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Original article

Frequency of *Helicobacter pylori* Infection in Patients Requiring GI Endoscopy in Seven Units in Three Antioquia Subregions

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Abstract

Aim: To determine the frequency of *Helicobacter pylori* and sociodemographic factors, life habits, and personal and family history of gastroduodenal diseases in patients who required and were taken to GI endoscopy (symptomatic or by screening) in seven endoscopy units in three Antioquia subregions. **Materials and methods:** A cross-sectional study conducted between 2016 and 2018 included 272 participants. Sociodemographic factors, life habits, and personal and family history were related to *H. pylori* infection. Descriptive statistics and bivariate analysis were performed to establish the association between the variables, and multivariate analysis (binomial regression) was used to adjust the prevalence ratios of the associated factors. A *p*-value ≤ 0.05 was considered statistically significant. **Results:** The frequency of *H. pylori* infection was 55.9%, with differences by subregion (Valle de Aburrá metropolitan area: 54.3%, Oriente: 64%, and Urabá: 79.2%). Factors associated with *H. pylori* infection were male sex (adjusted prevalence ratio [APR] = 1.26; 95% confidence interval [CI] = 1.04-1.52), age 18-55 years (APR = 1.62; CI 95% = 1.22-2.16), absence of drinking water (APR = 1.40; 95% CI: 1.15-1.72) and educational level below university (APR = 1.73; 95% CI% = 1.26-2.38). **Conclusion:** The frequency of *H. pylori* was higher than in other recent studies because different diagnostic tests were used for its detection, and differences were found in the frequency of infection by region, which is explained by the heterogeneity in the populations analyzed. This study suggests the need to improve the population's living conditions to reduce *H. pylori* and direct measures of primary prevention of the infection, especially in family groups, men, individuals between 18 and 55 years old without drinking water, and with an educational level lower than university.

Keywords

Helicobacter pylori, epidemiology, gastroduodenal diseases, diagnostic tests.

INTRODUCTION

Helicobacter pylori infection is a public health problem because it affects more than half of the world's population; it is transmitted orally-orally, gastric-orally, and fecal-orally through close or intrafamilial contact, although there are other possible routes[1]. Transmission is associated with low socioeconomic conditions, low educational level, overcrowding, poor hygiene practices, mother being infected with *H. pylori*, and intake of non-drinking water[1,2]. The prevalence of infection varies according to geographic region and ranges from 20% in middle- and high-income

countries to more than 79% in low-income countries. The regions with the highest prevalence are Africa (79.1%), South America (63.4%), and Asia (54.7%), and those with the lowest prevalence are Oceania (24.4%), Western Europe (47%), and North America (37.1%)[3].

H. pylori produces gastroduodenal diseases due to a multifactorial process involving factors of the microorganism, genetic and epidemiological characteristics of the host, and environmental or sociocultural factors[1,4]. In 80% of patients, the infection is chronic, persistent, and asymptomatic. The rest develop diseases such as peptic ulcer, gastric cancer (GC), and B-cell lymphoma of the mucosa-associated lymphoid tissue (MALT). In 1994, the International Agency for Research on Cancer (IARC) classified *H. pylori* as a grade I carcinogen[5]; furthermore, 89% of non-cardial GC is associated with bacterial infection[6]. According to the Global Cancer Observatory (GLOBOCAN) in 2020, GC ranked fifth in incidence (1,089,103) and third in mortality (768,793) worldwide, while in Colombia, it was fourth in incidence (8,214) and first in mortality (6,451)[7].

GC mortality data in Colombia vary geographically; they are higher in mountainous regions than in coastal areas[4,8]. According to data from the National Administrative Department of Statistics (DANE, for its acronym in Spanish) for 2019 in Antioquia, mortality from GC shows differences by subregion. Of the 749 cases in the department (11.4/100,000 inhabitants), mortality was highest (114 deaths, 16.7/100,000) in the eastern mountainous subregion (1,900-2,600 meters above sea level [masl]; mean: 484 deaths, 12.2/100,000) and in the Valle de Aburrá metropolitan area (AMVA, for its acronym in Spanish) (1,150-1,700 masl) and low (30 deaths, 5.8/100,000) in the coastal subregion of Urabá (30-919 masl)[9]. These variations are explained by the genetic heterogeneity of the population, sociocultural diversity, and geographical differences[8,10,11].

