was detected using the stool antigen test (HpSA), which qualitatively identifies *H. pylori* antigens in human fecal samples. Demographic and behavioral data including age, gender, smoking status, family size, number of rooms in the household, educational level, Khat (*Catha edulis*) consumption, and tobacco (Shamma) chewing were collected through structured interviews. Logistic regression models were used in the analysis of odds ratios (ORs) and their respective 95% confidence intervals (CIs), with a 5% significance level.

Results: A total of 515 stool samples were collected from individuals in Dhamar Governorate, Yemen, to evaluate the prevalence of *H. pylori* infection. The overall infection rate was found to be 68.5%, corresponding to 353 positive cases. Among the 185 male participants, 107 (57.8%) tested positive, while 246 of the 330 female participants (74.5%) were positive. Although no significant association was found between infection rates and family size, statistically significant correlations were observed with several factors, including gender, age, number of rooms in the household, educational level, smoking status, khat chewing, and tobacco (Shamma) use.

Conclusion: This study highlights the substantial prevalence of *H. pylori* infection in the Dhamar community. A comprehensive understanding of the associated risk factors is essential for devising effective strategies to control and ultimately eliminate the transmission of this pathogen within the Yemeni population.

Article Info

Keywords:
Helicobacter pylori, Associated risk factors, *H.pylori* antigen, Yemen, prevalence

