**Helicobacter pylori** and **Helicobacter heilmannii** in untreated Bulgarian children over a period of 10 years

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The aims of the study were to evaluate the incidence of **Helicobacter pylori** and **Helicobacter heilmannii** in untreated Bulgarian children from 1996 to 2006, to analyse the performance of diagnostic tests, and to look at **H. pylori** density in specimens by culture. Antral specimens from children with chronic gastritis (n=513), peptic ulcers (n=54) and other diseases (n=91) were evaluated by direct Gram staining (DGS), in-house rapid urease test (RUT) and culture. The living environment and semi-quantitative **H. pylori** density were assessed in 188 and 328 children, respectively. **H. pylori** infection was found in children with ulcers (77.8 %), chronic gastritis (64.5 %) and other diseases (36.3 %). Half (51.4 %) of patients aged 1–5 years and 77.4 % of those aged 16–17 years were **H. pylori**-positive. Of all children, 328 (49.8 %) showed positive DGS, 184 (28 %) had a positive RUT, and 386 (58.7 %) were culture-positive. Unlike gastric mucus specimens, frozen biopsy specimens provided reliable diagnosis. **H. heilmannii** was observed in two (0.3 %) children. High **H. pylori** density (growth into all quadrants of plates) was found in 18 % of 328 children evaluated, involving 31 % of ulcer and 16.7 % of non-ulcer patients. **H. pylori** infection was more common in rural children with chronic gastritis (91.3 %) than in the remainder (66.7 %). In conclusion, **H. pylori** infection was common in symptomatic Bulgarian children. The infection prevalence was >77 % in patients aged 16–17 years, in children with a duodenal ulcer, and in rural patients. **H. heilmannii** infection was uncommon. The performance of the bacterial culture was good. The impact of **H. pylori** density on the clinical expression and eradication of the infection requires further evaluation. The results highlight the need for routine **H. pylori** diagnosis in rural children with chronic gastritis.

**INTRODUCTION**

**Helicobacter pylori** infection is associated with gastroduodenal diseases in humans (Matysiak-Budnik et al., 2006). The incidence of the infection in children ranges from 10 to 80 %, and is high in developing and some other countries (Torres, 2000; Janulaityte-Gunther et al., 2005; Kato et al., 2004). **H. pylori** infection is most often intrafamilial and spreads by oral–oral or faecal–oral transmission (Megraud, 2003; Mladenova et al., 2006). **Helicobacter heilmannii** can also infect the human stomach. The incidence (usually <1 %) of this zoonotic infection in dyspeptic patients is much lower than that caused by **H. pylori** (Ierardi et al., 2001; Okiyama et al., 2005). There are, however, only a few reports concerning **H. heilmannii** incidence in children (Coman et al., 1996; Mention et al., 1999; Sykora et al., 2004).

The aims of the present study were to assess the incidence and characteristics of **H. pylori** and **H. heilmannii** infections in untreated Bulgarian children over a period of 10 years, according to age, sex, disease and living environment; to analyse the performance of diagnostic tests according to the type of antral specimen; and to evaluate **H. pylori** density in the biopsy specimens by culture.

**METHODS**

**Patients and specimens.** In total, 658 consecutive, untreated children with upper gastrointestinal complaints were evaluated from January 1996 to November 2006. Informed written consent was obtained from the parents of all the children. The patients were aged 1–5 years (n=37), 6–10 years (n=216), 11–15 years (n=272) and 16–17 years (n=133). The classification of patients’ diseases was based on endoscopic findings and clinical signs (Kalpak et al., 2005). The children suffered from chronic gastritis (n=513), duodenal ulcers (n=50), gastric ulcers (n=4), other gastroduodenal diseases (n=36) and non-ulcer dyspepsia (n=55).
One antral biopsy specimen per child was taken from 585 children and gastric mucus specimens were taken from 73 children. Both antral biopsy and gastric mucus specimens were taken from five children. The mucus specimens were taken by a brush that was introduced into the stomach through the biopsy channel of the endoscope, and then the antral mucosal surface was stroked with the brush. All the specimens were transported in Stuart transport medium (Becton Dickinson). In total, 622 fresh specimens were transported in Stuart transport medium for <5 h, and 36 specimens were frozen in Stuart transport medium at −70 °C for 1–7 days (15 specimens) or for 8–16 days (21 specimens).