The regional prevalence of *H. pylori* is not systematically recorded, especially in low-income countries. Infection prevalence studies show variations in diagnostic methods, samples studied, selection criteria, age groups, and clinical conditions of patients, which hinders interpretation of the representativeness of the data in the general population[3,12,13]. In Colombia, regional prevalence studies cannot be extrapolated to the general population, and no consolidated data exists; however, the available figures estimate prevalences greater than 70%[12,13].

GC prevention aims to identify high-risk populations and factors related to *H. pylori* because eliminating the infection reduces the risk of developing GC[6,11,14]. Previous studies show that these measures reduce the incidence of GC in high-risk populations[11,14-16]. In Colombia, GC is a disease with a poor prognosis and survival of <20% at five years[17,18]. Accordingly, this study aims to determine the relationship of *H. pylori* with clinical, epidemiological, environmental, and sociocultural characteristics in patients consulting and requiring endoscopic procedures from seven gastroenterology services in three subregions of Antioquia, Colombia.

MATERIALS AND METHODS

Study population and selection criteria

This analytical cross-sectional study was approved by the ethics committee of the Medicine School of the Universidad de Antioquia (Minutes 013-2016). The study population consisted of volunteers over 18 years of age treated in the upper digestive endoscopy (EGD) service of seven health institutions in three subregions of Antioquia: AMVA, Oriente, and Urabá, Colombia, between 2016 and 2018 who accepted and signed the consent. Patients treated with proton pump inhibitors (PPIs) 15 days before EGD, histamine H2 receptor antagonists 15 days before EGD, or antibiotics in the last month were excluded. We also excluded individuals with upper gastrointestinal bleeding, anticoagulant treatment, coagulation disorders, pregnant women, previous surgery of the upper digestive tract, diagnosis of severe chronic diseases (kidney, liver, decompensated heart failure, and decompensated diabetes *mellitus*), or radiochemotherapy.

Sample size

The sample size was calculated based on the number of patients treated in four months in the EGD services of the participating institutions (n = 4024 individuals). It was estimated using Epidat version 3.1 with a confidence interval (CI) of 95%, power of 80%, and accuracy of 5.8%. In total, 265 individuals were included, distributed as follows: 63.8% (n = 169) came from AMVA, 27.5% (n = 73) from Oriente, and 8.7% (n = 23) from Urabá.

Survey

Participants completed a structured survey supervised by previously trained project staff. The information included sociodemographic data, housing conditions, socioeconomic characteristics, lifestyle habits, and personal and family clinical history of gastroduodenal diseases.

Diagnosis of *H. pylori*

Patients were fasted for 7 hours before EGD, and nine stomach biopsies were taken for bacterial diagnosis. Five sam-

ples from each patient were intended for histopathological study; they were stored in tubes with 10% buffered formalin (Protokimica S. A. S.®) and transported to the cytology and pathological anatomy unit of Clínica Las Vegas for processing and reading. Two antrum samples and two body samples were placed in a Brucella broth transport medium with 20% glycerol and taken to the Medicine School of the Universidad de Antioquia laboratory for subsequent microbiological culture, detection of the urease enzyme, and study by molecular biology. The diagnosis of *H. pylori* infection was established as positive when at least two tests were positive.

Microbiological culture

An antrum sample and a body sample were plated on supplemented Brucella agar and incubated under microaerophilic conditions (5-10% oxygen [O_2], 10% carbon dioxide [CO_2], and 80%-90% humidity). Compatible colonies were identified down to species by biochemical and molecular tests. The negative cultures were followed for 15 days. Then, if they showed growth, identification and cryopreservation were carried out in Brucella broth with 20% glycerol; those in which no growth was observed were reported as negative. The isolates of *H. pylori* were cryopreserved in Brucella broth with glycerol.

Urease test

An antral biopsy was deposited in urea-based agar broth (BD and Company, Sparks, MD, United States) supplemented with urea (Carlo Erba Reagents S. A. S., Italy). The test was positive when an instantaneous color change from yellow to pink was noted. The initially negative samples were incubated in an aerobic atmosphere, 21% O_2 at 37 °C for 2 hours to confirm the results. Subsequently, the antrum biopsy was placed in Brucella broth with glycerol and cryopreserved for molecular testing.

