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Epidemiology of *Helicobacter pylori* infection in six Latin American countries (SWOG Trial S0701)

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Conflict of interest
The authors declare that they have no conflict of interest.

Abstract

Objective—To investigate the potential determinants of *Helicobacter pylori* infection between adults 21–65 years old.

Methods—Data are from the initial screening visit of a randomized clinical trial of three antibiotic regimens to eradicate *H. pylori*, conducted in seven sites (Santiago–Chile, Túquerres–Colombia, Guanacaste–Costa Rica, Copán–Honduras, Obregón and Tapachula–México, León–Nicaragua). Thousand eight hundred and fifty-nine adults from the general population were screened for *H. pylori* infection using an urea breath test (UBT) and were interviewed to assess socioeconomic-, demographic-, and symptom-related characteristics. Logistic regression was used to assess the relationship between these characteristics and *H. pylori* positivity at enrollment.

Results—Among the 1,852 eligible participants for whom a conclusive UBT result was obtained, *H. pylori* prevalence was 79.4 %, ranging from 70.1 to 84.7 % among the seven centers. Prevalence did not differ by sex (female: 78.4, male: 80.9; $p = 0.20$) or age ($p = 0.08$). *H. pylori* positivity increased with increasing number of siblings (p trend <0.0001). Participants with education beyond 12 years were less likely to be UBT-positive (OR 0.4: 0.3–0.6, compared to participants with 0–6 years of schooling) as were those employed outside the home (OR 0.7: 0.6–1.0). Odds of *H. pylori* infection increased with the presence of certain living conditions during childhood including having lived in a household with an earth floor (OR 1.8: 1.4–2.4), lack of indoor plumbing (OR 1.3: 1.0–1.8) and crowding (OR 1.4: 1.0–1.8, for having more than two persons per bedroom). Regarding current household conditions, living with more than 3 children in the household (OR 1.7: 1.2–2.5) and crowding (OR 1.8: 1.3–2.3) were associated with *H. pylori* infection.

Conclusions—The prevalence of *H. pylori* in adults was high and differed significantly among the six Latin American countries studied ($p < 0.001$). Our findings confirm the strong link between poor socioeconomic conditions and *H. pylori* infection.

Keywords

Helicobacter pylori; Infection; Prevalence; Risk factors; Determinants; Epidemiology

Introduction

Helicobacter pylori (*H. pylori*) is a gram negative microaerophilic bacillus found in the human stomach, where it can induce chronic inflammation of the gastric mucosa. Infection with *H. pylori* is acquired early in the childhood and if not treated may persist throughout a person's lifetime [1, 2]. Despite *H. pylori* being present in more than 50 % of the world's population, only a small proportion of infected individuals develop clinically significant disease, including duodenal or gastric ulcers, gastric cancer, and gastric mucosa-associated lymphoid tissue lymphoma (MALT) [3–5].

The exact mechanisms of *H. pylori* transmission are unknown and are probably multiple. However, the most likely mode of transmission is by direct person-to-person contact, via oral–fecal, gastro–oral, and oral–oral route [6]. Factors related to living conditions, particularly during childhood, are associated with *H. pylori* infection. These include low socioeconomic status, increasing number of siblings, and decreasing height and weight [7–10]. Some studies have shown that host genetics may also play a role in the acquisition and persistence of infection [2].

Although *H. pylori* infection is ubiquitous worldwide, the prevalence of infection varies among and within countries. This has been attributed to differences in the rate of acquisition of *H. pylori* in childhood. As a consequence of improvements in living conditions, the

prevalence of infection is declining in developed countries, while remaining high, about 80 %, in the developing world [7].

We conducted a randomized phase III clinical trial of three antibiotic regimens to eradicate *H. pylori* in six Latin American countries. Trial participants were screened for *H. pylori* infection with a urea breath test and completed a detailed risk factor questionnaire, offering the unique opportunity to investigate the epidemiology of *H. pylori* infection in Latin America where there is limited information on prevalence and determinants of this infection.