Microbiology. The specimens were used for direct Gram staining (DGS), in-house rapid urease test (RUT) and culture. Each specimen was divided into three parts. A smear was prepared from one part of the specimen by scraping the biopsy onto a slide. The smear was fixed and used for a modified Gram stain with carbol fuchsin as the counterstain. For performing the RUT, one-third of the biopsy specimen was placed in urea agar medium with 10 % urea. The RUT was prepared using urea agar base (Merck) by adding the filter-sterilized urea (Merck) after the agar had been autoclaved and cooled to 48 °C. Clinical strains of Proteus mirabilis and Escherichia coli were used as a positive and negative control, respectively. The RUT was incubated at 35 °C. Observations for colour change were made after 30 min and 3 h. The remaining part of the specimen was homogenized in 0.1 ml sterile saline using sterile needles, and the homogenate was used for culture.

The culture was performed on Columbia agar (Becton Dickinson) with 10 % sheep blood (non-selective medium) and the following medium with 1 % Isovitalex (Becton Dickinson) and the following strain of a Japanese study (Kato et al., 2004). In the present study, more duodenal ulcer patients (80 %) were H. pylori-positive than were those with chronic gastritis (64.5 %, P <0.05) and the other patients (36.8 %, P <0.001) (Table 1). However, H. pylori incidence in children with chronic gastritis was higher than that (25.6 %) reported in a recent study (Wong et al., 2005). The results of the present study were similar to those of a Japanese study (Kato et al., 2004).

H. pylori growth in the antral biopsy specimens of 328 consecutive children was expressed semi-quantitatively (as the density of H. pylori) as follows: no growth, score 0; sparse density with growth into the first or first and second quadrants of the plate, score 1; moderate density with growth into the third quadrant, score 2; and high density with growth into all quadrants of the plate, score 3. Both media were considered H. pylori-positive if the culture was positive, or in case of negative culture, if the two other tests used (DGS and RUT) were both positive. The performance of the tests was evaluated.

RESULTS AND DISCUSSION

H. pylori infection was detected in 406 (61.7 %) of the untreated Bulgarian children with gastroduodenal diseases. The infection was common even in the youngest patients, with about half (51.4 %, 19 of 37) of the children aged 1–5 years being H. pylori-positive.

The overall infection incidence in Bulgarian paediatric patients was higher than that (25.6–30.5 %) reported in some European countries and China (Koletzko et al., 2003; Wong et al., 2005; Sykora et al., 2004), but was lower than that in Lithuanian children (79 %; Janulaityte-Gunther et al., 2005). In the present study, more duodenal ulcer patients (80 %) were H. pylori-positive than were those with chronic gastritis (64.5 %, P <0.05) and the other patients (36.8 %, P <0.001) (Table 1). However, H. pylori incidence in children with chronic gastritis was higher than that (25.6 %) reported in a recent study (Wong et al., 2005). The results of the present study were similar to those of a Japanese study (Kato et al., 2004).

In two (0.3 %) children, H. heilmannii was diagnosed by a Gram-stained smear. The patients were an 11-year-old girl with erosive gastritis and a 13-year-old boy with chronic non-erosive gastritis. Both children were from towns and were H. pylori-negative. H. heilmannii was seen in the Gram-stained biopsy specimens and differed from H. pylori by its four to eight visible spirals and larger size. The urease test was positive after 24 h incubation. There are still only a few reports on H. heilmannii incidence in children. The present study demonstrated a slightly lower incidence of H. heilmannii in paediatric patients than that reported by other authors (0.4–1.1 %) (Coman et al., 1996; Mention et al., 1999; Sykora et al., 2004).

Increasing age has been associated significantly with the higher risk of H. pylori infection in symptomatic children (Wong et al., 2005). Likewise, in the present study, H. pylori infection was less common (51.4 %, 19 of 37 cases) in children aged 1–5 years than in those aged 16–17 years (77.4 %, 103 of 133; P <0.01). Although a male predominance of H. pylori infection has been observed in adults, the role of gender as a risk factor for the infection, especially in children, is still debated (de Martel & Parsonnet, 2006). In the present work, there was no difference in the infection incidence between boys (62.9 %, 175 of 278 patients) and girls (60.8 %, 231 of 380; P >0.20).