Histopathological and molecular diagnosis

The histopathological methodology was performed as previously described[19]. For molecular diagnosis, one antrum and one body sample were processed with the Dneasy blood & tissue kit (Qiagen, Hilden, Germany) according to the manufacturer's recommendations. The concentration of genomic DNA was determined with NanoDropOne-2000 (Thermo Fisher Scientific, United States). The ureA and vacA genes (alleles s1, s2, m1, and m2) were amplified by a standard polymerase chain reaction (PCR) with previously described primers[20-22]. PCR was performed in a Multigene® thermal cycler (Labnet International, Inc. NJ, United States) using the strains of *H. pylori* ATCC 43504, NCTC 11637, NCTC 11638, the clinical strain 3062 as positive controls, and *Escherichia coli* ATCC 25922 as a negative control. Amplifiers were run on 1.5% agarose gels and developed with Hydragreen (Piscataway, NJ). The fragments were visualized with a transilluminator (Molecular Imager® Gel Doc™ XR System. BioRad Laboratories, Inc. Hercules, CA, United States). The 100 bp molecular weight marker (New England Biolabs, Inc.) was used to determine the amplicons' size.

Statistical analysis

A Microsoft Office Access 2016 database was built and subjected to external quality control. Data were analyzed using SPSS version 25.0 (SPSS Armonk, NY, United States: IBM Corporation). Epidat version 4.2 and Stata Corp version 15 were used to obtain the continuous variables' means ± standard deviation (SD); categorical variables are presented as frequencies and percentages. To identify the risk factors associated with the frequency of *H. pylori*, a bivariate analysis was performed with the chi-squared test (χ^2). For the multivariate analysis, binomial regression was employed. Crude and adjusted prevalence ratios were estimated with 95% confidence intervals (95% CI). The variables with p <0.25 (Hosmer-Lemeshow criterion) were entered into the multivariate model, and a p-value <0.05 was accepted as statistically significant.

RESULTS

Description of the study population

The total number of patients screened was 1093; 764 were not accepted due to the exclusion criteria and 57 for other reasons (**Figura 1**). A total of 272 participants were included, of which 271 were collected by EGD and one by gastrectomy.

Sociodemographic characteristics

65.1% (177) were women. The average age was 48.9 ± 15.6 years, and 45.3% (123) participants were between 36 and 55 years old. 95.6% (260) of the study population were mestizos, and 3.4% (12) called themselves *Afro-Colombian*, *indigenous,* and *gypsy/ROM*. Patients residing in Urabá had unfavorable socioeconomic characteristics compared to the other subregions. In Urabá, we found a higher proportion of people in the subsidized system (66.7%), low level of schooling (complete elementary or lower) (45.8%), a higher proportion of unemployment (8.3%), informal employment (29.2%), monthly income greater than or equal to a minimum wage (52.2%), and low socioeconomic status (87.4%) (**Table 1**).

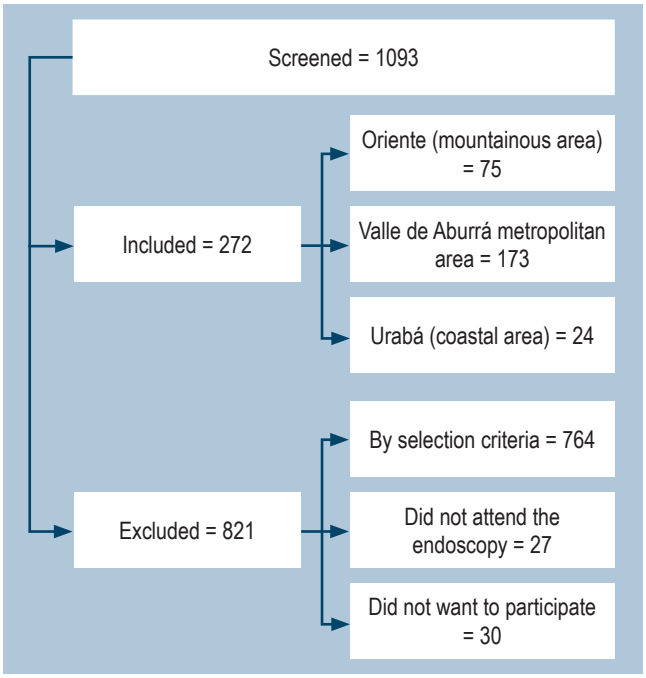

Figure 1. Selection of study participants. Figure prepared by the authors.

