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Prevalence of *Helicobacter pylori* Infection in Korean Children: Inverse Relation to Socioeconomic Status Despite a Uniformly High Prevalence in Adults

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The prevalence of *Helicobacter pylori* infection in US adults was shown to be inversely correlated with the socioeconomic status of the family during childhood, and it was suggested that this was additional evidence of transmission occurring in childhood. The present study of *H. pylori* infection was conducted in South Korea, which has emerged as a developed country in the last two decades. The authors attempted to determine whether there was a difference in prevalence of *H. pylori* infection in Korean children of different socioeconomic classes despite the high prevalence of infection in childbearing adults. The authors also attempted to identify the factors responsible for the different patterns of transmission by estimating the age-specific prevalence of *H. pylori* infection in 413 healthy 1- to 75-year-old asymptomatic volunteers who resided in Seoul. *H. pylori* status was evaluated using an enzyme-linked immunosorbent assay for anti-*H. pylori* immunoglobulin G. Demographic data were obtained from each individual, and socioeconomic class was assessed by the education level of the adults and of the children's parents as well as family income. *H. pylori* infection was present in 75% of adults and 22% of children, and its prevalence increased with age ($p < 0.001$). In adults, the rate of infection was high and independent of socioeconomic class. In children, it was inversely related to the socioeconomic class of the child's family: 12% among upper socioeconomic class, 25% among the middle class, and 41% among the lowest class ($p = 0.016$). No associations were found between prevalence of *H. pylori* infection and any factor tested including sex, smoking, and alcohol consumption. In addition, type of housing, whether owned or rented, number of family members living in the same household, water source, and type of community in which a child grew up were not found to be risk factors influencing *H. pylori* infection prevalence. The prevalence of *H. pylori* infection in Korea appears to be changing with markedly lower prevalence in children of families of higher socioeconomic status. The factor(s) responsible for the break in the pattern of transmission in children of the higher socioeconomic class was not discovered. Future studies will concentrate on possible differences, eating practices, hygiene, and sanitary practices. *Am J Epidemiol* 1996;143:257–62.

adult; child; community acquired infections; *Helicobacter pylori*; seroepidemiologic methods; socioeconomic factors

Helicobacter pylori infection is causally related to chronic gastritis and peptic ulcer disease, and it is indirectly related to gastric adenocarcinoma and primary gastric B-cell lymphoma (1–6). *H. pylori*-related diseases are responsible for tremendous morbidity and mortality in both developed and developing countries. *H. pylori* infection can be cured, prevented, or both, suggesting that it may be possible to eliminate the infection from a population.

Although the route(s) of transmission of *H. pylori* infection remain unclear, potential mechanisms can be obtained by epidemiologic studies of the infection. The prevalence of *H. pylori* infection follows the pattern previously established for gastritis (e.g., the frequency of the infection increases with age and is associated with lower socioeconomic classes) (7). The prevalence of *H. pylori* infection varies both between and within populations, with a generally higher rate of acquisition in underdeveloped countries than in industrialized countries (7–18).

The major difference between developing and developed countries is the high rate of acquisition of *H. pylori* infection during childhood in developing coun-

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Abbreviation: ELISA, enzyme-linked immunosorbent assay.

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tries (8, 11, 14, 15). Even within developed countries, there are marked differences in prevalence among different groups. For example, in the United States, *H. pylori* infection is approximately twice as frequent in African-Americans and white Hispanics as in age-matched whites (10, 16). The high prevalence of *H. pylori* in African-Americans initially appeared to be independent of socioeconomic status (10). Recently it was shown that the prevalence of *H. pylori* infection in African-Americans and Hispanics was inversely related to social class during childhood (19). The inverse correlation between social class and *H. pylori* infection remained after adjustments were made for present social class and age. It was hypothesized that the prevalence of *H. pylori* infection in African-Americans and Hispanics was related to a close generation distance from ancestors of low socioeconomic status and that childhood was a period of major risk for acquisition of *H. pylori* infection (19). To investigate any such factor(s) responsible for a break in the pattern of transmission that is associated with high social class, we examined the pattern of *H. pylori* infection among adults and children in Korea, a country that has been transformed from an underdeveloped to a developed country in the last two decades.

