Epidemiological Features of *Helicobacter pylori* Infection in Developing Countries

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*Helicobacter pylori* infection has a worldwide distribution, and it has distinct epidemiological features in developing countries. In contrast to that in developed countries, *H. pylori* infection in developing countries seems to be nearly universal, beginning in early childhood. Children become infected in the first few months of life; in some communities as many as 50% of the children are infected by the age of 5 years, and up to 90% are infected by the time they reach adulthood. In some developing countries with improvements in industrialization, socioeconomic conditions, and hygiene, infection rates are lower. The incidence of *H. pylori* infection, determined indirectly, also suggests a rate several times higher than that in developed countries. Marked differences in *H. pylori* seroprevalence have been observed between various ethnic and racial groups. Although the mode of transmission of *H. pylori* remains uncertain, evidence suggests person-to-person transmission occurs.

Since identification of the bacterium *Helicobacter pylori* in 1982, overwhelming evidence from an explosion of research has implicated it as an etiologic component of a variety of gastrointestinal disorders, including diffuse antral gastritis, peptic ulcers, and gastric carcinoma [1–3]. Indeed, it has become apparent that it may be the most common cause of human bacterial infection. Thus, a great interest in the epidemiology of this infection has been provoked with the realization that *H. pylori* is a human pathogen associated with some of the most common gastrointestinal disorders and a common gastric colonizer. *H. pylori* infection occurs worldwide, but there are some differences in the epidemiological features of *H. pylori* infection in developed vs. developing countries. This review focuses on the epidemiology of this infection in developing countries.

Prevalence

The ideal technique for identifying *H. pylori* infection is endoscopic biopsy, involving either histologic examination of the biopsy sample with Warthin-Starry silver or Giemsa stains or isolation of the organism by microbiological culture, or performance of $^{13}$C- or $^{14}$C-labelled urea breath testing [4]. These methods are impractical in developing countries for various reasons, and thus most epidemiological studies have relied upon serological evidence of *H. pylori* infection. Despite the problems of sensitivity, specificity, and replicability of the serological tests [5], serological testing is the most practical method for large-scale epidemiological surveys, although relatively few studies employing serodiagnosis have used internal validation against an established standard procedure.

The sensitivity and specificity of serological tests in most of the reports cited in the present article generally varied between 84% and 100% and 76% and 100%, respectively [6–17]; the variation results from the choice of the "gold standard," the antigens used, choice of the population from whom reference sera are drawn, and the epidemiological characteristics of the population tested.

Whereas only a minority of children in developed countries are infected with *H. pylori*, *H. pylori* infection in developing countries is, in general, characterized by a high prevalence rate during childhood (figure 1), so that the majority of young adults acquire a chronic infection persisting throughout adult life [18, 19].

Prevalence data from different countries in the developing world are summarized in table 1. One of the first studies of *H. pylori* prevalence in developing countries was by Megraud et al. in 1989 [6]. Among Algerian children, 43% were seropositive, and the prevalence rose steadily with age, reaching a peak of 92% between the ages of 40 and 49 years. In Ivory Coast [6], the seroprevalence of *H. pylori* in children was 54%, rising gradually to a plateau of 70%–80% throughout adulthood. An age-specific increase in the prevalence of *H. pylori* infection was observed also in South Africa, where the prevalence was $>50\%$ by the age of 10 years and 94% by the age of 30 years [24]. There was no difference in the prevalence between urban and rural Africans.

In Nigerian children aged 6 months to 2 years, the seropositivity rate was 57%, rising to 82% in children between 5 and 9 years of age [22]. Another study in Nigeria of children aged 0–9 years found the seroprevalence of *H. pylori* to be 69% [23]. In Gambia, the seroprevalence of *H. pylori* in rural children was 31% [20], and in Kenya 93% of 14 asymptomatic volunteers were found to have *H. pylori* during endoscopy [21]. In Zaire,
The prevalence of *Helicobacter pylori* infection among children 5–9 years of age was found to be 54.4% [12]. A continuous increase in *H. pylori* prevalence with age was noted, and about 41% of subjects younger than age 20 years were seropositive.

In India, the prevalence of *H. pylori* was 60% in children <9 years of age and increased with age to 81% by the age of 20 years [8]. Another study, conducted on Tibetan refugees settled in Southern India, found the overall prevalence of infection was 77.2% [28]. However, unlike in other studies, the prevalence of *H. pylori* was found not to rise with age but became lower in those older than age 40 years. The major demographic difference between the younger and older subjects was that the older subjects had spent the greater proportion of their early life outside India (in Tibet); therefore, it was suggested that the duration spent in a particular environment is critical to the acquisition of *H. pylori*.