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1. INTRODUCTION

The genus *Helicobacter* is a microaerophilic pathogen distinguished by its motility and gram-negative helical or curved rod morphology. It is classified under the family *Helicobacteraceae* [1]. To date, approximately 35 species of *Helicobacter* have been identified, including the non-gastric, enterohepatic, and gastric types. Certain non-*H. pylori* species have been documented to be transmissible to humans, where they may induce or exacerbate gastric conditions and are associated with various non-gastric diseases [2]. Non-pylori *Helicobacter* species exhibit distinct features compared to *H. pylori*, including differences in cell morphology, spiral shape, and arrangement and number of flagella. These variations present a valuable opportunity to explore how such structural differences influence motility within this bacterial genus [3]. *H. pylori* is transmitted through fecal–oral, oral–oral, and gastric–oral routes, with the fecal–oral pathway being recognized as the most common. Although oral–oral transmission also plays a role, its prevalence remains uncertain. The gastrooral route is most frequently observed in children and individuals who are prone to vomiting. Human-to-human and foodborne transmission are the primary patterns of *H. pylori* infection, and stringent environmental and occupational restrictions are linked to exposure of animals to humans and workplace settings [4]. *Helicobacter pylori* ($\sim$2–3.5μm$\times$0.5 1.0 μm) is the most clinically significant species and is identified as a causative agent of active chronic gastritis, peptic and duodenal ulcers, gastric neoplasia, and mucosa-associated lymphoid tissue malignancies in humans [4]. This bacterium is proficient in colonizing the human gastric environment and its high prevalence has a substantial impact on human health. It is associated with various gastric and extragastric conditions including gastric cancer. Colonization by *H. pylori* induces significant alterations in the gastric microenvironment, which subsequently affects the gastrointestinal microbiota by modulating gastric acidity, host immune responses, antimicrobial peptides, and virulence factors [5], thereby contributing to the pathogenesis of *H. pylori*. *H. pylori* infection is one of the most prevalent infections globally, affecting an estimated 4.4 billion individuals, with cases reported in 2015 across both developing and developed countries [6]. Clinically, $>$ 80% of infections are asymptomatic, and previous studies have indicated that the risk of *H. pylori* infection varies according to ethnicity, household characteristics, and geographical location. Socioeconomic status is a significant risk factor for *H. pylori* infection [7]. *H. pylori* infection is associated with numerous risk factors, including demographic characteristics, socioeconomic status, environmental hygiene and sanitation standards, dietary habits, and lifestyle behaviors [8]. The incidence of *H. pylori* infection exhibits considerable heterogeneity, with prevalence rates ranging from 7.3% to 92.0% depending on factors such as geographical location, age, and socioeconomic conditions [9] Numerous studies conducted throughout the Americas have indicated a general *H. pylori* infection prevalence of approximately 50%. In contrast, the prevalence in Africa is notably higher, at approximately 70% [10]. Previous epidemiological studies have shown a higher incidence of *H. pylori* infections in developing countries, with certain regions such as Bhutan and Myanmar reporting rates as high as 90% [11, 12]. The prevalence of *H. pylori* infection in the Ibb Governorate, Yemen, varied significantly depending on the diagnostic method employed. The Stool Antigen Test (SAT) indicated a prevalence rate of 54%, whereas the serum *H. pylori* IgG antibody test showed a higher rate of 78.5%. Notably, a screening serum immune-chromatographic antibody test reported a prevalence rate of 100 %[13]. The prevalence of *H. pylori* infection in Aden, Yemen, was 69% according to a stool antigen test [14]. In the Dhamar governorate, the seroprevalence of *H. pylori* antibodies in human blood samples was 82.52%, while the prevalence of *H. pylori* in stool samples, as assessed by the *H. pylori* antigen test, was 18.45% (15). In Mukalla City, Hadhramout, Yemen, the *H. pylori* infection rate was reported to be 15% based on the antigen detection test and 18.5% using serum anti-*H. pylori* antibody tests [15]. Inadequate sanitation and overcrowded living conditions can significantly influence the prevalence of *H. pylori* infection, particularly in politically unstable nations that have experienced civil conflict [14]. Socioeconomic factors and hygiene practices are recognized as critical determinants of infection risk, with a higher incidence observed in densely populated areas, particularly in rural regions characterized by low income and inadequate sanitation facilities [11, 16]. A case-control study conducted in Nairobi County revealed a significantly higher incidence of *H. pylori* infection among individuals who chew khat, suggesting that khat consumption may predispose individuals to gastrointestinal disorders [17]. Another study confirmed that the prevalence of gastrointestinal disorders is higher among khat chewers, indicating a potential association between khat use and *H. pylori* infection. Therefore, it is advisable to promote community awareness of the adverse effects of khat consumption [18]. A range of diagnostic techniques are available for detecting and characterizing *H. pylori* infection, which can be broadly classified into invasive and noninvasive methods based on the need for gastric biopsy [19]. To improve the management of this infection, invasive diagnostic approaches, such as endoscopic imaging, histopathological assessment, rapid urease testing, and bacterial culture have significant clinical relevance because of their ability to provide biopsy samples [19]. The diagnosis of *H. pylori* infection commonly follows a test-and-treat strategy, employing a range of diagnostic tools categorized as invasive or noninvasive. Invasive methods include endoscopy, histological examination, rapid urease testing, culture, and molecular techniques such as PCR analysis. In contrast, noninvasive approaches include serological tests, urea breath tests, and stool antigen detection [20]. Conversely, the diagnosis of infectious diseases frequently depends on noninvasive methodologies, such as stool antigen tests (SATs), serological assessments, urea breath tests, and molecular diagnostics, all of which demonstrate significant versatility [20]. The concurrent use of shamma and khat may present health risks, particularly concerning oral and systemic health, although specific research on shamma remains limited. There is a scarcity of published data regarding the prevalence of *H. pylori* infection among gastrointestinal patients across various regions of Yemen, and no evaluation of the risk factors associated with this infection [15, 21]. Accordingly, the present population- and sex-based investigations were conducted to determine the prevalence of *H. pylori* infection and identify its associated risk factors among individuals with gastrointestinal disorders in Dhamar City, Yemen.

2. MATERIALS AND METHODS

2.1. Specimen Collection:

A cross-sectional study was conducted from January to December 2022, during which 515 stool samples were collected in sterile containers from patients at General Dhamar Hospital and various diagnostic laboratories across Dhamar Governorate, Yemen. The samples were stored in cooler boxes and transported to the laboratory within two hours. Upon arrival, the patients were promptly and thoroughly analyzed for the presence of *H. pylori* antigens using stool antigen testing.

2.2. Detection of *H. pylori*

***H. pylori* Antigen Rapid Test Cassette.** The *H. pylori* Antigen Rapid Test Cassette (ACON, San Diego, CA 92121, USA) is a non-invasive diagnostic tool that employs a chromatographic immunoassay to qualitatively detect *H. pylori* antigens in human stool samples. The test demonstrated a sensitivity of 99.0 % and a specificity of 98.9%. The following section provides a concise overview of the operational procedures. Approximately 50 mg of stool specimen was placed in a tube containing 2 mL phosphate-buffered saline (PBS). The sample was vigorously mixed for 2 min to obtain a homogeneous suspension. Subsequently, two drops (approximately 90 μL) of the suspension were added to the wells of the rapid *H. pylori* antigen test cassette. The results were recorded after 10-15 minutes. A positive result was indicated by the emergence of a red line in the test (T) region of the cassette. A negative result was indicated by the presence of a red line in the control line (C) or absence of a line in the test line region (T). Detailed procedural steps are provided in the manufacturer's guidelines.

