JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Prevalence and Factors Associated with Helicobacter Pylori Infection Among Adult Patients Attending Ruhengeri Referral Hospital, Rwanda

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Abstract
Helicobacter pylori (H. pylori) is a globally prevalent bacterial infection, affecting nearly half of the world's population and posing a significant public health challenge, especially in developing countries. It is associated with gastrointestinal conditions such as peptic ulcers, chronic gastritis, and gastric cancer. Despite this, limited data exist on its prevalence and risk factors in Rwanda, particularly at Ruhengeri Referral Hospital. This study aims to determine the prevalence of H. pylori infection and identify associated factors among adult outpatients. A cross-sectional study was conducted among 422 adults using systematic random sampling. Data were collected through structured interviews and H. pylori stool antigen testing. Statistical analyses were performed using SPSS version 20, with descriptive statistics used to determine prevalence, chi-square tests to explore associations, and logistic regression to identify independent predictors. The overall prevalence of H. pylori infection was 33.4%. Male participants had significantly higher infection rates ($p = 0.048$). Consumption of fermented foods ($p = 0.005$) and processed meats ($p < 0.001$) were linked to increased risk. Environmental and behavioral factors such as eating outside the home ($p = 0.039$), having infected family members ($p = 0.024$), inconsistent handwashing ($p < 0.001$), and irregular use of clean water ($p < 0.001$) were also associated. These findings emphasize the need for targeted public health interventions focusing on hygiene, safe water access, and dietary education to curb H. pylori transmission.

Keywords: H. pylori, Prevalence, Associated factors

1 Introduction

Helicobacter pylori (H. pylori) is a highly prevalent bacterial infection, affecting nearly half of the global population. While many infections remain asymptomatic, H. pylori is recognized as a primary cause of gastrointestinal disorders such as peptic ulcers, chronic gastritis, and gastric cancer (Harris et al., 2022). Due to its strong association with gastric malignancies, the International Agency for Research on Cancer (IARC), in conjunction with the World Health Organization (WHO), classified H. pylori as a Group I carcinogen in 1994. Approximately 4.4 billion people worldwide are estimated to be infected, making it one of the most successful human pathogens (Reyes, 2023). Global prevalence varies markedly by region, with the highest rates reported in the African and Eastern Mediterranean regions and the lowest in Europe. Socioeconomic and demographic factors significantly influence infection rates, which are generally higher in low-income settings with poor sanitation (Chen et al., 2024). In Africa, the prevalence often exceeds 70%, contributing substantially to gastric cancer morbidity and mortality. Limited healthcare access, environmental exposure, genetic factors, and inaccurate diagnostic methods exacerbate the burden (Emmanuel et al., 2024b). In East Africa, pooled evidence indicates a 51% prevalence of H. pylori, with increased risk linked to poor hygiene, unsafe water, rural residence, and limited education (Mnichil et al., 2024a). In Rwanda, a study found prevalence rates of 75.8% among stomach cancer patients and 80.2% among chronic gastritis patients, underscoring the critical burden of H. pylori infection (Nizeyimana et al., 2021).

1.1 Statement of the Problem

Helicobacter pylori infects nearly half of the world's population and is a major cause of gastritis, peptic ulcers, and gastric cancer. Rising antibiotic resistance has led to increased treatment failures, costing an estimated six billion dollars annually, prompting the WHO to classify H. pylori as a high-priority pathogen (Olleik et al., 2019). Globally, 80–90% of gastric cancer and lymphoma cases are linked to the bacterium, leading to WHO recommendations for eradication to reduce mortality (Elbehiry et al., 2023). In Africa, the absence of standardized treatment guidelines, limited healthcare infrastructure, and increasing antimicrobial resistance hinder effective management (Smith et al., 2022). Prevalence varies widely, and many African regions lack recent epidemiological data, making it difficult to track current trends (Smith et al., 2019). Transmission occurs mainly through fecal-oral and oral-oral routes, with risk factors including poor hygiene, unsafe water, smoking, stress, and dietary habits (Sun et al., 2023). In Rwanda, H. pylori infection remains high, with a 77.5% prevalence among patients with gastritis and gastric cancer (Nizeyimana et al., 2021). Understanding its prevalence and associated factors is essential for guiding effective prevention and control strategies.