In a poor peri-urban community in Bangladesh, prevalence of *H. pylori* was found to be 85% [26]. In a cross-sectional study conducted in the same area, 42% of asymptomatic infants younger than 1 year of age were positive for *H. pylori*. In another Bangladeshi study on asymptomatic healthy adult volunteers, 52% were found to be *H. pylori*–positive [27].

In 1990 a study in Saudi Arabia [10] found a seroprevalence of 40% in the children aged 5–10 years, rising to >70% in those aged >20 years, and in Iran the seroprevalence in pastoral nomads and industrial laborers was found to be 88.4% and 93%, respectively [29]. The prevalence of *H. pylori* infection was 64% in Jordanian adults with histologically normal gastric mucosa [30] and 27% in asymptomatic Kuwaiti children within the age range of 9 months to 13 years [31].

In Vietnam [6], the seroprevalence was 13% in children, rising to 43% between the ages of 10 and 19 years and then varying between 50% and 80% during the rest of life. Examination of sera collected from Papua New Guineans for studies of viruses that were unrelated to gastrointestinal infections revealed an overall *H. pylori* seroprevalence of 56%; the seroprevalence was 36% in children up to 10 years of age and peaked at 75% in the age group of 41–50 years [9].

In Brazil, the seroprevalence of *H. pylori* in adult asymptomatic blood donors was observed to be 62.1%, and the prevalence increased with age [15]. Another Brazilian seroprevalence study reported a prevalence of 16.4% in children <24 months of age, rising to 64.3% in those aged 15–18 years [16]. The increase in prevalence with age was highly significant. Seroprevalence of *H. pylori* among Chilean city-dwellers was ~60% in the age group of 15–19 years [17]. The risk of *H. pylori* seropositivity was related to increasing age, low socioeconomic status, and consumption of vegetables.

Another study in Chile revealed increasing prevalence of *H. pylori* antibodies with age [32]. In Colombia, the seroprevalence of *H. pylori* among poor rural children was 68%, but among 57 children of the same age group from well-to-do urban families the seroprevalence was 54% [33]. A similar prevalence of *H. pylori* was noted in a serosurvey in Costa Rica [34].

In Peru, children acquired *H. pylori* infection early in life, with an overall prevalence of 48% [35]. This finding was confirmed in a later report on a seroepidemiological survey of children predominantly from lower socioeconomic strata, which demonstrated that *H. pylori* infection begins in the first years of life; by the age of 4–5 years, ~60% of these children are seropositive [36]. Another study in Peru [37] following a cohort of 6-month-old infants in socially deprived slum-dwelling families found that the overall prevalence decreased from...


Table 1. Prevalence of *Helicobacter pylori* in developing countries.

<table>
<thead>
<tr>
<th>Country [reference]</th>
<th>Study population age (no. of subjects)</th>
<th>Method</th>
<th>Prevalence (%)</th>
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<tbody>
<tr>
<td>Africa</td>
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<tr>
<td>Nigeria [22, 23]</td>
<td>1–60 y (311)</td>
<td>Serology</td>
<td>69–91</td>
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<tr>
<td>South Africa [24]</td>
<td>2 mo–87 y (1,352)</td>
<td>Serology</td>
<td>50–94</td>
</tr>
<tr>
<td>Zaire [25]</td>
<td>5–45 y (133)</td>
<td>14C-UBT</td>
<td>77.4</td>
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<td>Asia</td>
<td></td>
<td></td>
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<tr>
<td>Bangladesh [26, 27]</td>
<td>1 mo–35 y (180)</td>
<td>13C-UBT, histology</td>
<td>42–85</td>
</tr>
<tr>
<td>China [7]</td>
<td>1–50 y (1,727)</td>
<td>Serology</td>
<td>38.6–52.4</td>
</tr>
<tr>
<td>India [8, 28]</td>
<td>3–81 y (435)</td>
<td>Serology, histology</td>
<td>60–81</td>
</tr>
<tr>
<td>Iran [29]</td>
<td>35–55 y (947)</td>
<td>Serology</td>
<td>88.4–93</td>
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<tr>
<td>Jordan [30]</td>
<td>17–86 y (169)</td>
<td>Histology, culture</td>
<td>64</td>
</tr>
<tr>
<td>Kuwait [31]</td>
<td>9 mo–13 y (18)</td>
<td>Histology, culture</td>
<td>27</td>
</tr>
<tr>
<td>Saudi Arabia [10]</td>
<td>5–91 y (577)</td>
<td>Serology</td>
<td>40–70</td>
</tr>
<tr>
<td>South Korea [11]</td>
<td>1–75 y (413)</td>
<td>Serology</td>
<td>22–75</td>
</tr>
<tr>
<td>Taiwan [12]</td>
<td>&lt;10–70 y (823)</td>
<td>Serology</td>
<td>54.4</td>
</tr>
<tr>
<td>Thailand [13, 14]</td>
<td>1–60 y (1,788)</td>
<td>Serology</td>
<td>74</td>
</tr>
<tr>
<td>Latin America</td>
<td></td>
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<tr>
<td>Brazil [15, 16]</td>
<td>1 mo–45 y (629)</td>
<td>Serology</td>
<td>16.4–64.3</td>
</tr>
<tr>
<td>Chile [17, 32]</td>
<td>4 mo–35 y (2,203)</td>
<td>Serology</td>
<td>5–70</td>
</tr>
<tr>
<td>Colombia [33]</td>
<td>2–9 y (742)</td>
<td>Serology</td>
<td>54–68</td>
</tr>
<tr>
<td>Costa Rica [34]</td>
<td>Children and adolescents (290)</td>
<td>Serology</td>
<td>68</td>
</tr>
<tr>
<td>Peru [35–37]</td>
<td>2 mo–70 y (1,632)</td>
<td>14C-UBT, serology</td>
<td>3–92</td>
</tr>
</tbody>
</table>

