Prevalence and risk factors of *Helicobacter pylori* infection among children in Kuichong Subdistrict of Shenzhen City, China

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**Background:** *Helicobacter pylori* infection is a significant burden to the public health in China as it can lead to various gastric diseases including peptic ulcers and gastric cancer. Since most infections occurred during childhood, it is therefore necessary to understand the prevalence and risk determinants of this bacterial infection in children. Herewith we conducted a cross-sectional study in the Kuichong Subdistrict of Shenzhen City to assess the prevalence and risk factors of *H. pylori* infection among children.

**Methods:** From September 2018 to October 2018, 1355 children aged 6-12 years from four primary schools in the Kuichong Subdistrict of Shenzhen City were recruited. These children were screened for *H. pylori* infection using the $^{13}$C-urea breath test. In addition, parents were requested to fill out a standardized questionnaire. Chi-square test and multivariable logistic regression analysis were used to identify risk factors for *H. pylori*.

**Results:** Among 1355 children recruited in this study, 226 (16.7%; 95% CI: 14.7%-18.7%) were positive of *H. pylori* infection. Multivariable logistic regression analysis identified six factors significantly associated with *H. pylori* infection children including parent(s) with tertiary education level (OR: 0.64; 95% CI: 0.46-0.89), testing bottle feed temperature using the mouth (OR: 1.79; 95% CI: 1.19-2.68), sharing of cutlery between the feeding person and young children during meals (OR: 1.84; 95% CI: 1.22-2.78), eating fruit after peeling (OR: 2.56; 95% CI: 1.4-4.71), frequent dining out (OR: 3.13; 95% CI: 1.46-6.68) and snacking (OR: 1.43; 95% CI: 1.01-2.01).

**Conclusions:** Overall, better educated parent(s) played a protective role against the acquisition of *H. pylori* infection in children. Testing bottle feed temperature using the mouth, cutlery sharing between the feeding person and young children, and snacking posed a lower but significant risk for *H. pylori* infection. Only eating peeled fruits and frequent dining out were associated with greater infection risks.
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Abstract

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Conclusions: Overall, better educated parent(s) played a protective role against the acquisition of *H. pylori* infection in children. Testing bottle feed temperature using the mouth, cutlery sharing between the feeding person and young children, and snacking posed a lower but significant risk for *H. pylori* infection. Only eating peeled fruits and frequent dining out were associated with greater infection risks.
**Introduction**

*Helicobacter pylori* is a key gastric pathogen infecting nearly half of the world’s population, causing several gastric disorders including chronic gastritis, gastric atrophy, peptic and duodenal ulcerations, gastric mucosa-associated lymphoid tissue (MALT) lymphoma and gastric adenocarcinoma (Marshall & Windsor 2005). In China, in tandem with a high overall *H. pylori* prevalence rate of 55.8%, gastric cancer has been reported as the third most predominant cancer type and the second leading cause of cancer-related death in this nation, with an estimated 456,124 new cases and 390,182 deaths in 2018, respectively (Feng et al. 2019; Hooi et al. 2017).

Based on a recent systematic review analyzing the medical expenses of Chinese patients with gastric cancer during 2002-2011, it was estimated that in 2012 the first course treatments alone would cost China nearly $3 billion USD, signifying the clinical and economic impact of *H. pylori*-related gastric diseases on the public health system (Sun et al. 2018).

Poor socioeconomic status, overcrowding and improper hygiene standards have been reported as risk factors for acquisition of *H. pylori* infection (Malaty & Graham 1994; Yucel et al. 2009). It is also believed that *H. pylori* infections mostly occur during early childhood in an intrafamilial transmission setting through both the fecal–oral and oral–oral routes as live bacterium had been previously successfully isolated from human fecal and oral sample (Awuku et al. 2017; Ertem 2013; Malaty et al. 2001; Parsonnet et al. 1999; Thomas et al. 1992; Urita et al. 2013; Yucel et al. 2009). Therefore, the best way of reducing *H. pylori* prevalence, perhaps, is to improve
personal hygiene awareness among the primary caregivers of children, especially mothers, to prevent childhood infection.

At present and overall, there is a lack of epidemiological investigation assessing the prevalence of *H. pylori* infection among the asymptomatic children in China. Therefore, this cross-sectional study aimed to examine *H. pylori* prevalence among healthy children from Kuichong Subdistrict situated in Shenzhen, China by using the $^{13}$C-urea breath test (UBT). The $^{13}$C-UBT was selected due to its non-invasive nature and has been proven to be highly accurate in determining *H. pylori* infection status in children aged 6 to 12 years (Elitsur et al. 2009). Plus, to allow more effective strategies to be drawn for the prevention and management of *H. pylori* infection in early childhood, we also explored the relations between *H. pylori* infection rate and different socioeconomic and demographic parameters to identify the potential risk factors.