1.2 Objectives of Study

i. To determine the prevalence of H. pylori infection among adult patients attending Ruhengeri Referral Hospital, Rwanda

ii. To identify associated factors with H. pylori infection among adult patients attending Ruhengeri Referral Hospital, Rwanda.

iii. To determine the independent predictors of H. pylori infection among adult patients attending Ruhengeri Referral Hospital, Rwanda

2.Review of Related Literature

2.1 Empirical Literature

2.1.1 Prevalence of H. pylori Infection Among Adult Patients

Hooi et al. (2017) conducted a systematic review and meta-analysis spanning studies from 1970 to 2016 to explore global variations in H. pylori prevalence. Their findings revealed that approximately 4.4 billion people were infected in 2015, with stark regional disparities: Africa had the highest prevalence at 70.1%, while Oceania had the lowest at 24.4%. Nigeria recorded 87.7% prevalence, compared to Switzerland's 18.9%. These differences underscore the need for tailored regional eradication strategies. Similarly, Alsulaimany et al. (2020) examined H. pylori prevalence in the Middle East and North Africa (MENA) region, reporting rates ranging from 36.8% to 94% in adults. Factors such as lower socioeconomic status and food or water contamination were significant contributors. Notably, prevalence rates varied, with Egypt at 53%, Iran at 64.2%, and Tunisia at 82%. In Ethiopia, Belay et al. (2020) found a 42.8% prevalence of H. pylori among dyspeptic adults. Infection rates were higher among housewives, individuals living in larger households, those with domestic animals, and consumers of untreated water. In Uganda, Namyalo et al. (2021) reported a 35.7% 5-year prevalence among affluent patients in Kampala, with a peak rate of 43.4% in 2018. In Rwanda, Nizeyimana et al. (2021) assessed archived tissue samples and reported an overall H. pylori prevalence of 77.5% among patients with gastritis and gastric adenocarcinoma. The study found no significant association between infection rates and demographic factors, suggesting the widespread nature of the infection.

2.1.2 Factors Associated with H. pylori Infection Among Adult Patients

Kouitcheu Mabeku et al. (2018) investigated risk factors among 205 dyspeptic patients in Cameroon and found a 64.39% prevalence. Significant predictors included low socioeconomic status, poor hygiene, crowded living conditions, NSAID use, and a family history of gastric diseases. Harris et al. (2022) conducted household surveys assessing water sources, sanitation, and lifestyle factors, highlighting the influence of environmental and socioeconomic conditions on infection rates. In developing regions like Africa, where prevalence exceeds 70%, risk factors include overcrowding, inadequate housing, and contaminated water sources (Aminde et al., 2019). Dao et al. (2021) emphasized behavioral risk factors such as pre-masticated food and raw vegetable consumption, which contribute to intra-familial transmission in Vietnam. Negash et al. (2018) further confirmed that H. pylori infection remains prevalent in Ethiopia, with well water consumption and poor sanitation being primary risk factors. These studies collectively highlight that H. pylori infection is influenced by socioeconomic, environmental, and behavioral factors, especially in low-resource settings.

2.2 Theoretical Framework

2.2.1 Social Determinants of Health Models

The Social Determinants of Health (SDH) concept originates from the 19th-century work of Rudolf Virchow and Friedrich Engels, who linked health outcomes to social conditions such as poverty and working environments. Over time, researchers like Thomas McKeown and Aaron Antonovsky expanded on this relationship, emphasizing the role of environmental and social contexts in creating health inequalities. A significant advancement came from Dr. Michael Marmot through the Whitehall Studies in the 20th century, which demonstrated the direct correlation between social gradients—like income and education—and health outcomes. Marmot later chaired the WHO Commission on Social Determinants of Health, which, through its 2008 report *"Closing the Gap in a Generation,"* underscored the global importance of addressing social inequality to improve health equity (Chelak & Chakole, 2023).

Socioeconomic status (SES), a core SDH component, comprises income, educational attainment, occupation, and access to resources. It influences living conditions, access to healthcare, and exposure to disease. Research shows that SES disparities contribute to the uneven burden of H. pylori infection, particularly through overcrowded living, unsafe water, and limited healthcare access (Factor & Pulmonary, 2024).This study applies the SDH framework to assess the prevalence of H. pylori at Ruhengeri Referral Hospital, analyzing demographic, behavioral, environmental, and socioeconomic factors. This approach informs targeted interventions and public health strategies aimed at reducing infection rates and improving health outcomes.