2.3. Questionnaire.

A structured questionnaire was used to gather comprehensive demographic data from participants through face-to-face interviews. The collected variables included sex, age, level of education, and household size. The questionnaire also explored behavioral risk factors such as khat consumption, cigarette smoking, and use of smokeless tobacco products (shamma) [14].

2.4. Statistical Analyses.

Statistical analyses were conducted using SPSS software, version 21. To determine statistically significant associations between categorical variables, chi-squared tests were used, with significance levels set at $p < 0.05$, within a 95 % confidence interval. Odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated to evaluate the strength of the association between the binary exposure and outcome variables. A multivariate logistic regression analysis was performed to assess potential risk factors, with a p-value of less than 0.05, or close to 0.05, used to confirm the variables as risk factors for *H. pylori* infection.

3. RESULTS

The current study comprised 515 participants, of whom 353 tested positive for the *H. pylori* antigen, resulting in an overall prevalence rate of 68.5 % (Figure 1).

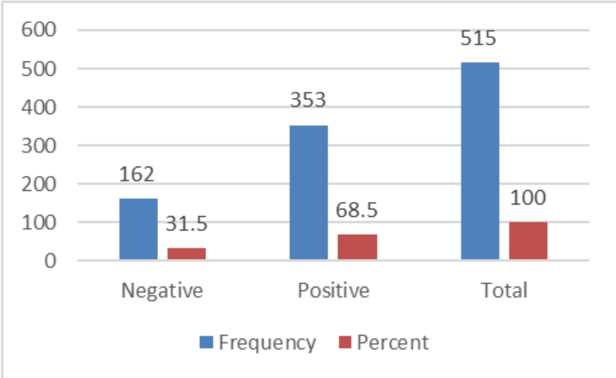

Figure 1. Prevalence of H. pylori antigen in total human samples

Table 1 presents the demographic and lifestyle characteristics of participants. Among the 515 participants, 185 (35.9%) were male and 330 (64.1%) were female. A significant majority (87.6%) originated from large families with more than four members, whereas only 12.4% belonged to small families with four or fewer members. The high proportion of individuals from larger households is a notable demographic characteristic. Additionally, over half of the participants (55.1%) resided in houses with three or fewer rooms, suggesting potentially crowded living conditions for a substantial segment of the study population. In contrast, 44.9% of respondents lived in houses with more than three rooms. Smoking was not prevalent among participants, with a substantial majority (77.1%) indicating that they did not smoke, whereas only 22.9% were identified as smokers. Conversely, khat chewing was a common practice, with more than half (57.9 %) of the participants reporting engaging in this activity. This finding underscores the significance of khat chewing as a lifestyle factor for this population. Tobacco chewing was significantly less prevalent than khat chewing, with only a small proportion (5.6%) of participants reporting this behavior. Most participants (94.4%) did not chew tobacco. The age distribution indicated that the largest segment of participants was within the 21-30 years age group (32.8%), followed by those aged 11-20 years (22.9%) and 31-40 years (20.8%). The study encompassed a broad age range, including children (1-10 years, 5.2%) and individuals over 60 years (3.9 %). The participants had diverse educational backgrounds. University graduates represented the largest group (22.3%), followed by individuals with secondary education (21.4%), and those with primary education (20.0%). Illiteracy was reported by 19.8 % of participants, while only 1.0% held a postgraduate degree. This variation reflects the mixed socioeconomic profile within the study population.