In rural patients, the overall incidence of the infection (88.9 %, 24 of 27 patients) was higher than that (65.8 %, 106 of 161; P <0.05) in the other children. A similar difference in the infection incidence was observed between rural children with chronic gastritis (91.3 %, 21 of 23 patients) and the rest (66.7 %, 94 of 141; P <0.05). These results could have been due to several reasons, such as a higher incidence of H. pylori infection, or lower antibiotic usage in rural children than in those from towns, as well as differences in health-care-seeking behaviour or referral for endoscopy of the paediatric patients.

Of all children, 328 (49.8 %) had positive DGS, 184 (28 %) had positive RUT, and 386 (58.7 %) had positive culture. The specimens from 13 (2 %) of the 658 children, nine...
(1.5 %) of 585 antral biopsy specimens and four (5.5 %) of 73 antral mucus specimens, were positive by RUT and negative by both DGS and culture. In addition, the specimens from 44 (6.7 %) of all 658 children, involving 37 (6.3 %) of the antral biopsy specimens and seven (9.6 %) of the antral mucus specimens, were positive by DGS and negative by both RUT and culture. According to diagnostic criteria in the present study, if only the DGS or RUT was positive, the specimen was considered _H. pylori_-negative. Culture exhibited the best performance among the diagnostic methods in the present study. This could have been due to the use of both selective and non-selective media with a long incubation (up to 11 days) of the specimens, or to the use of only one-third of a specimen per child for the RUT. The RUT can give false-negative scores with small numbers of _H. pylori_ (De Korwin, 2003). Therefore, we recommend evaluating two gastric biopsy specimens per child, in order to optimize the diagnosis of _H. pylori_ infection. According to Ogata _et al._ (2001), 5–10 % of _H. pylori_-infected children and adolescents have been misdiagnosed with a single antral-biopsy-based test.

_H. pylori_ infection was detected in 387 (62.2 %) of the 622 fresh antral specimens, compared with 19 (52.8 %) of the 36 frozen specimens _P_ >0.20. Eight (53.3 %) of 15 specimens frozen for 1–7 days and 11 (52.4 %) of 21 long-term-frozen specimens were positive for _H. pylori_. However, _H. pylori_ infection was detected in significantly more gastric biopsies (63.9 %, 374 of 585 specimens) than gastric mucus specimens (43.8 %, 32 of 73 specimens; _P_ <0.001). The mucus specimens may have included smaller sample volumes than the biopsy specimens, which led to a lower diagnostic performance. By evaluating only the five children with both gastric biopsy and gastric mucus specimens, _H. pylori_ was cultured from biopsy specimens of three of the children but not from the antral mucus specimen of only one child. Therefore, the frozen biopsy specimens provided acceptable _H. pylori_ detection, while the gastric mucus specimens were not suitable for _H. pylori_ diagnosis in paediatric patients. The number of positive results for DGS, culture and RUT in gastric mucus specimens decreased by 22.2, 19.8 and 9.9 %, respectively, compared to those in antral biopsy specimens (Table 2). However, Minami _et al._ (2006) have reported that combination of the endoscopic brushing technique with the loop-mediated isothermal amplification method is a useful and safe system for identifying _H. pylori_ infection.

_H. pylori_ density has been found to correlate with the degree of gastric-mucosal inflammation in children (Elitsur _et al._, 2002). Different authors have used different methods for scoring _H. pylori_ density, including histology, culture, real-time quantitative PCR-based techniques or the urea breath test (Elitsur _et al._, 2002; Lai _et al._, 2003; Atherton _et al._, 1996; Abbas _et al._, 2001; He _et al._, 2002). One disadvantage of the invasive tests can be the patchy