2.3 Conceptual Framework

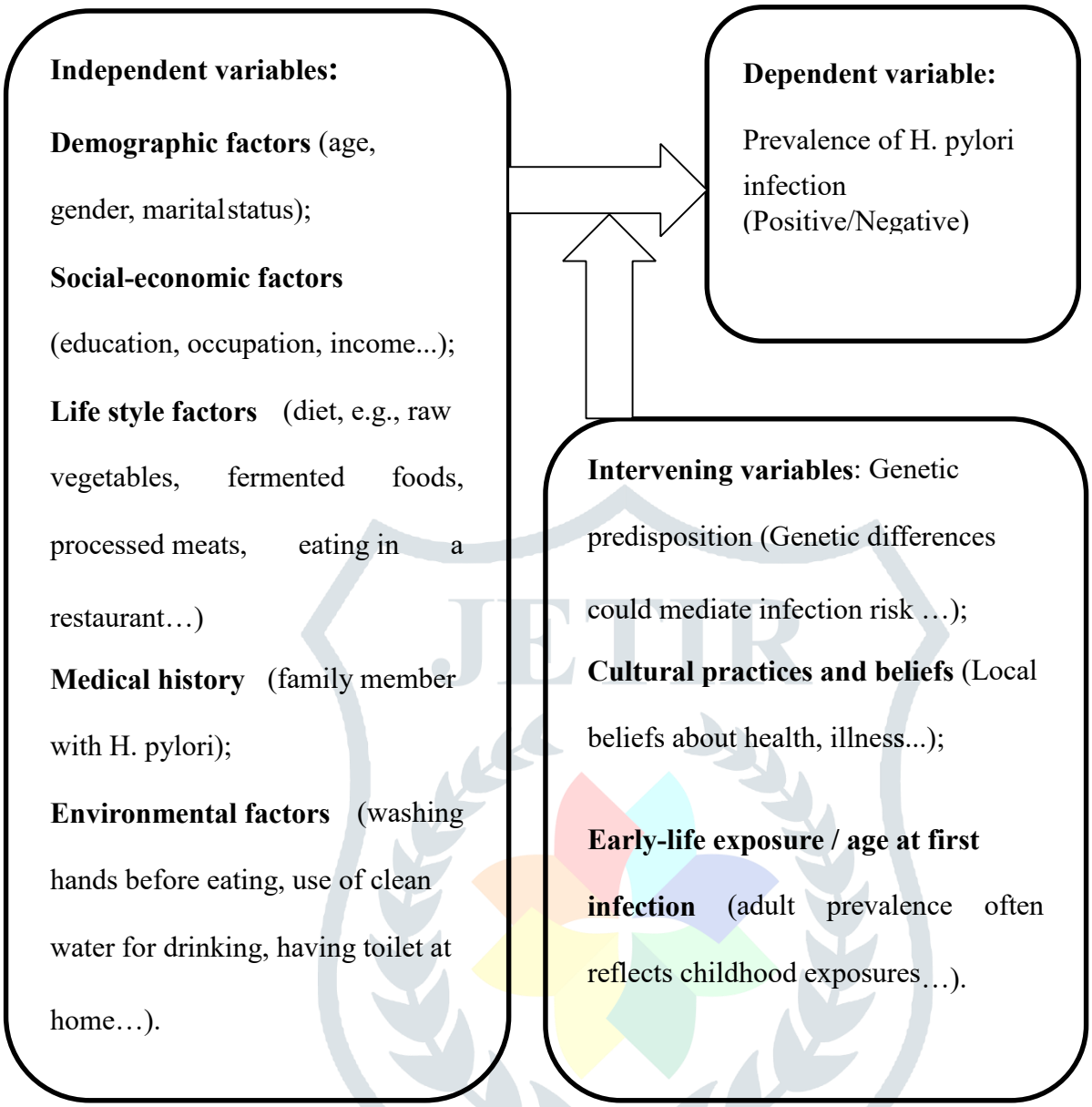

Figure 2.1: Conceptual Framework

Independent variable are factors associated with H. pylori infection. They include demographic factors (age, gender, marital status); Social-economic factors (education, occupation, income…); Environmental factors (hygiene, sanitation, washing hands, before eating, access to clean water); Life style factors (diet: raw vegetables, fermented foods, processed meats); Medical factors (family member with H. pylori).

The dependent variable is the prevalence of H. pylori infection in adult patients attending Ruhengeri Referral Hospital. The primary outcome or phenomenon under investigation is the prevalence of H. pylori infection. It refers to the proportion of adult patients at Ruhengeri Referral Hospital who tested positive for H. pylori infection.

The independent variables which includes socio-demographic, lifestyle, clinical, and environmental factors, were expected to influence the dependent variable, which is the prevalence of H. pylori infection. For instance, factors such as poor diet or inadequate sanitation may increase the likelihood of infection.

Intervening variables encompass elements that affect both the independent variables and the dependent variable yet are not directly assessed as the cause.

Genetic predisposition: Some individuals may have a genetic inclination to being infected with H. pylori due to variations in genes that regulate immune response. Genetic variations might influence the risk of infection, irrespective of lifestyle or environmental factors.

Cultural practices and beliefs: Local beliefs about health, illness, and healthcare could modify how demographic, socioeconomic, and lifestyle factors are associated with H. pylori infection, such as dietary habits or alternative health practices.

Early-life exposure / age at first infection: Adult prevalence often reflects childhood exposures (crowding, sanitation) that occurred years earlier and can't be changed or perfectly recalled.