Methods

The study protocol and informed consent were approved by the institutional review boards of each study site and the SWOG Statistical Center in Seattle, WA, USA. Details of the trial methods of the trial have been described elsewhere [11]. Briefly, between September 2009 and June 2012, potential participants from the seven study regions were screened for *H. pylori* infection positivity using a urea breath test (UBT) to assess their eligibility for participation in the trial. In Colombia, participants were recruited in Túquerres, a rural village of approximately 20,000 people in the Andes (the Nariño region). In the north of Mexico, the study staff worked with a local midwife to recruit participants from two villages whose inhabitants belong to the Yaqui Tribe in the state of Sonora. In the south of Mexico, the participants came from both the cities of Tapachula and rural communities in the mountains to the north of the city. The Chilean participants were recruited from a low-income neighborhood in Santiago. Participants in Honduras came from small, rural villages surrounding Santa Rosa del Copán, while the Nicaragua center recruited participants in León, the fourth largest city in the country. In Costa Rica participants were recruited in Hojancha, Guanacaste from the urban center of the town and from surrounding rural areas.

Individuals were identified in Colombia, Costa Rica, and Nicaragua from a census of households, in Chile from a list of individuals served by a large public primary care clinic and in Honduras and Mexico by house-to-house invitation within the local community or through announcements at primary care clinics. Clinical study staff contacted identified individuals and scheduled an initial screening visit. At the clinic, they were asked to provide written informed consent and were screened for eligibility to the randomized trial. To be eligible, individuals had to have no history of prior treatment for *H. pylori*, had to be willing to avoid alcohol and anti-acid medications for 2 weeks, had to have not used antibiotic or proton pump inhibitors in the past 30 days, and if female, could not be pregnant or nursing. Individuals were excluded if they were allergic to any of the study medications or had serious illnesses.

Individuals who met the eligibility criteria were interviewed to obtain information about socioeconomic and demographic characteristics, history of alcohol use and smoking, and current and childhood conditions (at age 10) in the household. The Spanish language version of the Rome III diagnostic questionnaire was administered to assess a detailed gastrointestinal-symptom history. Height and weight were obtained, and participants performed a UBT by exhaling into foil balloons at two time points, baseline and 30 min after consuming a 75 mg dose of ^{13}C-labeled urea dissolved in water. Trained staff at each study center analyzed the breath samples using an infrared mass spectrometry device (IRIS, Wagner Analysen Technik, Bremen, Germany) that detected the conversion of ^{13}C-labeled urea to labeled carbon dioxide by the urease of *H. pylori*. The result was considered positive if a change relative to baseline was ≥4.0 %.

Analyses were based on 1,852 eligible patients that had a conclusive baseline UBT result. Socio-demographic, body mass index, current smoking and alcohol use characteristics,

symptoms of chronic dyspepsia, and household conditions (current and during childhood at age 10) were evaluated as possible determinants of *H. pylori* infection. Household crowding was calculated as the number of people in the household divided by the number of sleeping rooms, and overcrowding was defined as >2 persons per sleeping room [12]. Chi-square and Fisher's exact tests were used to assess differences in *H. pylori* prevalence for factors of interest. Logistic regression was used to calculated age-, sex- and study center-adjusted odds ratios (OR) and 95% confidence intervals (CIs). Individuals with missing information for the characteristic evaluated were excluded from the logistic regression. Chi-square drop-in-deviance tests were used to evaluate the significance of factors that had more than two levels.

Analyses were performed using SAS 9.2 and R 2.14.0.

Results

Of the 1,852 individuals analyzed, 60 % were women (median age = 41.6 years), and 40 % were men (median age = 42.6 years). Five percent never attended school and 60 % completed 7 or more years of school. According to the World Health Organization (WHO) classification for body mass index (BMI) [13], 35.6 % of individuals were overweight (BMI ≥ 25 kg/m^2), and 23.8 % were obese (BMI ≥ 30 kg/m^2). Seventeen percent currently smoked and only 8 % currently drank. Twenty-five percent of the subjects had symptoms of chronic dyspepsia, and 36 % reported the use of antibiotics within the past year.