Housing characteristics, conditions, and living habits

84.2% (229/272) of the population lived in urban areas. The AMVA has the highest percentage with 93.6% (162/173), and the Oriente subregion concentrated the most significant number of individuals from rural areas with 28/75 (37.3%). Concerning utilities, 100% of the participants had electricity at home. Regarding access to aqueducts, differences were observed: of the participants, 9.5% (26/272) used untreated water for consumption (**Table 2**). Of the population, 1.5% (4/272) lived in overcrowded conditions, and as to lifestyles, 10.3% of patients (28/272) had a smoking habit. Of the latter, 21.4% (6/28) were heavy smokers (> 15 cigarettes/day), according to the classification of the World Health Organization (WHO)[23].

Personal and family history

The most frequently reported symptoms were epigastric pain (61.8%) and abdominal distension (61%), and the least frequent were vomiting (17.3%) and hematemesis (5.9%). 50% of the patients had a history of gastroduodenal tract diseases; 80% reported previous episodes of gastritis, 19% peptic ulcer, 12% hiatal hernia, 10% esophagitis, 6% gastroesophageal reflux, and 1.5% GC. Other diagnoses (duodenitis, Barret's esophagus, inverted esophagus, or pyloric hypertrophy) were present in 3% of cases. The percentage of patients with a history of iron deficiency anemia was 18.3% (50/272). Concerning family clinical history, it was found that the most common were gastritis (65.3%), *H. pylori* (30%), and GC (26%). Of the latter, 37.7% were relatives in the first degree of consanguinity (**Table 3**).

Diagnosis of *H. pylori* and factors associated with infection

54.3%, 64%, and 79.2% of the patients studied in the AMVA, Oriente, and Urabá subregions, respectively, had a positive diagnosis for *H. pylori* by at least two of the tests used (**Table 3**). Upon the bivariate analysis, we found that the frequency of *H. pylori* was higher in men, people between 18 and 55 years old, patients in the subsidized system, with a low educational level, underemployed or informal workers, with income less than 2 SMLV, from a low/middle socioeconomic level, without a home water supply, with signs of hematemesis, and in patients without treatment adherence (**Table 4**). The results of the multivariate analysis showed that the risk factors associated with *H. pylori* were male ($p = 0.01$), aged 18-35 years ($p < 0.00$) and 36-55 years ($p = 0.01$), not having a home water supply ($p < 0.00$), and having less than a college degree ($p < 0.00$) (**Table 5**).

DISCUSSION

This study found that the frequency of *H. pylori* in patients who attended the seven endoscopy services of the three subregions of Antioquia was 59.2%, with the following differences: 54.3% in AMVA, 64% in Oriente, and 79.2% in Urabá. A relationship was also identified between *H. pylori* infection and factors such as male sex, ages between 18 and 55, lack of a drinking water supply system, and less than college education.

When contrasting our findings with other studies from AMVA or Antioquia, we noted a higher frequency of *H. pylori* (59.2%) compared to that described by other authors such as Correa et al. in 2016 (36.4%)[24], Roldan et al. in 2019 (44.2%)[25], and Sánchez et al. in 2022 (36.4%)[26]. The higher frequency found in this study could be explained by including the sample of patients who attended the endoscopy services of two subregions of Antioquia other than the AMVA with less favorable socioeconomic conditions[27,28]. Another explanation for the high frequency is that the population captured included consulting patients and patients requiring endoscopic procedures who attended the seven institutions in the three subregions. Furthermore, the majority were patients with gastroduodenal symptoms. Notably, the findings in this study have limitations because it is impossible to calculate epidemiological information for the regions or draw conclusions that can be extrapolated to the general population.

Table 1. Sociodemographic characteristics of the population discriminated by subregion