3. Research Methodology

3.1 Research Design

A cross-sectional research design was employed to determine the prevalence of Helicobacter pylori infection and identify associated factors among adult patients at Ruhengeri Referral Hospital. This design involved collecting data at a single point in time, which is ideal for estimating prevalence within a defined population. By simultaneously gathering information on infection status and potential risk factors, the study efficiently assessed associations between H. pylori and variables such as demographic, behavioral, and environmental factors. The choice of a cross-sectional design was driven by its practicality, cost-effectiveness, and suitability for prevalence studies. Unlike longitudinal studies requiring prolonged follow-up and larger resources, this design provided a timely and feasible approach for the hospital setting. It offered a reliable snapshot of infection patterns while conserving time and resources.The study was conducted at Ruhengeri Referral Hospital in Musanze District, Northern Province, Rwanda. This major healthcare institution serves diverse urban and rural populations and is renowned for services in gastroenterology, internal medicine, and laboratory diagnostics, making it an appropriate setting for this investigation.

3.2 Target population

The target population comprised adults aged 18 years and above seeking medical services at Ruhengeri Referral Hospital. This group included individuals from diverse socioeconomic backgrounds, residing in both urban and rural areas within the hospital's catchment. Based on recent demographic and hospital records, the hospital serves an estimated population of 300,000, with approximately 60,000 adults eligible for this study.

Inclusion criteria covered adults attending outpatient services during the study period who provided informed consent, could understand the questionnaire, and agreed to submit stool samples for H. pylori testing. Individuals recently treated with antibiotics, PPIs, or bismuth compounds, critically ill patients, and those refusing participation were excluded.

The size of the sample was determined using the formula for estimating a proportion with a defined level of accuracy:

$$n = \frac{Z^2 \times P \times (1 - P)}{d^2}$$

Where:

n = necessary sample size

Z = Z-score (1.96 for a 95 percent confidence level)

P = estimated prevalence of H. pylori infection (considered to be 50% for maximum sample size since no previous data is available) d = margin of error (0.05)

Assuming 50% prevalence and a 5% margin of error, the required size of the sample is:

$$n = \frac{1.96^2 \times 0.5 \times (1 - 0.5)}{0.05^2} = 384$$

To address possible non-responses or incomplete data, the sample size was increased by 10%, leading to a final sample size of about 422. The sampling frame included all adult patients who visited Ruhengeri Referral Hospital during the study period. Systematic random sampling was applied. After generating a daily list of eligible patients, the sampling interval (k) was calculated by dividing the total number of patients by the desired sample size. A random starting point between 1 and k was selected using a random number generator, and every k-th patient thereafter was included until the target sample size was reached. This method was used to minimize selection bias and supported the cross-sectional study design, which was appropriate for analyzing the prevalence and associated factors of H. pylori infection among the targeted population.

3.3 Data collection methods

Data were collected using structured questionnaires and face-to-face interviews. The questionnaires, designed with standardized questions, were administered uniformly to all participants, ensuring consistency and reducing bias. Their structured format allowed efficient collection of data from multiple respondents while maintaining anonymity and encouraging honest responses. In addition, face-to-face interviews were conducted to supplement the questionnaires. These involved one-on-one interactions between the researcher and participants, creating a comfortable environment for in-depth discussions. The interviews provided an opportunity for participants to express themselves freely, especially when discussing sensitive factors associated with H. pylori infection. Participants were selected based on predefined criteria and contacted individually. Each participant received a clear introduction to the study and an overview of the questionnaire. Interviews were scheduled at participants' convenience to accommodate their needs. During the interview, the researcher read questions aloud and recorded responses, following a standardized script to ensure uniformity and minimize interviewer bias. Reliability of the questionnaire was assessed through a pilot study involving

30 patients. Cronbach's alpha score exceeded 0.7, indicating acceptable internal consistency. Inter-rater reliability for stool antigen testing was ensured through technician training, with a Cohen's kappa above 0.7. Validity was established through expert review, factor analysis, and comparison with serology results, confirming the tools' accuracy and relevance.

3.4 Data analysis procedure

Data were analyzed to determine the prevalence of H. pylori infection among adult patients presenting with dyspeptic symptoms at Ruhengeri Referral Hospital. Prevalence was calculated by dividing the number of stool antigen-positive cases by the total sample size and presented using tables and pie charts. Associations between infection status and demographic, lifestyle, environmental, and clinical factors were assessed using Chi-square tests. Logistic regression was performed to identify independent predictors of infection. A p-value < 0.05 was deemed statistically significant. After data cleaning in Excel, analysis was conducted in SPSS version 20. Results were presented in graphical and tabular formats for clarity.