MATERIALS AND METHODS

Study population

Asymptomatic healthy Korean individuals who resided in the vicinity of Seoul, South Korea, were invited to participate in the study. The study population consisted of adults and children who visited a health screening center of Guro Hospital for routine health examination. Guro Hospital is affiliated with Korea University College of Medicine in Seoul, South Korea. The majority of the individuals served by the center are from the middle class with fewer private patients and families from lower socioeconomic class. The criteria for enrollment included no history of peptic ulcer disease, no active symptoms of gastrointestinal tract illness, no surgery within 2 months prior to the visit, and no use of drugs such as antacids, antibiotics, or H2-receptor antagonists. Each adult was questioned about the presence and the frequency of symptoms referable to the upper gastrointestinal tract, including indigestion, heartburn, sour stomach, burning pain in the stomach area and/or in the chest. Subjects were excluded from the study if they had symptoms referable to the upper gastrointestinal tract. A trained interviewer surveyed and completed the screening questionnaire. Members of the same family were not studied to prevent bias by known familial clustering. The sampling of the study was not random but instead, depended on invitation and eligibility for the entry criteria. The overall response was 90 percent. The study, which started July 1992 and ended December 1993, was approved by the Institutional Review Board of the Korea University School of Medicine.

Questionnaire

The questionnaire was designed to obtain demographic data such as age, sex, occupation, income, educational level, and place of birth. Environmental information was collected regarding type of house, type of community of current residence, type of community during childhood, number of rooms/bedrooms in the house, number of persons living in the house, and type of drinking water.

The questionnaire for children was designed to obtain information regarding educational level, income, and occupation of the parents, whether the child slept with the mother and until what age, whether the child attended a day-care center and until what age, and place of birth. Informed consent was obtained from each subject or parent.

Serologic methods

A blood sample was obtained from each participant. Serum was separated and frozen until assayed. Immunoglobulin G antibody to the high molecular weight cell-associated proteins of *H. pylori* was measured using an enzyme-linked immunosorbent assay (ELISA) (HM-CAP, EPI, Westbury, New York). The specificity and positive predictive value of the HM-CAP ELISA were each previously shown to be 100 percent; the sensitivity, 98.7 percent; and the negative predictive value, 98.6 percent (20). There is no cross-reactivity with *Campylobacter jejuni.*

Methods of analysis

H. pylori infection was defined as a positive ELISA result. Categorization of socioeconomic class was based on two combined factors (occupation and education) by applying the modified Hollingshead Index (21) and income. Six educational levels, five occupational categories, and three income levels were used to identify social classes. Categorization of family income was measured by the annual Korean won and its equivalent in US dollars. Five social classes were identified ranging from highest (I) to lowest (V) (table 1). That scale was applied to determine the adults' and the children's parents' socioeconomic classes. As the combination of five socioeconomic classes and nine age groups resulted in some age groups with very small sample sizes, we combined social classes into

TABLE 1. Educational and occupational categories used in forming the modified Hollingshead Index* of socioeconomic class

Social class	Education	Occupation	Income†
I	College graduate and postgraduate	Major professionals	High
II	Some college	Minor professionals and administrators	Middle to high
III	High school	Clerks, sales, and technicians	Middle
IV	High school	Skilled workers	Middle to low
V	Elementary school	Semiskilled and unskilled workers	Low

* Source: Hollingshead (21).
† Categorization of family income: Korean won (equivalent US dollar): high, >36,000000 (>$45,000); middle, 12,000,000–36,000,000 ($15,000–$45,000); low, <12,000,000 (<$15,000).

three categories: I (highest), II and III (intermediate), IV and V (lowest).