Overall *H. pylori* prevalence as determined by UBT was 79.4 % (95% CI 77.5–81.2) and did not differ significantly by sex (female: 78.4 %, male: 80.9 %; $p = 0.195$) or age ($p = 0.076$). *H. pylori* prevalence did, however, differ significantly by study center ($p < 0.001$), ranging from 70.1 % in Tapachula to 84.7 % in Obregón (Table 1).

Age-, sex-, and study center-adjusted logistic regression (Table 2) revealed that odds of *H. pylori* infection increased with increasing number of siblings (p for trend <0.0001). Participants with education beyond 12 years were less likely to be UBT-positive (OR 0.41: 0.29–0.59; compared to participants with 0–6 years of schooling), also those employed outside of home had a lower adjusted OR for *H. pylori* detection (OR 0.73: 0.56–0.96). Odds of infection were not associated with body mass index, current smoking or alcohol use, and use of antibiotics in the past year or chronic dyspeptic symptoms.

Furthermore, odds of *H. pylori* infection were strongly associated with the presence of certain living conditions during childhood (Table 3). Individuals whose childhood homes had an earth floor were significantly more likely to be UBT-positive (OR 1.79: 1.37–2.36), and those who had lived in a home that lacked indoor plumbing had 1.3-fold increase in *H. pylori* infection compared with individuals whose home had indoor plumbing. Having lived in crowded conditions increased the odds of infection (OR 1.36: 1.03–1.79, for having more than two persons per bedroom). Other living conditions during childhood, including having had a toilet inside the home, electricity, or three or more children living in the household were not associated with *H. pylori* infection.

Among current household conditions, having at least three children in the household (OR 1.69: 1.19–2.46) and crowded conditions (OR 1.75: 1.33–2.32) were associated with *H. pylori* infection.

We also examined the significance of key risk factors separately within study center. Similar patterns emerged, though numbers were too small to draw any formal conclusions.

Discussion

We assessed the prevalence and determinants of *H. pylori* infection in 1,852 adults (21–65 years old) within six Latin American countries. Although gastric cancer incidence for these six countries varies widely, 7.9 (Mexico), 14.4 (Nicaragua), 17.4 (Colombia), 17.9 (Chile), 21.8 (Costa Rica), and 26.6 (Honduras) (age-standardized gastric cancer incidence rates per 100,000 for both sexes, GLOBOCAN 2008) [14], *H. pylori* prevalence was high, above 70 %, in all seven study areas. The prevalence ranged from 70.1 to 84.7 % and did not differ by age or gender. While it has been suggested that acquisition of *H. pylori* is decreasing in younger cohorts as a consequence of improvements in hygiene [7, 15–17], we did not observe a significantly lower *H. pylori* prevalence for the youngest participants (21–29 years old) in our study suggesting that a reduction of the incidence rates of gastric cancer-*H. pylori* related would not be expected in the near decades for these Latin American countries.

Individual characteristics and living conditions related to lower socioeconomic status were positively associated with *H. pylori* infection in our analyses, and our data confirmed previous reports that infection is more common among individuals with limited schooling and with more siblings [7–10, 18, 19].

Because *H. pylori* infection is typically acquired in childhood, our data regarding participants' household conditions at age ten offer insights into the mechanisms of acquisition. Having had a home with an earth floor, lack of indoor plumbing and crowding (having more than two persons per bedroom) during childhood was strongly associated with infection, indicating that poor socioeconomic status, limited sanitary facilities, and poor hygienic conditions may contribute to the acquisition of the bacterium. This is consistent with studies conducted in children that have found that *H. pylori* infection is highly related to poor hygiene and crowded conditions [20–23]. Having an external source of water may be also a marker of poverty, but we cannot rule it out as a direct source of infection, as has been reported by several studies [6, 24–27].