3.5 Ethical consideration

Approval was obtained from the research ethics committee (Institutional Review Board, IRB) to ensure that the study adhered to established ethical standards. Participants were provided with clear and accessible information about the study's purpose, procedures, potential risks, and benefits. Consent was obtained voluntarily, with all participants informed of their right to withdraw from the study at any time without penalty. Data were protected using password secured databases and encryption methods to maintain confidentiality and privacy. Any risks or discomfort experienced by participants were addressed promptly. The research aimed to contribute to improved public health strategies for managing H. pylori infection and to reduce related healthcare costs. Anonymized data and strict access controls were implemented to safeguard participant privacy. Throughout the study, ethical standards were strictly upheld to maintain the integrity of the research and protect the rights of all participants.

4. Findings Presentation

4.1 Demographic Characteristic of Respondents

Table 4.1 Demographic Characteristic of Respondents vs H. pylori antigen tests results (Positive)

		H. pylori antigen tests results (Positive)
		N %
Age group	18-34	46.1%
	35-51	36.2%
	52 and above	17.7%
Gender	Male	42.6%
	Female	57.4%
Marital status	Single Married	27.0% 67.4%
	Divorced	0.0%
	Widowed	5.7%
Residence	Urban	34.8%
	Rural	65.2%
Education level	No official school Elementary school	21.3% 20.6%
	High school	36.9%
	Vocational/Technical trainings	4.3%
	Higher educational qualification	12.8%
	Graduate	4.3%
Occupation	Farmer	46.1%

	Breeder	2.8%
	Merchant	15.6%
	Salaried employee	19.9%
	Student	15.6%
Monthly income	Below 50K	23.4%
	Between 51K - 150K	36.9%
	Between 151K - 250K	24.8%
	251K and above	14.9%

Table 4.1 illustrates the demographic characteristics of respondents in relation to H. pylori antigen test results at Ruhengeri Referral Hospital, providing insights into how personal and social factors influence infection prevalence. The highest infection rate was observed among individuals aged 18–34 years (46.1%), followed by those aged 35–51 years (36.2%), suggesting that younger, economically active adults may be more exposed due to lifestyle choices such as eating out or stress-related factors. The infection rate dropped significantly among individuals aged 52 and above (17.7%), possibly reflecting reduced exposure or improved hygiene with age. Females had a higher infection rate (57.4%) compared to males (42.6%), potentially due to caregiving roles that increase exposure. Marital status also showed notable variation, with married individuals accounting for 67.4% of infections, likely due to shared living spaces and family exposure, while singles had 27% and widowed participants only 5.7%. No cases were found among the divorced, though sample size may be a factor. Rural residents (65.2%) were more affected than urban dwellers (34.8%), reflecting disparities in sanitation and health education. Education appeared protective; those with secondary education had the highest infection rate (36.9%), while degree holders had only 4.3%. Farmers recorded the highest occupational exposure at 46.1%, and infection rates decreased with higher income levels. These findings underscore the need for targeted public health interventions.

4.2 Prevalence of H. pylori infection among adult patients attending Ruhengeri Referral Hospital, Rwanda

Table 4. 2: Prevalence of H. pylori infection

		Frequency	Percent	Valid Percent
Valid	Negative	281	66.6	66.6
	Positive	141	33.4	33.4
	Total	422	100.0	100.0