### Table 1. Clinical and laboratory findings in 658 untreated children with gastroduodenal diseases

<table>
<thead>
<tr>
<th>Groups of patients</th>
<th>No. of patients</th>
<th>No. of H. pylori-positive</th>
<th>Percentage positive</th>
<th>95 % CI</th>
<th><em>P</em> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endoscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gastric ulcer</td>
<td>4</td>
<td>2</td>
<td>50.0</td>
<td>0–100.0</td>
<td></td>
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<tr>
<td>Duodenal ulcer</td>
<td>50</td>
<td>40</td>
<td>80.0</td>
<td>68.8–91.2</td>
<td></td>
</tr>
<tr>
<td>Chronic gastritis</td>
<td>513</td>
<td>331</td>
<td>64.5</td>
<td>60.4–68.6</td>
<td></td>
</tr>
<tr>
<td>Other diseases*</td>
<td>36</td>
<td>15</td>
<td>41.7</td>
<td>25.4–58.0</td>
<td></td>
</tr>
<tr>
<td>Non-ulcer dyspepsia</td>
<td>55</td>
<td>18</td>
<td>32.7</td>
<td>20.2–45.2</td>
<td></td>
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<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1–5</td>
<td>37</td>
<td>19</td>
<td>51.4</td>
<td>35.1–67.7</td>
<td></td>
</tr>
<tr>
<td>6–10</td>
<td>216</td>
<td>121</td>
<td>56.0</td>
<td>49.4–62.6</td>
<td></td>
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<tr>
<td>11–15</td>
<td>272</td>
<td>163</td>
<td>59.9</td>
<td>54.1–65.7</td>
<td></td>
</tr>
<tr>
<td>16–17</td>
<td>133</td>
<td>103</td>
<td>77.4</td>
<td>70.3–84.5</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>278</td>
<td>175</td>
<td>62.9</td>
<td>57.2–68.6</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>380</td>
<td>231</td>
<td>60.8</td>
<td>55.9–65.7</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>658</td>
<td>406</td>
<td>61.7</td>
<td>58.0–65.4</td>
<td></td>
</tr>
</tbody>
</table>

*Reflex oesophagitis and single cases of hiatal hernia, iron deficiency anaemia and Crohn’s disease.

### Table 2. Comparison of diagnostic tests for _H. pylori_ infection in 658 untreated Bulgarian paediatric patients

<table>
<thead>
<tr>
<th>Specimen (no.)</th>
<th>No. (%) positive by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DGS</td>
</tr>
<tr>
<td>Antral biopsy (585)</td>
<td>306 (52.3)</td>
</tr>
<tr>
<td>Antral mucus (73)</td>
<td>22 (30.1)</td>
</tr>
<tr>
<td>Total (658)</td>
<td>328 (49.8)</td>
</tr>
</tbody>
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distribution of *H. pylori* in gastric mucosa (Vinette et al., 2004); however, *H. pylori* density has often been evaluated by invasive tests. In the present study, by semi-quantitative scoring of *H. pylori* growth by culture, the infection in 59 (18 %) of 328 children evaluated was associated with high *H. pylori* density (score 3), and that in 103 (31.4 %) of the children was associated with either moderate (score 2) or high *H. pylori* density. In addition to cagA and other virulence markers of *H. pylori* strains, bacterial density can also contribute to a more severe infection (Gallo et al., 2003). According to the present results, slightly more ulcer patients (31 %, 9 of 29 patients) had high *H. pylori* density in the antral biopsy specimens, compared with those with other diseases (16.7 %, 50 of 299 patients; P >0.05) (Fig. 1).

In conclusion, *H. pylori* infection was common in symptomatic Bulgarian children, and the infection incidence was associated with increasing age, duodenal ulcer and rural living environment, but not with patient gender. In contrast, *H. heilmannii* infection was uncommon. Culture showed a good performance. Frozen biopsy specimens provided reliable *H. pylori* detection, unlike the gastric mucus specimens. Both moderate and high *H. pylori* densities were found in about one-third of the children. The impact of *H. pylori* density, assessed by semi-quantitative culture, on the clinical expression of the infection and the success of eradication requires further evaluation. The present results demonstrate the benefit of diagnosing *H. pylori* infection in rural children with chronic gastritis.

**REFERENCES**


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**Fig. 1.** *H. pylori* density assessed by semi-quantitative culture in 257 untreated paediatric patients.