Variable	Subregion							
	Metropolitan area n = 173		Oriente (mountainous) n = 75		Urabá (coastal) n = 24		Total n = 272	
	n	%	n	%	n	%	n	%
Sex								
- Woman	115	66.5	46	61.3	16	66.7	177	65.1
- Man	58	33.5	29	38.7	8	33.3	95	34.9
Age								
- 18–25	14	8.1	5	6.7	1	4.2	20	7.4
- 26–35	24	13.9	12	16.0	4	16.7	40	14.7
- 36–45	35	20.2	17	22.7	5	20.8	57	21.0
- 46–55	45	26.0	16	21.3	5	20.8	66	24.3
- 56–65	32	18.5	13	17.3	5	20.8	50	18.4
- 66–75	13	7.5	8	10.7	1	4.2	22	8.1
- 76–86	10	5.8	4	5.3	3	12.5	17	6.3
Social security								
- Contributory[1]	159	91.9	62	82.7	8	33.3	229	84.2
- Subsidized[2]	11	6.4	11	14.7	16	66.7	38	14.0
- Special[3]	2	1.2	1	1.3	0	0.0	3	1.1
- No enrollment	1	0.6	1	1.3	0	0.0	2	0.7
Education								
- Elementary	28	16.2	28	37.3	7	29.2	63	23.1
- High school	54	31.2	18	24.0	7	29.2	79	29.0
- Associate degree	25	14.4	13	17.3	2	8.3	40	14.7
- College	64	37.0	15	20.0	4	16.6	83	30.6
- None	2	1.2	1	1.3	4	16.7	7	2.6
Occupation								
- Employee	65	37.6	32	42.7	2	8.3	99	36.4
- Homemaker	44	25.4	19	25.3	8	33.3	71	26.1
- Underemployed[4]	2	1.2	1	1.3	2	8.3	5	1.8
- Informal worker[5]	4	2.3	5	6.7	7	29.2	16	5.9
- Unemployed	4	2.3	3	4.0	2	8.3	9	3.3
- Self-employee[6]	20	11.6	7	9.3	3	12.5	30	11.0
- Pensioner	21	12.1	8	10.7	0	0.0	29	10.7

Table 1. Sociodemographic characteristics of the population discriminated by subregion (*continued*)

Variable	Subregion							
	Metropolitan area n = 173		Oriente (mountainous) n = 75		Urabá (coastal) n = 24		Total n = 272	
	n	%	n	%	n	%	n	%
Occupation								
- Student	8	4.6	0	0.0	0	0.0	8	2.9
- Inmate	5	2.9	0	0.0	0	0.0	5	1.8
Wage								
- Less than 1 SMLV	12	7.2	18	24.0	12	52.2	42	15.8
- 1-2 SMLV	32	19.2	22	29.3	6	26.1	60	22.6
- > 2 SMLV	123	73.7	35	46.7	5	21.7	163	61.5
Socioeconomic level[7]								
- 1-2	58	34.6	28	37.8	21	87.4	107	40.2
- 3-4	84	50.0	43	58.1	3	12.5	130	48.9
- 5-6	26	15.5	3	4.1	0	0.0	29	10.9

[1]Contributory: enrolled in the health system through the payment of an individual or family contribution by the member or in conjunction with the employer. [2]Subsidized: mechanism through which the poorest population in the country, with no ability to pay, has access to health services through a subsidy offered by the State. [3]Special: people who belong to the military forces, police, teachers, and public servants. [4]Underemployed: employment in which workers' capabilities are underutilized; they work fewer hours and receive low remuneration. [5]Informal worker: a person who carries out some economic activity with no employment contract, no tax control, low income, and no social protection. [6]Self-employed: a person who works on their account without being bound by an employment contract and makes payments to the social security system by themselves. [7]Socioeconomic levels: classes or groups into which the population is divided according to purchasing power and socioeconomic level (1 minimum wage equals 277.19 USD in 2021 in Colombia). SMLV: current legal minimum wage. Table prepared by the authors.

In the Urabá subregion, 74.6% of the population has unmet basic needs, and 6.18% of individuals live in misery, exceeding the province's 26.4% and 1.52%, respectively[29]. Besides, 14.3% of the population lacks basic utilities, and only 48.5% have drinking water[28,29]. In 2018, 89.8% of people in Antioquia had a home water supply, but in Urabá, only 68.9%[30]. The high prevalence of *H. pylori* infection in developing countries is associated with health problems and poor water quality, which is why it is suggested as a possible important source of transmission of the microorganism[31]. The bacteria survive in chlorinated water and tolerate pH changes. However, it is difficult to isolate from natural water sources, possibly due to the low bacterial load or difficulties in isolation and culture[32].