Current household conditions, including more than three children in the household and crowding, were positively associated with infection. Also, participants unemployed or working at home were more likely to be UBT-positive. These findings may indicate the occurrence of repeated transmission of *H. pylori* (same or different strain) between the individuals who live in the same household, due to a greater opportunity of personal contact, helping to maintain a high *H. pylori* prevalence during adulthood. Evidence of intrafamilial transmission comes from studies reporting strain concordance between parents and children or between siblings, and there is evidence supporting transmission between spouses [28–31]. Schwarz et al. [32] reported that *H. pylori* from persons living in the same household were more similar than those from individuals that live in different households. The same study also reported that in areas of high prevalence of *H. pylori,* opportunities for horizontal transmission (from individuals outside the household) are higher. On the other hand, reinfection and recrudescence may occur after eradication therapy, supporting the acquisition of the bacteria during adulthood [33, 34].

Our results are based on the urea breath test, a highly sensitive and specific measure of active infection [35, 36]. Our study has a broad geographic coverage within Latin America; however, our findings may have limited external validity because selection of individuals was strictly population-based in only three of the seven study centers. Nevertheless, even with the substantial cultural, geographic, and socioeconomic diversity among our participating Latin American centers, the prevalence of *H. pylori* was generally similar for all study centers, and the pattern for determinants of infection did not differ significantly among centers. Another limitation of our study is that we were not able to characterize the

bacterial strains or the presence of host genetic factors in the different countries that could explain the differences in gastric cancer risk.

In conclusion, our results confirm the high prevalence of *H. pylori* in Latin America and the strong link between poor socioeconomic conditions and *H. pylori* infection. These findings may offer opportunities for further scientific discovery and approaches for prevention of *H. pylori* infection.

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Table 1

Prevalence of *H. pylori* infection by study center, gender, and age

Characteristics	Number of individuals	% *H. pylori* positive	*p* value χ^2	Prevalence by study center						
				Tapachula, México	Obregón, México	Copán, Honduras	Guanacaste, Costa Rica	León, Nicaragua	Santiago, Chile	Túqueres, Colombia
Overall	1,852	79.4								
Study Center			<0.001							
Tapachula, México	301	70.1								
Obregón, México	249	84.7								
Copán, Honduras	259	82.6								
Guanacaste, Costa Rica	272	77.6								
León, Nicaragua	240	83.3								
Santiago, Chile	276	76.8								
Túqueres, Colombia	255	83.1								
Gender			0.195							
Female	1,108	78.4		69.2	86.6	81.8	73.6	79.6	77.4	81.3
Male	744	80.9		72.0	76.6	84.6	83.2	85.7	76.2	85.3
p value χ^2				0.611	0.085	0.579	0.061	0.213	0.81	0.39
Age, years			0.076							
20–29	328	75.6		60.3	90.6	83.6	73.2	78.1	64.0	88.9
30–39	506	82.8		79.6	82.7	88.2	79.0	81.0	86.7	83.3
40–49	483	78.3		70.4	88.1	75.4	73.0	82.9	79.2	77.8
50+	535	79.6		64.1	79.3	80.7	83.8	88.4	77.4	84.1
p value Fisher				0.043	0.384	0.241	0.332	0.503	0.073	0.513