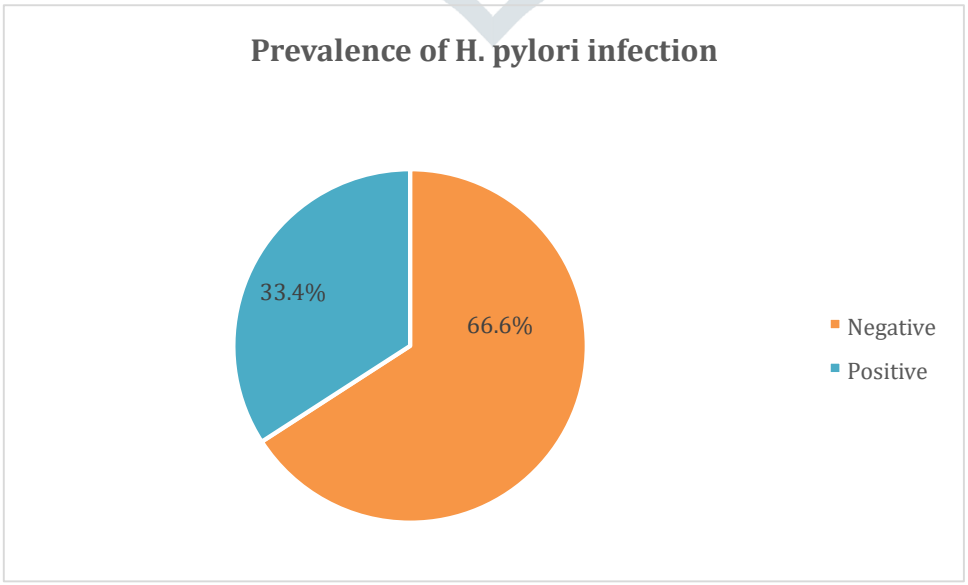

Figure 4. 1 : Prevalence of H. pylori infection

The results presented in Figure 4.1 shows that 33.4% of the adult patients tested positive for H. pylori antigen, while 66.6% tested negative. This means that about one in every three adult patients attending Ruhengeri Referral Hospital was infected with H. pylori. The prevalence observed here is quite significant and shows that H. pylori remains a serious public health concern in this region.

4.3 Factors associated with H. pylori infection among adult patients attending Ruhengeri Referral Hospital, Rwanda.

Table 4.3: Factors associated with H. pylori infection among adult patients attending Ruhengeri Referral Hospital, Rwanda.

Ruhengeri Referral Hospital, Rwanda.

			H. pylori antigen tests results						95% C.I for AOR	
			Negative		Positive					
			(n=281)	n%	(n=141)	n%	χ^2	P- value	AOR	Lower	Upper
Demographic factors	Age group	18-34	133	47.3%	65	46.1%			1.354	.673	2.725
		35-51	91	32.4%	51	36.2%			1.239	.529	2.898
		52 and above	57	20.3%	25	17.7%	3.756	0.289	.000	.000	.
	Gender	Male	92	32.7%	60	42.6%			.661	.396	1.101
		Female	189	67.3%	81	57.4%	3.923	**0.048**	.534	.179	1.592
	Marital status	Single	63	22.4%	38	27.0%			.000	.000	.
		Married	197	70.1%	95	67.4%			1.786	.374	8.529
		Divorced	5	1.8%	0	0.0%	3.415	0.332	.580	.320	1.050
		Widowed	16	5.7%	8	5.7%			1.201	.535	2.699
	Residence	Urban	80	28.5%	49	34.8%	1.746	0.186	1.616	.690	3.785
		Rural	201	71.5%	92	65.2%			.949	.221	4.063
Social economic factors	Education level								.589	.089	3.876
		No official school	71	25.3%	30	21.3%			1.773	.130	24.183
		Elementary school	52	18.5%	29	20.6%			.352	.144	.863
		High school	104	37.0%	52	36.9%			.389	.106	1.424
		Vocational/Technical trainings	14	5.0%	6	4.3%	1.469	0.917	.419	.113	1.556
		Higher educational qualification	29	10.3%	18	12.8%			.933	.395	2.204
		Graduate	11	3.9%	6	4.3%			1.262	.471	3.383
	Occupation	Farmer	138	49.1%	65	46.1%			3.743	.815	17.196
		Breeder	3	1.1%	4	2.8%			6.291	.787	50.298
		Merchant	41	14.6%	22	15.6%	2.283	0.684	2.456	.000	.
		Salaried employee	51	18.1%	28	19.9%			17.413	.000	.
		Student	48	17.1%	22	15.6%			27.404	.000	.
	Monthly income	Below 50K	77	27.4%	33	23.4%			1.580	.064	38.858
		Between 51K - 150K	101	35.9%	52	36.9%			.268	.018	4.038
		Between 151K - 250K	78	27.8%	35	24.8%			.200	.014	2.907
		251K and above	25	8.9%	21	14.9%	4.580	0.333	.000	.000	.
	Eating raw vegetables	Daily	0	0.0%	2	1.4%			.000	.000	.