Moreover, the low frequency of *H. pylori* in patients who attended the endoscopy services of the AMVA subregion is possibly due to better sanitary conditions such as access to quality drinking water, correct disposal of excreta and garbage, access to education, acceptable infrastructure conditions, among others[33]. However, as mentioned above, the findings in this study have limitations because it is impossible to calculate epidemiological information from the regions or draw conclusions that can be extrapolated to the general population. Some studies show that low socioeconomic and educational levels and lifestyles are risk factors for *H. pylori*[34-38], suggesting that the high frequency of the bacteria reflects the need to improve the population's living conditions by reducing exposure to risk factors and diseases associated with *H. pylori*.

A limitation of this work is the inability to determine the moment of primary infection, mainly because the pediatric population in which this entity occurs was not captured. Several studies demonstrate that primary infection is acquired during early childhood, and the main

Table 2. Housing characteristics and living habits of the studied population

Variable	Subregion							
	Metropolitan area n = 173		Oriente (mountainous) n = 75		Urabá (coastal) n = 24		Total n = 272	
	n	%	n	%	n	%	n	%
Housing type								
- Home	88	50.9	59	78.7	19	79.2	166	61.0
- Apartment	79	45.7	14	18.7	3	12.5	96	35.3
- Room	0	0.0	1	1.3	1	4.2	2	0.7
- Other[1]	6	3.5	1	1.3	1	4.2	8	2.9
Drinking water								
- Regulated aqueduct	171	98.8	44	58.7	6	25.0	221	81.3
- Unregulated aqueduct								
- Rural aqueduct	2	1.2	12	16.0	0	0.0	14	5.1
- Rainwater	0	0.0	0	0.0	6	25.0	6	2.2
- Tanker	0	0.0	0	0.0	1	4.2	1	0.4
- River or stream	0	0.0	5	6.7	0	0.0	5	1.8
- Other[2]	0	0.0	14	18.7	11	45.8	25	9.2
Eating out (times a week)								
- 1-2 times	53	54.6	26	72.2	6	50.0	85	58.6
- 3-4 times	16	16.5	3	8.3	5	41.7	24	16.6
- ≥ 5 times	28	28.9	7	19.4	1	8.3	36	24.8
Boils the water								
- Yes	3	1.7	33	44.0	5	20.8	41	15.1
- No	4	2.3	26	34.7	10	41.7	40	14.7
- Not applicable[3]	166	96.0	16	21.3	9	37.5	191	70.2
Other aspects								
- Has gas	159	91.9	67	89.3	19	79.2	245	90.1
- Has sewer	173	100	66	88.0	17	70.8	256	94.1
- Has an aqueduct	172	99.4	64	85.3	14	58.3	250	91.9
- Overcrowding	0	0.0	1	1.3	3	12.5	4	1.50
- Current/Former smoker	47	29.0	20	28.4	8	36.7	75	29.6
- Drinks alcohol	73	42.2	32	42.7	6	25.0	111	40.8
- Daily coffee	105	60.7	48	64.0	12	50.0	165	60.7
- Adds salt	36	20.8	18	24.0	4	16.7	58	21.3

[1]Other: halfway house, tenement, orphanage, nursing home, detention center. [2]Other: well, bottled water, filtered water. [3]Not applicable: for those who have an aqueduct and do not boil water. Table prepared by the authors.

Table 3. Personal and family history of gastroduodenal diseases and diagnosis of H. pylori in the study population

Variable	Región							
	Metropolitan area n = 173		Oriente (mountainous) n = 75		Urabá (coastal) n = 24		Total n = 272	
	n	%	n	%	n	%	n	%
Signs and symptoms								
- Epigastralgia	107	61.8	40	53.3	21	87.5	168	61.8
- Nausea	76	43.9	25	33.3	15	62.5	116	42.6
- Vomiting	29	16.8	10	13.3	8	33.3	47	17.3
- Dysphagia	46	26.6	11	14.7	10	41.7	67	24.6
- Feeling a lump	64	37.0	19	25.3	13	54.2	96	35.3
- Dyspepsia	90	52.0	32	42.7	15	62.5	137	50.4
- Belching	81	46.8	41	54.7	14	58.3	136	50.0
- Reflux	94	54.3	42	56.0	16	66.7	152	55.9
- Loss of appetite	41	23.7	20	26.7	7	29.2	68	25.0
- Weightloss	39	22.5	15	20.0	12	50.0	66	24.3
- Hematemesis	9	5.2	6	8.0	1	4.20	16	5.9
- Melenas	35	20.2	11	14.7	8	33.3	54	19.9
- Abdominal distension	109	63.0	39	52.0	18	75.0	166	61.0
Personal history								
- Diagnosis of previous gastroduodenal disease	88	50.9	43	57.3	5	20.8	136	50.0
- Previous endoscopy	98	56.6	45	60.0	9	37.5	152	55.9
- Previous H. pylori infection	61	35.3	23	30.7	3	12.5	87	32.0
- Received treatment	55	88.7	20	83.3	2	66.7	77	86.5
- Followed treatment instructions	51	91.1	19	95.0	1	50.0	71	91.0
- Diagnosis of anemia	27	15.6	14	18.7	9	37.5	50	18.4
Family background								
- Gastritis	109	63.0	55	73.3	13	56.5	177	65.3
- Gastric ulcer	33	19.1	20	26.7	5	21.7	58	21.4
- Intestinal metaplasia	11	6.4	3	4.0	1	4.30	15	5.5
- Stomach cancer	45	26.0	23	31.5	2	8.70	70	26.0
- History of H. pylori	53	30.8	26	34.7	2	9.10	81	30.1
Diagnosis of infection								
- H. pylori-positive	94	54.3	48	64.0	19	79.2	161	59.2
- H. pylori-negative	79	45.7	27	36.0	5	20.8	120	40.8