Mantel-Haenszel × 2 test was used to assess the associations between each independent factor of the study related to the prevalence of *H. pylori* infection. Univariate and multivariate analyses, odds ratios, and 95 percent confidence intervals were calculated for *H. pylori* seropositivity associated with the study variables. Risk factors that were significant in the univariate analysis were used in the multiple logistic regression model. These models help to assess the relative importance of *H. pylori* risk factors while controlling for other risk factors. The data were analyzed using the SAS program (22).

RESULTS

Prevalence of *H. pylori* infection

A total of 413 people (161 adults and 252 children) participated in the study. Adults ranged in age from 20 to 75 years and the children, from 1 to 19 years. The overall seropositivity rate of *H. pylori* infection was 75 percent among adults and 22 percent among children. The prevalence of *H. pylori* infection progressively and steeply increased with advanced age for the total population (figure 1) ($p < 0001$). There was no significant difference in the prevalence of antibody between males and females.

Socioeconomic class and risk of *H. pylori* infection in adults and children

The distribution of the prevalence rates in relation to the three socioeconomic classes for the adults and children separately are shown in table 2. Although *H. pylori* prevalence rates were very similar among the three classes of the adult population ($p = 0.60$), a

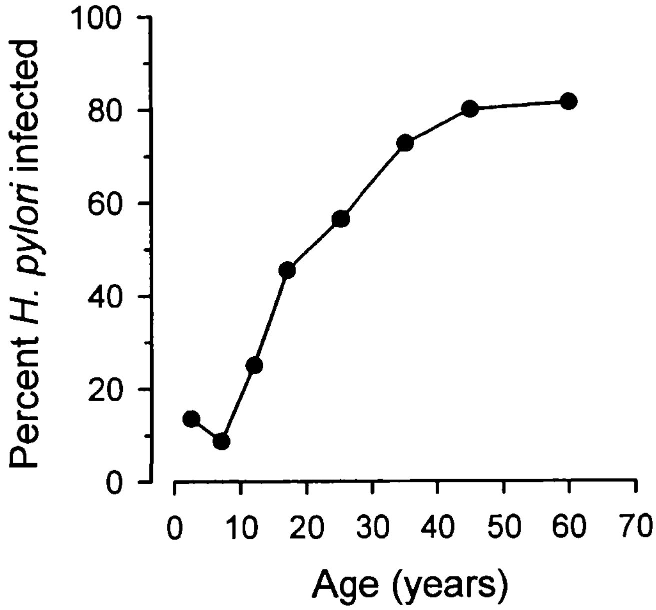

FIGURE 1. Age-specific distribution of *Helicobacter pylori* infection.

significant difference was observed among the three classes for the population of children ($p = 0.02$). Because age is known to affect the prevalence rate of *H. pylori* infection, and to increase sample size for more meaningful analysis, we examined age-specific prevalence in relation to socioeconomic class for children up to 10 years old, children between 10 and 19 years, and for adults (ages 20 and older) (figure 2). There was an inverse relation between social class and prevalence of *H. pylori* infection. For both age groups 1–9 and 10–19, the prevalence of *H. pylori* infection was statistically lower in children in social status group I compared with groups IV and V ($p = 0.01$ and 0.04, respectively).

Association between the study variables and *H. pylori* infection

To examine *H. pylori* associations, we applied the logistic regression model on adult and child populations separately. Table 3 presents the odds ratios for *H. pylori* positive serology in relation to age, socioeconomic class, type of community in which they grew up, type of dwelling, whether the dwelling was owned or rented, number of family members in the house during childhood (for adults), and number of family members in the house (for children). For the adult population, the youngest age group (20–29 years) showed the lowest rate of the infection (57 percent), and that difference remained significant after adjusting for socioeconomic class. For children, there was a

TABLE 2. Frequency of *Heliocobacter pylori* antibodies in 161 adults and 252 children according to socioeconomic class, Seoul, South Korea, July 1992 to December 1993

Variable	Socioeconomic class: Upper (I) No. (% positive)*	Middle (II and III) No. (% positive)*	Lower (IV and V) No. (% positive)*	*p* value†
Adults	62 (74)	75 (73)	24 (83)	0.591
Children	67 (12)	168 (25)	17 (41)	0.016
Total	82 (56)	112 (59)	33 (70)	

* Percentage of *H. pylori* positive.
† Statistical difference between social classes within adults and children separately.