Table 1. Characteristics of the study population

Category	Variable	Number	%
Gender	Male	185	35.9
	Female	330	64.1
Family size	≤4	64	12.4
	>4	451	87.6
Room in house	≤3	284	55.1
	>3	231	44.9
Smoking	Yes	118	22.9
	No	397	77.1
Khat chewing	Yes	298	57.9
	No	217	42.1
Tobacco chewing	Yes	29	5.6
	No	486	94.4
Age Groups	1–10	27	5.2
	11–20	118	22.9
	21–30	169	32.8
	31–40	107	20.8
	41–50	50	9.7
	51–60	24	4.7
	> 60	20	3.9
Education level	Illiteracy	102	19.8
	Primary	103	20.0
	Intermediate	80	15.5
	Secondary	110	21.4
	University	115	22.3
	Postgraduate	5	1.0

The results of the *H. pylori* antigen test demonstrated a higher prevalence of *H. pylori* infection among females, with 246 cases (74.5%), in contrast to 107 cases (57.8%). in males. Statistical analysis indicated a significant difference in infection rates between the sexes ($p<0.05$), with females exhibiting a higher incidence than males. Furthermore, the probability of acquiring an *H.pylori* infection was twice as high in females than in males, as indicated by an odds ratio (OR) of 2.135, thereby suggesting an elevated risk for females (Table 2).

By contrast, the chi-square statistic was 0.376, which was not statistically significant ($p> 0.05$). Consequently, there were no significant differences in *H. pylori* infection rates based on family size (Table 3).

Statistical analysis revealed a significant association ($p<0.05$) between the prevalence of H. pylori infection and number of rooms in a household. Specifically, individuals residing in homes with three or fewer rooms (≤ 3) demonstrated a higher likelihood of infection than those living in homes with more than three rooms.

rooms (> 3). An odds ratio (OR) of 1.597 further suggests that residing in a household with three or fewer rooms is associated with an increased risk of H. pylori infection compared with living in a household with more than three rooms, as detailed in (Table 4). The present study identified a statistically significant association between stool antigen levels and smoking status ($p < 0.05$). Among the 118 patients who smoked, 46 had positive stool antigen results. The odds ratio (OR) of 5.339 suggests that individuals who smoke are 5.3 times more likely to be infected with H. pylori than non-smokers, thereby highlighting a notable epidemiological trend. (Table 5).

In the present study, a statistically significant difference was observed between the stool antigen results and the cohort of individuals who consumed khat (*Catha edulis*) ($p << 0.05$). Among the study sample, 217 participants did not consume khat (*Catha edulis*) and 31 of these individuals exhibited negative stool antigen test results. In contrast, 167 of the 298 participants who were khat consumers (*Catha edulis*) demonstrated positive stool antigen results. The odds ratio (OR) value of 4.707 among khat consumers (*Catha edulis*) indicates a higher risk of *H. pylori* infection than among non-khat consumers (Table 6).

Within the study cohort, 486 participants did not engage in tobacco chewing (shamma), of whom 342 (70.4%) tested positive for stool antigens, and 144 (29.6%) tested negative. Conversely, among the twenty-nine individuals who chewed tobacco (shamma), 11 (37.9%) exhibited a positive stool antigen result, and 18 (62.1%) tested negative. The association between stool antigen results and tobacco use (shamma) was statistically significant (P-value = .000). Tobacco chewers (shamma) were 3.886 times more likely to be infected with *H. pylori* than non-chewers (shamma); the odds ratio (OR) for males was higher than that for females (Table 7).

The study determined that the age group with the highest prevalence of *H. pylori* infection was 1-10 years, with 26 individuals (96.3%) affected This was followed by the 51-60 years' age group, where 20 individuals (83.3%) were recorded, 41-50 years age group had 41 individuals (82.0%) were affected, followed by the 31-40 years' group with 75 individuals (70.1%). The 11-20 years' age group had 74 individuals (62.7%), and the 21-30 years' age group had 104 individuals (61.5%). The association between stool antigen results and age group was statistically significant, as indicated by the p-value ($p < 0.05$) shown in (Table 8).

The data presented in Table 9 indicates educational level showed significant association ($p<0.05$) with *H. pylori* infection. The prevalence of *H. pylori* infection was (88.2%) in illiteracy patients, (85.4%) in primary education level, (57.3%) in Secondary and (48.7%)in university education level.

Table 10 illustrates the results of logistic regression analysis showed no statistically significant association between H. pylori infection and sex, age, or primary and postgraduate education level. However, a statistically significant correlation was found between H. pylori infection and other risk factors($p<0.05$).