**Materials & Methods**

**Ethics approval**

The study was approved by the research ethics committee of the First Affiliated Hospital of Shenzhen University, Shenzhen Second People's Hospital. Written and informed consents were obtained from all participants and their legal guardians. A blank copy of the human participant consent form is available as File S1.
Sample size determination

According to a previous *H. pylori* prevalence study conducted in Guangzhou, we assumed that 22.9% of asymptomatic children would be infected with *H. pylori* (Chen et al. 2007). The samples size required for this study was estimated based on a 95% confidence interval and a 2.5% admissible error rate using the following formula:

\[
\text{Sample size, } n = \frac{Z_{\alpha/2}^2 \times \pi \times (1-\pi)}{\delta^2}
\]

where \(Z_{\alpha/2}\) is the 2-tailed normal deviate for an \(\alpha\) level of 0.05; \(\pi\) is the prevalence ratio; \(\delta\) is the admission error rate.

A sample size of 1152 was therefore required for this study. We added at least 25% to the estimate for contingency purpose, raising the final sample size to 1355.

Study population

To avoid selection bias, from September 2018 to October 2018, all school children aged 6-12 years from four primary schools located in Kuichong Subdistrict of Shenzhen City, China, who did not meet any of the exclusion criteria and had provided parental or guardian consent, were recruited. Exclusion criteria included intake of antibiotics within the last four weeks, intake of proton pump inhibitors within the last two weeks and previous history of *H. pylori* eradication therapy.

The \(^{13}\)C-UBT (Beijing Boran Pharmaceutical, China) was performed according to the
manufacturer’s instructions to determine *H. pylori* infection status. All breath samples were taken and analyzed immediately in the school by the same technician. Briefly, an initial baseline breath was collected from each study participant following an overnight fast of at least four hours. Each participant was then requested to ingest a tablet containing 75 mg $^{13}$C labelled urea with 80-100 mL of water. After 30 minutes of sitting, exhalation was again collected. The $^{13}$CO$_2$ content within the initial and 30-min expiratory air bags were analyzed using an HG-IRIS13C infrared spectrometer (Beijing Richen-Force Science & Technology Co., China). The concentration of $^{13}$CO$_2$ following 30 minutes of administration that exceeded the baseline by 4% was regarded as a positive indicator of *H. pylori* infection. The weight, height, and both head and chest circumferences of each participant were also recorded. Body mass index (BMI) was calculated as body weight divided by height squared (kg/m$^2$). The BMI category was classified according to the corresponding percentiles as recommended by The Centers for Disease Control and Prevention (CDC).

**Questionnaires**

On behalf of each study participant, parents or legal guardians were requested to complete a questionnaire for data collection on sociodemographic and living conditions, birth method and childhood feeding practices, lifestyle habits and health parameters. A blank copy of the questionnaire is available as File S2. The outcomes are summarized in supplementary file Table S1. Sociodemographic and living conditions consisted of age and gender of all children, number of siblings (3 categories: 1, 2-3 and >3), total annual income (2 categories: $\leq$200,000 or >200,000...
RMB), household population (2 categories: \( \leq 3 \) or \( > 3 \) persons), household space (2 categories: \( \leq 40 \) or \( > 40 \) m\(^2\)/person), parents' education level (2 categories: both were high school graduates or either one had completed tertiary education) and pet ownership (2 categories: yes or no).

The birth method of each child was assessed in 2 categories (via natural delivery or a caesarean section). Childhood feeding practices comprised the primary feeder of young children (4 categories: parents, grandparents, both parents and grandparents, or other caregivers), feeding methods (3 categories: feeding pre-chewed food, feeding by using shared cutleries or feeding by using a separate set of cutleries), breast feeding duration (3 categories: never, up to 6 months or more than 6 months) and how the milk bottle temperature was tested (3 categories: by dripping a few onto the wrist, taking a swig or using a thermometer).

Lifestyle investigations included the teeth brushing frequency (3 categories: \( \leq 3 \), 4-6 or \( \geq 7 \) times per week), hand washing before meal and after toilet (3 categories: rarely, sometimes or always), dining out frequency (3 categories: \( \leq 1 \), 2-4 or \( \geq 5 \) times per week), how fruit was eaten (2 categories: peeled or unpeeled), drinking water for consumption (2 categories: raw or boiled), toothbrush sharing (2 categories: yes or no), snacking regularly (2 categories: yes or no) and thumb sucking (2 categories: yes or no). The health conditions of each child were evaluated in 3 categories (\( \leq 1 \), 2-4 or \( \geq 5 \) times per week) for bloating, abdominal discomfort, burping and diarrhea, respectively, and in 2 categories (present or absent) for halitosis, anemia, asthma and skin allergy, respectively.
Statistical analysis