NOTE. UBT = urea breath test.

71.4% at 6 months of age to 47.9% at 18 months of age—a trend that was significantly more common in females. It was speculated that *H. pylori* infection in infants may be a reversible process; the initial infection might have been less established in the gastric mucosa of young children and/or could have been cleared by processes absent in adults [37].

Thus, it is apparent that in developing countries children acquire *H. pylori* infection very early in life and more frequently than those in developed countries, and the prevalence among adults may approach 90% in some populations.

Data available from several developing countries suggest that rates of *H. pylori* infection in men and women are approximately the same [6, 8, 12]. However, Peruvian women from higher socioeconomic backgrounds had a significantly lower age-specific rate of infection than did men from both high and low socioeconomic levels; the significance of this circumstance remains to be determined, but it may be related to the effect of lifestyle on the route(s) of transmission [36].

**Incidence**

Although the natural history of *H. pylori* infection has not been fully defined, results from serological, therapeutic, and volunteer studies suggest that once infection is acquired it persists for years and possibly for life. As acute *H. pylori* infection passes undetected, the incidence of infection has to be determined indirectly from epidemiological studies. Acquisition of *H. pylori* infection appears on the basis of age-specific prevalence to be relatively constant over time in some populations.

Incidence extrapolated from prevalence data from developed countries is estimated to be 0.5%–1.0% of susceptible persons per year; in developing countries the incidence appears to be higher. For example, in Thailand prevalence curves match an incidence rate of 5% per year [5]. However, the incidence of *H. pylori* infection does not appear to be constant with age in all populations. In a Taiwanese population, the observed age-specific prevalence indicates a 5% incidence in children but a lower incidence in adults [12]. This trend has also been noted in South China [7], where in children <5 years of age the incidence was high but was only 1% in subjects >5 years of age.

One explanation could be that with industrialization and improvement of sanitation and hygiene, prevalence is gradually shifted from childhood to adulthood, thus translating the high childhood infection rate into a high prevalence of adult infection [38]. In Brazil, the reinfection rate in patients treated for *H. pylori* infection was estimated to be 13.5% per year [39]; however, this probably overestimated the true incidence owing to unrecognized recrudescence of suppressed but uncured primary infection.
Effect of Socioeconomic Status and Environmental Factors

A lower socioeconomic status is associated with a higher prevalence of *H. pylori* infection, and this association has been found worldwide, including countries in Asia [10, 28], South America [17, 36], and Africa [40]. In Peru, e.g., among persons <30 years of age, *H. pylori* seropositivity rates were 66% and 43% for men and women, respectively, in private clinics and 88% and 82% for men and women, respectively, in public clinics. Several of these studies have also demonstrated an inverse relationship between *H. pylori* prevalence and the educational level of the population studied. For example, in Saudi Arabia [10] the prevalence of *H. pylori* infection in college graduates and nongraduates was 54% and 77%, respectively. Environmental factors, such as general level of hygiene, water supply and sanitation, and crowding in the household, have been reported to be linked with *H. pylori* infection [10, 24, 28, 41]. All these factors are interrelated and are linked with the overall standard of socioeconomic development.