Table 2. Prevalence of *H. pylori* antigen in humans by gender

Category	Variable	No. of samples	*H. pylori*				Odds ratio	95% Confidence Interval		χ^2	p-value
			Positive		Negative			Lower	Upper		
			No.	%	No.	%					
Gender	**Male**	185	107	57.8	78	42.2	2.135	1.456	3.130	15.3	.000
	Female	330	246	74.5	84	25.5					
	Total	515	353	68.5	162	31.5					

Table 3. Prevalence of *H. pylori* antigen in human according to family size

Category	Variable	No. of samples	*H. pylori*				Odds ratio	95% Confidence Interval		χ^2	p-value
			Positive		Negative			Lower	Upper		
			No.	%	No.	%					
Family size	≤ 4	64	46	71.9	18	28.1	0.834	0.467	1.490	0.38	0.540
	> 4	451	307	68.1	144	31.9					
	Total	515	353	68.5	162	31.5					

Table 4. Prevalence of H. pylori antigen in humans according to the room in the house

Category	Variable	No. of samples	*H. pylori*				Odds ratio	95% Confidence Interval		χ^2	p-value
			Positive		Negative			Lower	Upper		
			No.	%	No.	%					
Room in house	≤3	284	182	64.1	102	35.9	1.597	1.091	2.338	5.84	.016
	>3	231	171	74.0	60	26.0					
	Total	515	353	68.5	162	31.5					

Table 5. Prevalence of *H. pylori* antigen in human according to smoking

Category	Variable	No. of samples	*H. pylori*				Odds ratio	95% Confidence Interval		X^2	*P*-value
			Positive		Negative			lower	upper		
			No.	%	No.	%					
Smoking	Yes	118	46	39.0	72	61.0	5.339	3.445	8.276	62.0	.000
	No	397	307	77.3	90	22.7					
	Total	**515**	**353**	**68.5**	**162**	**31.5**					

Table 6. Prevalence of *H. pylori* antigen in human according to khat (*Catha edulis*) chewing

Category	Variable	No. of samples	*H. pylori*				Odds ratio	95% Confidence Interval		χ^2	*p*-value
			Positive		Negative			Lower	Upper		
			No.	%	No.	%					
khat	Yes	298	167	56.0	131	44.0	4.707	3.020	7.335	51.2	0.000
	No	217	186	85.7	31	14.3					
Total		353	68.5	162	31.5						

Table 7. Prevalence of *H. pylori* antigen in Human according to Tobacco chewing (Shamma)

Category	Variable	No. of samples	*H. pylori*				Odds ratio	95% Confidence Interval		X^2	p-value
			Positive		Negative			Lower	Upper		
			No.	%	No.	%					
Tobacco chewing (Shamma)	Yes	29	11	37.9	18	62.1	3.886	1.791	8.435	13.4	.000
	No	486	342	70.4	144	29.6					
	Total	515	353	68.5	162	31.5					

4. DISCUSSION

Helicobacter pylori (H. pylori) is a globally prevalent bacterium that infects more than half of the world's population. As a major public health concern, *H. pylori* has significantly higher prevalence rates in developing countries than in developed regions [21]. *H. pylori* infection is a health challenge in developing countries. linked to chronic gastritis, which has the potential to progress to severe Gastroduodenal disorders include peptic ulcers, gastric cancer, and gastric mucosa-associated lymphoid tissue (MALT) lymphoma [15, 22].

Table 8. Prevalence of *H. pylori* antigen according to age group among suspected gastrointestinal patients

Age groups	No. of samples	H. pylori				χ^2	p-value
		Positive		Negative			
		No.	%	No.	%		
1–10	27	26*	96.3	1*	3.7	22.2	0.001
11–20	118	74	62.7	44	37.3		
21–30	169	104	61.5	65	38.5		
31–40	107	75	70.1	32	29.9		
41–50	50	41	82.0	9	18.0		
51–60	24	20	83.3	4	16.7		
>60	20	13	65.0	7	35.0		

* means statistically significance difference by Post hoc analysis

Table 9. Prevalence of *H. pylori* antigen according to education level among suspected gastrointestinal patients

Education level	No. of samples	*H. pylori*				χ^2	p-value
		Positive		Negative			
		No.	%	No.	%		
Illiteracy	102	90*	88.2	12*	11.8	62.6	0.001
Primary	103	88*	85.4	15*	14.6		
Intermediate	80	51	63.8	29	36.3		
Secondary	110	63*	57.3	47*	42.7		
University	115	56*	48.7	59*	51.3		
Postgraduate	5	5	100.0	0	0.0		

* means statistically significance difference by Post hoc analysis

Table 10. Logistic regression analysis of risk factors for prevalence of *H. pylori* antigen among suspected gastrointestinal patients