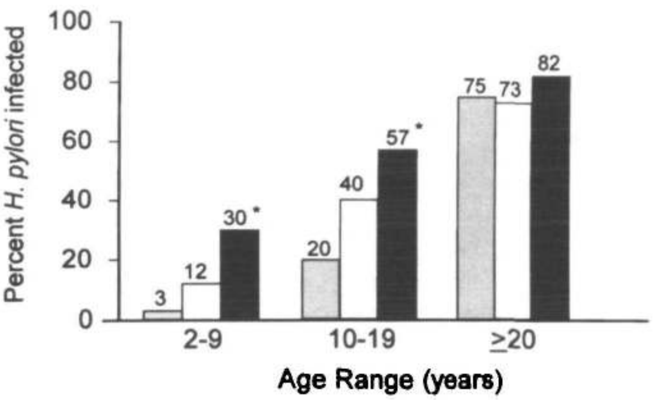

FIGURE 2. Age-specific prevalence of *Helicobacter pylori* infection in relation to social class. ■, social class I; □, social classes II and III; ■, social classes IV and V. (See text for social class categories.) *, $p < 0.05$ for the prevalence of *H. pylori* infection in the lowest social class compared with the high social class. None of the other comparisons were significant.

strong inverse correlation between family social class and *H. pylori* infection. The odds ratio for children from the low social class was 5.2 compared with 2.5 for those from the middle social class. When all of the study variables were fitted in the logistic regression model to prevent any confounding effect, the results did not alter the observed strong effect of childhood social class as a risk for acquiring the infection. Neither type of community and type of dwelling nor number of family members who lived in the house was significantly associated with presence of *H. pylori* antibodies for adults or children. In an attempt to identify the factor(s) responsible for the apparent break in the pattern of transmission of *H. pylori* infection in children of the highest social group, we repeated our analyses comparing children in social group I with those in groups IV and V for age groups 1–9, 10–19, and 1–19. No factor emerged except socioeconomic status.

DISCUSSION

The variation in the prevalence of *H. pylori* infection between different populations suggests that different parameters such as socioeconomic status (10, 23–25), genetic predisposition (26), social and cultural background (19, 27), or environmental factors (28) play a role in the acquisition of *H. pylori* infection. Examination of different populations in which some of these factors are relatively constant should provide important information regarding the epidemiology and transmission of *H. pylori* infection.

Korea is a country that has been transformed from an underdeveloped to a developed country in the last two decades. This change provided the opportunity to examine the effect of socioeconomic level on the acquisition rate of *H. pylori* infection among adults and children in a population in which the epidemiology of *H. pylori* is probably in flux. The prevalence of *H. pylori* infection in Korean adults was as high as that reported from other developing countries and from some ethnic groups in developed countries (8, 11, 16, 28, 29). The high prevalence of *H. pylori* infection in adults was consistent with the prevalence of 78 percent reported from a study examining the associations of *H. pylori* with gastritis and peptic ulcer diseases among urban Koreans (30).

In a previous study, we found that low socioeconomic status of the family when the adults were children was related to the apparent increase in *H. pylori* prevalence in African-Americans and Hispanics in the United States (19). As in the United States, the prevalence of *H. pylori* infection was inversely related to the socioeconomic status of the family (23). These data suggest that there are birth cohorts defined by socioeconomic status that have different risks for acquiring *H. pylori* infection and, by inference, the symptomatic forms of infections such as peptic ulcer, gastric cancer, or primary gastric B-cell lymphoma. These data are also consistent with the notion that part of the increase in *H. pylori* prevalence noted with age may reflect the relative size of different birth cohorts with marked environmental differences (19, 27, 28).