Marked differences in the seroprevalence of *H. pylori* have been observed between various ethnic and racial groups living in the same area. In South Africa, the seropositivity among Africans, Indians, and coloreds was 93%, 83%, and 81%, respectively; these rates were significantly higher than the seropositivity among whites, which was 43% [24]. A study conducted in Singapore among patients with nonulcerative dyspepsia found the seropositivity among Malays, Chinese, and Indians to be 22%, 48%, and 57%, respectively [42]. Although the exact reasons for the differences in *H. pylori* seropositivity in different ethnic and racial groups are not known, socioeconomic factors, environmental factors, sociocultural practices, and genetic predisposition may all contribute toward acquisition of *H. pylori* infection.

Transmission of *H. pylori*

Reservoir

Although *H. pylori* is believed to be strictly a human pathogen, *H. pylori* or similar organisms could be isolated from several nonhuman species, including primates, pigs, and cats [43]. However, human contact with such animals may not be sufficiently frequent and intimate to explain the widespread prevalence of *H. pylori* infection if these animals serve as reservoirs. Pigs have been implicated as a reservoir of *H. pylori* on the basis of the facts that gastric Helicobacter-like organisms (GHLOs) could be isolated from pig stomachs and germ-free pigs could be colonized with *H. pylori*.

However, the high prevalence of *H. pylori* in Saudi Arabia and Algeria, two strictly Muslim countries, lessens the likelihood of transmission from this source. Moreover, attempts to isolate *H. pylori* from abattoir pigs in Brazil have failed [44]. Although several studies have reported isolation or colonization of nonhuman primates by *H. pylori* or GHLOs, these animals were maintained in a laboratory environment and not in their natural habitat. One study in India revealed that only 4% of wild rhesus monkeys had gastritis on necropsy [45].

The extensive prevalence of *H. pylori*, the clustering of cases in families, the higher prevalence of *H. pylori* seropositivity rates among persons living in institutions or in other crowded conditions, and the lack of a plausible environmental reservoir strongly suggest that humans act as the major reservoir of *H. pylori* and that person-to-person contact is the primary mode of transmission [33]. The two modes of transmission that have been proposed are fecal-oral and oral-oral transmission.

Fecal-Oral Transmission

*H. pylori* can be detected in the gastric juice and thus can pass down into the intestine, where it may or may not survive. Successful isolation of *H. pylori* from feces of Gambian children proved that *H. pylori* can survive in the intestinal tract and be shed into the environment along with feces [46]. *H. pylori* has also been detected in feces from Mexican patients by PCR [47], although this does not necessarily imply the presence of viable bacteria.

Presence of *H. pylori* in sewage water in Peru has been reported [48]. Two South American studies suggested that *H. pylori* infection could be food-borne or water-borne. In Chile, consumption of raw vegetables was strongly correlated with *H. pylori* seropositivity [17]. In Peru, a case-control study found that children using municipal water are three times more likely to acquire *H. pylori* than are children using an internal water source [35]. Hepatitis A virus has a fecal-oral route of transmission, and comparison of age-specific prevalence curves of hepatitis A virus and *H. pylori* infection shows a similar pattern in Saudi Arabia [10], India [8], and South Africa [24]; however, studies in South China [49] showed that this finding is not universal.

Oral-Oral Transmission

*H. pylori* can reach the oral cavity via regurgitation of gastric juice. The oral cavity then can act as a reservoir, and saliva as the vehicle of transmission. *H. pylori* can be isolated from saliva, and a study in India isolated *H. pylori* from dental plaques in 100% of *H. pylori*-positive subjects [50]. A case-control study in Burkina Faso reported that premastication of food by *H. pylori*-positive mothers to feed their infants constitutes a threefold greater risk to the infants, as compared with the risk for controls [51]. However, the finding that dentists have the same prevalence of *H. pylori* as age-matched controls suggests that exposure to saliva is not a risk factor [52]. This is in agreement with studies showing that sexual intimacy and cohabitation among adult individuals are not risk factors for *H. pylori* transmission [53].
Concluding Remarks

In developing countries *H. pylori* infection occurs at younger ages, frequently during infancy, and reaches a prevalence of 70% to >90% in some regions. The incidence of *H. pylori* infection, determined indirectly, also suggests a rate several times higher than that in developed countries. However, the full implications of these observations are unclear. Although the mode of transmission of *H. pylori* remains uncertain, evidence suggests that person-to-person transmission occurs, although the possibilities of exposure to a common environmental reservoir or nonhuman reservoirs cannot be ruled out.

Fecal-oral transmission may be more important than oral contact in the spread of this infection, although both routes may coexist. Large-scale population-based prospective studies utilizing improved noninvasive tests and molecular typing of the infecting strains should provide greater insights into these unresolved issues.

References