Logistic regression					
Variables	Odds ratio	CI 95%		χ^2	p-value
		Lower	Upper		
Sex	0.7	0.4	1.2	1.3	0.2
Room in house	1.9	1.2	3.2	8.2	0.004
Smoking	3.9	2.2	6.8	22.3	0.001
Khat chewing	3.2	1.8	5.7	14.8	0.001
Tobacco chewing (shamma)	3.0	1.2	7.9	5.2	0.02
Age	......	......	......	9.8	0.1
Education level	......	......	......	33.5	0.001
Primary	0.8	0.3	2.1	0.2	0.7
Intermediate	0.3	0.1	0.7	7.0	0.008
Secondary	0.2	0.09	0.6	8.6	0.003
University	0.1	0.03	0.3	22.4	0.001
Postgraduate	......	......	......	......	0.99
Constant	......	......	......	16.2	0.001
Illiteracy used as reference for comparison					

H. pylori infection primarily spreads through five primary transmission pathways: fecal–oral, oral–oral, gastric-oral, anal–oral, and genital–oral [23, 24]. Socioeconomic conditions are significantly correlated with the acquisition of *H. pylori* infection, particularly during childhood, in both developed and developing countries. If left untreated, the infection may persist throughout an individual's lifetime owing to various risk factors that compromise immune responses, thereby facilitating the persistence of the organism [25]. As illustrated in Figure 1, the prevalence rate observed in this study was 68.5%. This elevated rate may stem from multiple contributing factors, including inadequate sanitation, use of unsafe drinking water, insufficient hygiene practices, improper washing of vegetables and khat (*Catha edulis*), contamination from agricultural wastewater, unhealthy dietary habits, and overcrowded living conditions within the Yemeni population [13]. These findings align with previous surveillance studies reporting prevalence rates ranging from