Table 2

Sociodemographics and *H. pylori* positivity

Characteristics	Number of individuals[a]	% *H. pylori* positive	Adjusted OR[b]	(95 % CI)
Total individuals	1,852	79.4		
Study center				
Tapachula, México	301	70.1	1.00	
Obregón, México	249	84.7	2.43	(1.60–3.75)
Copán, Honduras	259	82.6	2.04	(1.37–3.08)
Guanacaste, Costa Rica	272	77.6	1.46	(1.00–2.13)
León, Nicaragua	240	83.3	2.04	(1.34–3.14)
Santiago, Chile	276	76.8	1.37	(0.94–2.01)
Túqueres, Colombia	255	83.1	2.06	(1.37–3.13)
Gender				
Female	1,108	78.4	1.00	
Male	744	80.9	1.18	(0.93–1.51)
Age, years				
20–29	328	75.6	1.00	
30–39	506	82.8	1.53	(1.08–2.17)
40–49	483	78.3	1.12	(0.80–1.57)
50+	535	79.6	1.24	(0.89–1.73)
p for trend				0.98
Number of siblings				
≤3	323	74.3	0.54	(0.38–0.76)
4–6	664	78.0	0.67	(0.51–0.89)
7+	817	83.2	1.00	
p for trend				<0.0001
Years of school				
0–6	688	83.1	1.00	
7–9	299	79.3	0.73	(0.51–1.05)
10–12	335	83.0	0.91	(0.63–1.33)
13+	309	68.9	0.41	(0.29–0.59)
Employment status				
Working at home	897	82.2	1.00	
Employed outside of home	939	77.4	0.73	(0.56–0.96)
Body mass index[c]				
Normal (below 18.5)	617	80.7	1.00	
Underweight (18.5–24.9)	26	92.3	2.87	(0.83–18.08)
Overweight (25–29.9)	660	80.9	1.06	(0.80–1.43)
Obese (30 and above)	441	79.6	0.95	(0.69–1.33)
Current smoker				
No	1,523	79.7	1.00	
Yes	304	79.6	0.95	(0.68–1.34)

Characteristics	Number of individuals[a]	% *H. pylori* positive	Adjusted OR[b]	(95 % CI)
Current drinker				
No	1,685	79.5	1.00	
Yes	142	82.4	1.15	(0.73–1.89)
Antibiotic use (within past year)				
No	1,167	80.0	1.00	
Yes	667	79.5	1.06	(0.83–1.35)
Chronic dyspepsia				
Absent	1,388	79.1	1.00	
Present	464	80.4	1.09	(0.84–1.43)

[a] Numbers vary because of missing values for some characteristics

[b] Adjusted for study center, age, and gender. Individuals with missing information for the variable evaluated were excluded

[c] The standard weight status categories associated with BMI ranges for adults were established based on the categorization of the WHO (World Health Organization)

Table 3

Household conditions and *H. pylori* positivity

Characteristics	Number of individuals[a]	% *H. pylori* positive	Adjusted OR[b]	(95 % CI)
Total individuals	1,852	79.4		
Household conditions, at age 10				
Flooring material				
Earth	871	84.2	1.79	(1.37–2.36)
Other	951	75.8	1.00	
Indoor plumbing				
Yes	788	77.8	1.00	
No	1,034	81.3	1.33	(1.00–1.77)
Private toiled				
No	524	83.8	1.00	
Yes	1,302	78.1	0.76	(0.49–1.16)
Electricity				
Yes	1,068	78.4	1.00	
No	754	81.7	1.24	(0.92–1.67)
Children in household				
<3	749	77.6	1.00	
≥3	1,019	81.4	1.23	(0.97–1.56)
Overcrowded housing				
No	460	76.1	1.00	
Yes	1,306	81.1	1.36	(1.03–1.79)
Household conditions, current				
Flooring material				
Earth	271	85.2	1.32	(0.86–2.04)
Other	1,562	78.8	1.00	
Indoor plumbing				
Yes	1,389	78.9	1.00	
No	444	82.4	1.24	(0.85–1.84)
Private toiled				
No	523	83.8	1.00	
Yes	1,311	78.1	0.77	(0.50–1.17)
Electricity				
Yes	1,729	79.3		
No	103	86.4	1.39	(0.76–2.72)
Children in household				
<3	1,525	78.4	1.00	
≥3	295	86.4	1.69	(1.19–2.46)
Overcrowded housing				
No	1,131	76.8	1.00	
Yes	696	84.8	1.75	(1.33–2.32)

[a] Numbers vary because of missing values for some characteristics

[b] Adjusted for study center, age, and gender. Individuals with missing information for the variable evaluated were excluded