Table prepared by the authors.

Table 4. Factors associated with H. pylori by bivariate analysis

Variable	n/N	(%)	CPR	95% CI	*p*
Sex					
- Woman	97/177	54.8	1	—	**0.044**
- Man	64/95	67.4	1.229	1.013-1.492	
Age					
- 18-35	41/60	68.3	1.448	1.095-1.914	**0.009**
- 36-55	78/123	63.4	1.343	1.038-1.738	**0.025**
- 56-86	42/89	47	1	—	
Social security					
- Contributory[1]	131/232	56.5	1	1.075-1.641	**0.028**
- Subsidized[2]	30/40	75	1.328		
Education					
- Elementary	45/70	64.3	1.482	1.096-2.003	**0.011**
- High school	52/79	65.8	1.517	1.132-2.033	**0.005**
- Associate degree	28/40	70.0	1.613	1.173-2.219	**0.003**
- Incomplete or complete college degree	36/83	43.4	1	—	
Occupation					
- Employee	61/99	61.6	1.069	0.817-1.398	0.625
- Homemaker	34/71	47.9	0.83	0.599-1.152	0.267
- Underemployed[3]/Informal workers[4]	17/21	81.0	1.404	1.039-1.899	**0.027**
- Pensioner/Self-employed[5]	34/59	57.6	1	—	
- Unemployed/Student/Inmate	15/22	68.1	1.183	0.825-1.695	0.92
Wage					
- Less than 1 SMLV	29/42	69.0	1.308	1.020-1.679	**0.034**
- 1-2 SMLV	41/60	68.3	1.295	1.033-1.622	**0.024**
- More than 2 SMLV	86/163	52.8	1	—	
Socioeconomic level[6]					
- Low (1-2)	76/107	71.0	1.872	1.157-3.029	**0.011**
- Middle (3-4)	70/130	53.8	1.419	0.867-2.321	0.163
- High (5-6)	11/29	37.9	1	—	
House location					
- Rural/Other[7]	33/43	76.7	1.373	1.123-1.678	**0.011**
- Urban	128/229	55.9	1	—	
Aqueduct					
- Yes	141/250	56.4	1	—	**0.002**
- No	20/22	90.9	1.612	1.358-1.913	
Black stools					
- Yes	40/54	74.1	1.335	1.095-1.626	**0.013**
- No	121/218	55.5	1	—	
Diagnosis of gastric disease					
- Yes	59/136	43.38	0.578	0.466-0.717	**< 0.001**
- No	102/136	75	1	—	

Table 4. Factors associated with H. pylori by bivariate analysis (*continued*)

Variable	n/N	(%)	CPR	95% CI	*p*
Previous endoscopy					
- Yes	65/152	42.76	0.535	0.436-0.656	< 0.001
- No	96/120	80	1	—	
Previous diagnosis of H. pylori infection					
- Yes	26/87	29.9	0.41	0.293-0.572	**< 0.001**
- No	135/185	73.0	1	—	
Followed the treatment indications for H. pylori					
- Yes	18/71	25.4	1	—	**0.021**
- No	5/7	71.4	2.817	1.522-5.214	