The precise mode of transmission of *H. pylori* infection is still not established, although intrafamilial clustering has been reported suggesting person-to-person, fecal-oral, or a common source (31–34). Childhood is thought to be the major risk period for *H. pylori* acquisition. Considering both the high prevalence of *H. pylori* infection among Korean adults and the results from our previous study in African-American and Hispanic individuals in the United States (16), one would expect that the risk of children acquiring *H. pylori* infection would be proportional to the prevalence of *H. pylori* in adults. The finding of

TABLE 3. Final model showing the results of logistic regression analysis of risk factors and their association with *Heliocobacter pylori* infection for adults and children, Seoul, South Korea, July 1992 to December 1993

Variable	Adults				Children			
	Total no. (% positive)*	OR†	95% CI†	*p* value	Total no. (% positive)*	OR	95% CI	*p* value
Age group (years)								
1–4					52 (13)			
5–9					81 (9)	0.7	0.40–2.1	0.52
10–14					64 (25)	2.1	1.78–5.7	0.12
15–19					55 (45)	5.3	2.0–13.8	0.01
20–29	23 (57)							
30–39	44 (73)	2.0	1.4–5.9	0.18				
40–49	40 (80)	3.1	1.1–9.3	0.05				
≥50	54 (81)	3.3	1.1–9.7	0.02				
Social class								
High (I)	62 (74)				67 (12)			
Middle (II and III)	75 (73)	1.0	1.0–2.2	0.90	168 (25)	2.5	1.1–5.5	0.03
Low (IV and V)	24 (83)	1.7	1.7–18.0	0.30	17 (41)	5.2	1.5–17.4	0.01
Community								
Urban	39 (72)				197 (20)			
Rural	122 (76)	1.3	1.3–2.8	0.57	55 (27)	1.4	1.0–7.2	0.27
Dwelling								
Apartment	43 (81)				62 (16)			
Single/multihouse	18 (73)	0.75	0.4–3.2	0.27	190 (27)	1.7	1.2–2.6	0.18
Residence								
Own	108 (75)				107 (25)			
Rent	53 (75)	1.0	1.0–1.8	0.94	144 (19)	1.4	1.1–7.7	0.27
No. of family members in the house								
1–4	21 (71)				186 (20)			
≥5	140 (76)	1.2	1.1–4.5	0.67	65 (20)	1.3	0.5–5.3	0.39
Water source								
Well water	3 (67)							
City water	92 (74)	1.4	1.2–2.6	0.8				
Bottled water	66 (77)	1.7	1.4–6.8	0.7				

* Percentage of *H. pylori* positive.
† OR, odds ratio; CI, confidence interval.

low prevalence in children despite high prevalence in adults suggests that it should be possible to identify the factor(s) responsible for *H. pylori* transmission and to develop strategies to break the chain of that transmission.

This study suggests that although the route(s) of transmission from host to host remain unclear, a systematic search should identify factors or behaviors vital to the transmission of *H. pylori* infection. Control or elimination of those factors should eliminate or greatly reduce the transmission of *H. pylori* infection. Until recently, it would have been unthinkable to suggest that the scourge of peptic ulcers and gastric carcinoma might be eliminated. This possibility now deserves serious consideration.

There are some potential limitations to our analyses that may affect inferences derived from these data. The participants in this study were volunteers and did not comprise a random sample of the general population. Thus, our population may have included more than the typical number of individuals from the middle social class. Subsequent studies will focus on households with children younger than 18 years with increased emphasis on practices and habits concerning diet and hygienic conditions while evaluating preventive strategies.

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