40% to 82% in nearby countries, such as Egypt, Iraq, Turkey, the United Arab Emirates, and Iran [26]. In contrast, lower rates of 12%–18% have also been documented within the region [27]. This study revealed a significant association between sex, and positive detection of *H. pylori* via the stool antigen test (SAT) ($p < 0.05$). This result is consistent with the findings reported by Salahi-Niri et al. (2024), who similarly observed a significant correlation between sex and *H. pylori* positivity in stool antigen assays. Multiple factors, including ethnicity; place of birth; socioeconomic conditions; and environmental, cultural, and educational influences, play a critical role in shaping infection risk, even among populations within the same country [28]. Huseyin (2024), in Duhok City, Iraq, found significant variation between male and Female (p=0.012) [29]. Conversely, this observation contrasts with the findings of Xie et al. (2025), who reported no significant association between sex and *H. pylori* infection [30]. The prevalence of *H. pylori* infection was higher among females than males because lower levels of education or health literacy in some female populations can contribute to higher infection rates due to reduced knowledge about prevention and treatment. This result aligns with findings from previous studies (Adeniyi et al., 2012), which found that H. pylori infection was *H.pylori* in females higher than males among dyspepsia patients [31]. However, this result contrasts with that of Naqid et al. (2024), who reported a lower prevalence among females (33.6%) than among males (46.0%) in a similar Iraqi cohort. Such discrepancies may reflect differences in regional lifestyles or demographic characteristic [32]. The present study found no significant association between *H. pylori* infection and family size. These results are not in agreement with the study by Zhang et al. (2021), who found a significant difference between family members (P<0.05) [33]. However, a statistically significant correlation was observed between the infection rates and the number of rooms within a household ($p < 0.05$). This aligns with the findings of Ikobah et al. (2024), who also reported a significant relationship between *H. pylori* infection and household room count ($p = 0.001$) [34]. Interestingly, the infection rate was higher among non-smokers than smokers ($p < 0.05$) Smoking increases gastric acid secretion, which may create a less favorable environment for *H.pylori* colonization, thereby reducing infection rates among smokers, a finding that agreement the results of Odigie et al. (2020), who reported the prevalence of *H. pylori* infection was lower in smokers (21.9%) than nonsmokers (35.4%) [35]. In contrast, numerous studies have demonstrated that smoking is a risk factor for various diseases, including gastric cancer (GC) and *Helicobacter pylori* infection [36]. In our sample, smoking status was associated with *H. pylori* infection. Similarly, Al-Mekhalfi et al. (2023) [37] reported a statistically significant association between smoking and *H. pylori* infection (p=0.03). Moreover, the results of the present study diverge from those reported by Al-Awadhi et al. (2020) [38], who found a higher prevalence of *H. pylori* infection among individuals who chew khat (*Catha edulis*). Conversely, Abdu et al. (2020) [39] observed no significant association between khat chewing and *H.pylori* infection rates. Khat use has been linked to various gastrointestinal disturbances such as gastritis, which may compromise the integrity of the gastric mucosa. Additionally, because *H. pylori* is commonly transmitted through oral-to-oral and fecal-to-oral routes, khat chewing may contribute to an increased risk of colonization [16, 39]. The current findings demonstrate a statistically significant correlation ($p < 0.05$) between age and the prevalence of *H. pylori* infection. Notably, the highest prevalence (96.3%) was observed among children aged 1–10 years, whereas the second-highest prevalence was identified in the 51–60 years age group (83.3%). These results suggest that *H. pylori* infection is frequently acquired in early childhood and persists throughout life in the absence of effective eradication therapy [40]. These findings contrast with those of other studies that reported the absence of a statistically significant correlation between *H. pylori* infection and age [40]. It is well established that advancing age constitutes a contributory factor for *H. pylori* infection, with numerous studies demonstrating a higher prevalence of *H. pylori* infection among older individuals and those with lower socioeconomic status [41]. These findings corroborate previous studies by showing that individuals over the age of 50 are more susceptible to *Helicobacter pylori* infection, with age serving as a significant predictor. Additionally, participants with illiteracy and primary education levels exhibited the highest prevalence of *H. pylori* infection, indicating a notable correlation. This observation is consistent with other research that identified a link between *H. pylori* infection and both low and secondary education levels. [42], although illiteracy was identified as the primary predictor of *H. pylori* seroprevalence [43]. This may be attributed to the influence of a low educational level on personal and environmental hygiene, which affects the incidence of *H. pylori* infection. Socioeconomic determinants are intricately linked with *H. pylori* infection in both industrialized and developing nations, particularly during the early stages of life, and this association persists into adulthood [44]. Additional risk factors associated with *H. pylori* infection include socioeconomic status, living conditions such as overcrowding, rural residency, sanitation and hygiene practices, drinking water sources, and a family history of gastric diseases, all of which can affect the acquisition and spread of *Helicobacter pylori*. Although *H. pylori* is typically treated with antibiotics, treatment failure can occur due to factors related to *H. pylori* itself, environmental influences, and host factors, particularly when antibiotic resistance is present [25, 45]. The outcomes highlight the importance of early detection and targeted health education in communities with a high *H. pylori* incidence, with a special emphasis on younger children, less educated persons, and frequent khat and tobacco users. Interventions should be designed to address behavioral and environmental risk factors to reduce infection burden.

5. CONCLUSION

In conclusion, this investigation on *H. pylori* infection and its associated risk factors yielded significant results. The prevalence of *H.pylori* infection was notably high (68.5%) among the gastrointestinal patients in Dhamar and Yemen. These findings underscore the pivotal influence of environmental, socioeconomic, and behavioral determinants on the acquisition and persistence of infection. The observed disparities in infection rates, particularly the elevated prevalence among females and their correlation with identified risk factors, suggest the existence of specific population subgroups that exhibit heightened susceptibility to *H. pylori* infection. This delineates a clear framework for targeted health intervention. These results necessitate prompt implementation of effective public health strategies in Dhamar and analogous regions in Yemen. Such strategies should prioritize early detection and customized health education campaigns, with a critical focus on the specific demographic, socioeconomic, and behavioral risk factors identified in this study. Health policymakers are advised to direct educational and sanitation interventions for high-risk populations including children and low-income households. Future research should employ longitudinal and molecular diagnostic methodologies to validate these findings and to explore causality. This study affirms that *H. pylori* infection remains a significant public health challenge in Dhamar, Yemen and that understanding the associated risk factors is essential for the development of effective prevention and treatment programs. Ethical Compliance: All methodologies utilized in studies involving human participants adhered to the ethical standards set forth by the pertinent institutional and/or national research committees as well as the 1964 Helsinki Declaration and its subsequent amendments or equivalent ethical guidelines. Conflict of Interest Declaration: The authors declare that they have no affiliations or engagements with any organization or entity that holds a financial interest in the subject matter or materials discussed in this manuscript.

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