1 indicates the reference category. [1]Contributory: enrolled in the health system through the payment of an individual or family contribution by the member or in conjunction with the employer. [2]Subsidized: mechanism through which the poorest population in the country, with no ability to pay, has access to health services through a subsidy offered by the State. [3]Underemployed: employment in which workers' capabilities are underutilized; they work fewer hours and receive low remuneration. [4]Informal worker: a person who carries out some economic activity with no employment contract, no tax control, low income, and no social protection. [5]Self-employed: a person who works on their account without being bound by an employment contract and makes payments to the social security system by themselves. [6]Socioeconomic levels: classes or groups into which the population is divided according to purchasing power and socioeconomic level (1 minimum wage equals 277.19 USD in 2021 in Colombia). [7]Other: detention centers. SMLV: current legal minimum wage. Table prepared by the authors.

Table 5. Variables associated with the prevalence of H. pylori. Bivariate (CPR) and multivariate (adjusted PR) analysis

Variable	CPR	95% CI	*p*	APR	95% CI	*p*
Male sex	1.22	1.01-1.49	0.04	1.26	1.04-1.52	**0.01**
Age (18-35 years)	1.44	1.09-1.91	0.00	1.62	1.22-2.16	**0.00**
Age (36-55 years)	1.34	1.03-1.73	0.02	1.39	1.07-1.79	**0.01**
No home water supply	1.61	1.35-1.91	0.00	1.40	1.15-1.72	**0.00**
Elementary	1.48	1.09-2.00	0.01	1.60	1.17-2.19	**0.00**
High school	1.51	1.13-2.03	0.00	1.65	1.24-2.18	**0.00**
Associate degree	1.61	1.17-2.21	0.00	1.73	1.26-2.38	**0.00**

APR: adjusted prevalence ratio; CPR: crude prevalence ratio. Table prepared by the authors.

transmission occurs from person to person in the family environment[39-46]. Therefore, new research is necessary for the pediatric population in Antioquia to compare the findings with other studies in infants because it is not ruled out that the infection was acquired in childhood or adolescence, which is common in developing countries such as Colombia[47-49].

The above reflects the importance of preventive measures in early childhood, such as screening and treatment when required to avoid progression in adulthood to diseases such as GC and peptic ulcer. Education for mothers and caregivers in early childhood is also essential to avoid infection and the spread of the bacteria to other individuals[46].

The patients analyzed could have been exposed to other risk factors since childhood, different from those evaluated in our research. Considering this study's cross-sectional design, risk factors and their long-term influence on developing preneoplastic lesions or serious diseases, such as GC, were not monitored.

This is the first research on *H. pylori* that includes populations other than AMVA and evaluates the frequency of *H. pylori* in patients who required digestive endoscopy in seven

units in three subregions of Antioquia. An advantage of this study is that the patients belonged to different socioeconomic levels and healthcare systems. In addition, they were captured in seven endoscopy services in three subregions of Antioquia with more than 200,000 inhabitants, reflecting the heterogeneity in the province's geographical, cultural, environmental, and socioeconomic characteristics.

Finally, the study was conducted in Antioquia, a province located northwest of the country with a coastal region (Urabá), where mortality from GC is less common. In contrast, the medium and high mountain regions (AMVA and Oriente) have more deaths from GC[9]. These figures contrast the differences in the frequencies found in this study concerning *H. pylori*. While it had already been described as "the enigma of the Andes" in the south of the country, it had not been evaluated in populations with many inhabitants or the coastal area of Antioquia[4,50,51].

CONCLUSION

The frequency of *H. pylori* found in patients who required and were taken to digestive endoscopy (symptomatic or by screening) in seven endoscopy units in three subregions of Antioquia was greater than 50%, with substantial differences between them. The variables related to the highest frequency of infection were male sex, age between 18 and 55 years, an educational level less than college, and individuals without a home water supply. The above suggests the need to implement programs to improve the population's living conditions, such as access to drinking water supply systems, and continue with the detection of *H. pylori* and the associated risk factors, which could influence the reduction of gastroduodenal diseases associated with the bacteria. Likewise, it is necessary to direct primary prevention measures against infection, especially in family groups, to impact the transmission dynamics of the bacteria. Lastly, it should be taken into account that the findings in this study have limitations because it is not possible to calculate epidemiological information from the regions or draw conclusions that can be extrapolated to the general population.

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Conflicts of interest

The authors state no conflict of interest.

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