Life Style Factors		Weekly	11	3.9%	4	2.8%			.000	.000	.
		Monthly	18	6.4%	10	7.1%	4.370	0.224	.000	.000	.
		Rarely	252	89.7%	125	88.7%			.315	.059	1.691
		Never	0	0.0%	0	0.0%			.249	.052	1.181
	Consumption of fermented foods	Daily	1	0.4%	7	5.0%			.050	.005	.528
		Weekly	11	3.9%	10	7.1%			.000	.000	.
		Monthly	38	13.5%	17	12.1%	13.047	**0.005**	2.152	1.088	4.257
		Rarely	231	82.2%	107	75.9%			3.286	1.367	7.902
		Never	0	0.0%	0	0.0%			8.798	1.899	40.753
	Consumption of processed meats	Daily	0	0.0%	4	2.8%			3.557	1.683	7.519
		Weekly	3	1.1%	9	6.4%			59.71	5.725	622.792
		Monthly	13	4.6%	14	9.9%	24.23	**<0.001**	1.201	.115	12.526
		Rarely	214	76.2%	87	61.7%			1.049	.450	2.444
		Never	51	18.1%	27	19.1%			.830	.491	1.403
	Eating outside or in a restaurant	Daily	8	2.8%	10	7.1%			1.018	.133	7.798
		Weekly	20	7.1%	16	11.3%			.000	.000	.
		Monthly	240	85.4%	105	74.5%	8.359	**0.039**	5.890	.505	68.626
		Rarely	13	4.6%	10	7.1%			.416	.028	6.089
		Never	0	0.0%	0	0.0%			.441	.166	1.170
	Family member	No	132	47.0%	52	36.9%			.661	.396	1.101
		Yes	0	0.0%	2	1.4%			.534	.179	1.592
Medical History	diagnosed with H. pylori infection	Don't know	149	53.0%	87	61.7%	7.445	**0.024**	.000	.000	.
	Washing hands before eating	Always	66	23.6%	16	11.3%			1.786	.374	8.529
		Sometimes	207	73.9%	109	77.3%	20.773	**<0.001**	.580	.320	1.050
Environmental factors		Rarely	7	2.5%	16	11.3%			1.201	.535	2.699
	Usage of clean water for drinking and cooking	Yes	77	27.4%	21	14.9%			1.616	.690	3.785
		Sometimes	202	71.9%	107	75.9%	25.652	**<0.001**	.949	.221	4.063
		Rarely	2	0.7%	13	9.2%			1.536	.477	4.942
	Having toilet at your home	No	4	1.4%	2	1.4%			.589	.089	3.876
		Yes	275	98.6%	138	98.6%	0.000	0.997	1.773	.130	24.183
	Having waste material management system at your home	No	36	12.8%	19	13.5%			.352	.144	.863
		Yes	245	87.2%	122	86.5%	0.000	0.848	.389	.106	1.424
	Number of people living at your home	Between 1 - 5	129	45.9%	64	45.4%			.419	.113	1.556
		Between 5 - 10	147	52.3%	75	53.2%			.933	.395	2.204
		Above 10	5	1.8%	2	1.4%	0.093	0.955	1.262	.471	3.383
	Source of water at your home	Rivers	21	7.6%	13	9.2%			3.743	.815	17.196
		Lakes	1	0.4%	0	0.0%			6.291	.787	50.298
		Tanks	1	0.4%	4	2.8%	5.786	0.216	2.456	.000	.
		Rain water	2	0.6%	1	0.8%			17.413	.000	.
		Tap water	253	91.0%	123	87.2%			27.404	.000	.

Table 4.3 presents an analysis of the association between various demographic, behavioral, and environmental factors and H. pylori infection among 422 adult patients at Ruhengeri Referral Hospital. The study employed chi-square tests to determine whether each factor significantly influenced infection status, with a p-value threshold of 0.05 used for statistical significance. The analysis revealed that age group was not significantly associated with H. pylori infection ($\chi^2 = 3.756$, $p = 0.289$), indicating that the infection affected all age categories relatively evenly. Similarly, marital status ($\chi^2 = 3.415$, $p = 0.332$), place of residence ($\chi^2 = 1.746$, $p = 0.186$), education level ($\chi^2 = 1.469$, $p = 0.917$), occupation ($\chi^2 = 2.283$, $p = 0.684$), income ($\chi^2 = 4.580$, $p = 0.333$), frequency of eating raw vegetables ($\chi^2 = 4.370$, $p = 0.224$), availability of a toilet ($\chi^2 = 0.000$, $p = 0.997$), household waste management ($\chi^2 = 0.036$, $p = 0.848$), household size ($\chi^2 = 0.093$, $p = 0.955$), and water source ($\chi^2 = 5.786$, $p = 0.216$) were all not significantly associated with infection. These results suggest that demographic and household structural factors alone may not be sufficient to influence infection risk. In contrast, several behavioral and dietary factors showed significant associations. Gender was significantly associated with infection ($\chi^2 = 3.923$, $p = 0.048$), with males more likely to be infected. Consumption of fermented foods ($\chi^2 = 13.047$, $p = 0.005$) and processed meats ($\chi^2 = 24.227$, $p < 0.001$) were strongly associated with higher infection rates, indicating that dietary habits can influence bacterial exposure and colonization. Eating food outside the home was also significant ($\chi^2 = 8.359$, $p = 0.039$), reflecting the impact of food hygiene and preparation practices. Hygiene-related factors were particularly influential. Having a family member diagnosed with H. pylori ($\chi^2 = 7.445$, $p = 0.024$) showed a significant association, highlighting possible interfamilial transmission. Handwashing before meals ($\chi^2 = 20.773$, $p < 0.001$) and consistent use of clean water for cooking and drinking ($\chi^2 = 25.652$, $p < 0.001$) were highly significant, emphasizing the critical role of personal hygiene and safe water in preventing infection.

5 Discussion

5.1 Prevalence of *H. pylori* Infection

The current study found that 34.4% of adult patients attending Ruhengeri Referral Hospital tested positive for *H. pylori* infection, indicating that approximately one in three adults in this setting is living with the infection. This prevalence highlights a substantial public health concern. Comparable studies in the East African region have reported similar findings. For instance, a study at Bule Hora University Teaching Hospital in Ethiopia reported a prevalence of 28%, with higher rates among women and individuals over 60 years, suggesting that demographic factors such as age and gender may influence infection (Ashenafi et al., 2024). In Northern Tanzania, symptomatic adults exhibited a prevalence of 43.4%, with chronic gastritis being the most common endoscopic finding, and increasing age and blood group were significant factors (Muhina et al., 2024). In Nigeria, Port Harcourt reported a seroprevalence of 34.6% among adults, with urban communities exhibiting higher rates, highlighting the role of environmental and socioeconomic conditions in influencing infection burden (Metropolis & Adah, 2024). These findings underscore the multifactorial nature of *H. pylori* infection and the importance of context-specific public health interventions.

5.2 Factors Associated with *H. pylori* Infection

The study identified several demographic, behavioral, and environmental factors associated with infection. Gender was significantly associated with infection ($\chi^2 = 3.923$, $p = 0.048$), with males more likely to be infected, consistent with findings from Southern Ethiopia, where lifestyle and occupational exposures were implicated (Tadesse et al., 2014). Contrastingly, studies in Nigeria observed higher prevalence among females, emphasizing regional variations and the influence of behavioral and socioeconomic factors (Abbah et al., 2023). Dietary habits played a key role. Frequent consumption of fermented foods was significantly associated with infection ($\chi^2 = 13.047$, $p = 0.005$), likely due to traditional fermentation practices lacking adequate hygiene, allowing bacterial colonization (Duche et al., 2023; Mah & Ruiz-Capillas, 2022). Processed meat intake was strongly linked to infection ($\chi^2 = 24.227$, $p < 0.001$), potentially due to chemical preservatives compromising gastric defenses (Abd El-Ghany et al., 2022; Mwangi et al., 2023). Eating food outside the home also increased infection risk ($\chi^2 = 8.359$, $p = 0.039$), reflecting hygiene inconsistencies in food establishments (Leodegard et al., 2025; Nubahumpatse et al., 2024). Household and hygiene-related factors were significant. Having a family member previously diagnosed with *H. pylori* was associated with higher infection risk ($\chi^2 = 7.445$, $p = 0.024$), suggesting intra-familial transmission via shared utensils or close contact (Alshareef et al., 2023; Mnichil et al., 2024b). Handwashing before meals was strongly protective ($\chi^2 = 20.773$, $p < 0.001$), consistent with findings from Vietnam and East Africa highlighting hygiene as a key preventive measure (Che et al., 2023; Mnichil et al., 2024a). Access to clean water was also critical. Regular use of safe

water for drinking and cooking significantly reduced infection rates ($\chi^2 = 25.652$, $p < 0.001$), corroborating studies showing higher *H. pylori* prevalence among individuals using untreated surface water (Abebaw et al., 2014; Belay et al., 2020).

6 Conclusions and Recommendations

This study found that the prevalence of Helicobacter pylori infection among adult patients at Ruhengeri Referral Hospital was 33.4%, indicating a moderate-to-high public health concern. Among demographic factors, only gender was significantly associated with infection, with males more affected. Socioeconomic variables such as education, income, and occupation did not show significant effects, suggesting that exposure to H. pylori occurs across all economic groups. Dietary behaviors, particularly frequent consumption of processed meats and eating outside the home, were significantly linked to higher infection rates, highlighting the importance of food safety and preparation practices. Personal hygiene was a critical factor, as inconsistent handwashing and irregular use of clean water were strongly associated with infection. Additionally, having a family member previously diagnosed with H. pylori increased the likelihood of infection, suggesting intra-household transmission. Conversely, environmental sanitation factors like access to toilets, household size, and waste management did not show significant associations, possibly due to relatively uniform access among participants. Based on these findings, it is recommended to strengthen health education programs emphasizing hand hygiene and safe food handling, particularly targeting males. Promoting safe dietary practices, reducing processed meat consumption, and enhancing restaurant food inspection are essential. Public awareness campaigns should address household transmission and advise infected patients on infection control measures. Ensuring access to clean, treated water and integrating routine H. pylori screening for symptomatic patients, especially those with infected family members, is crucial. Collaborating with food vendors to enforce hygiene standards in preparation and service will further reduce transmission risks. Future research should include longitudinal studies, molecular strain characterization, qualitative assessments of community practices, and interventional trials to evaluate hygiene and food safety education impacts.

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