Unpaired, two-tailed Student’s *t*-test was used for statistical comparison of continuous variables between *H. pylori* positive and negative groups. For comparison of categorical variables, the chi-square test was employed, followed by univariate logistic regression analysis using JASP software v0.11.1 (https://jasp-stats.org/). Variables significantly associated with *H. pylori* infection in the univariate test (*P* < 0.05) were selected as candidates for entry into the multivariable logistic regression models using the forward selection process. During this iterative selection process, any variable with *P* > 0.1 was eliminated. Subsequently, variables previously not included in the original model were introduced, one at a time, to identify any variable that could have an important role in *H. pylori* infection in the presence of significant variables retained earlier. The selection process was repeated but only for the additionally loaded variables until a final model was obtained. Both univariate and multivariate analyses were adjusted for age. Results were presented as odds ratio (OR) with 95% confidence intervals (CI). A *p*-value of less than 0.05 was regarded as statistically significant.

Results

Prevalence of *H. pylori* infection

In this study, 1355 children aged from 6 to 12 years were recruited, among which 747 (55.1%) were males and 608 (44.9%) were females (Table 1). The overall *H. pylori* prevalence rate was
There was no distinguishable difference in \textit{H. pylori} infection rate in gender and between children who were locally and elsewhere born. Interestingly, while 8-year-old children had the highest prevalence of \textit{H. pylori} infection at 23.2%, lower than the overall prevalence positivity rates were seen in children aged 6 and 10 years old, at 10.6% and 12.6%, respectively. No significant differences in anthropometric measurements were observed among the infected and non-infected children.

We performed chi-square test to examine for any significant difference in different sociodemographic, lifestyle and clinical characteristics between \textit{H. pylori}-positive and \textit{H. pylori}-negative children. Variables tested with no significant difference between both groups are available in supplementary file Table S2. As demonstrated in Table 2, the following variables contributed to greater \textit{H. pylori} prevalence among children: having more than one child, both parents attended no education after high school, smaller living space, testing milk bottle temperature by taking a swig, feeding infant with pre-chewed food or by using feeder’s cutlery, sharing toothbrush, eating out at least 5 times a week, snacking and eating fruits after peeling.

\textbf{Protective and risk factors for \textit{H. pylori} infection}

Risk factors for \textit{H. pylori} infection were further investigated by univariate and multivariable logistic regression analyses adjusting for age. The final model of multivariable analysis revealed six variables significantly associated with \textit{H. pylori} in children (Table 3). Children whose parent(s) with tertiary education level (OR: 0.64; 95% CI: 0.46-0.89; P = 0.008) and larger living
space at home (OR: 0.54; 95% CI: 0.28-1.07; P = 0.078) were protective factors against *H. pylori* infection. Conversely, testing milk bottle temperature by taking a swig as opposed to dripping a few onto the wrist (OR: 1.79; 95% CI: 1.19-2.68; P = 0.005), sharing of cutlery between the feeding person and young children rather than using separate cutlery each during meals (OR: 1.84; 95% CI: 1.22-2.78; P = 0.004), and snacking (OR: 1.43; 95% CI: 1.01-2.01; P = 0.043) resulted in lower risks for *H. pylori* infection. Only eating fruits peeled than unpeeled (OR: 2.56; 95% CI: 1.4-4.71; P = 0.002) and eating out frequently for at least 5 times a week (OR: 3.13; 95% CI: 1.46-6.68; P = 0.003) would result in substantially higher risks for *H. pylori* infection.

**Discussion**

In the present study, *H. pylori* infection in 1355 children aged 6-12 years was screened using the non-invasive $^{13}$C-UBT, which has been shown to achieve both sensitivity and specificity of at least 95% in children and adults (Vaira & Vakil 2001). The overall *H. pylori* prevalence was 16.7%, which was at least two-fold higher compared to the global infection rate of 7.9% among children aged 7-12 years from Beijing, Guangzhou and Chengdu (Ding et al. 2015). In contrast to Beijing, Guangzhou and Chengdu which are all highly developed cities, Kuichong is only a developing subdistrict of the Shenzhen City. Therefore, the higher *H. pylori* infection rate among Kuichong’s children is likely due to the differences in socioeconomic status and living conditions. Our data demonstrated that parent(s) with higher education level and having a larger living space at home are important protective factors against *H. pylori* infection. These findings
are consistent with several previous studies from Houston, Czech Republic, Iran and Vietnam 
that reported children living in a crowded household and whose parent(s) with less education are 
at significantly greater risks of acquiring *H. pylori* infection (Malaty et al. 2001; Nguyen et al. 
2017; Nouraie et al. 2009; Sykora et al. 2009).

Poor hygiene practices when feeding the young ones such as giving pre-chewed food and the use 
of same spoon by both mother and child are among the risk factors of *H. pylori* infection in 
children (Nguyen et al. 2017; van Duynhoven & de Jonge 2001). Our study demonstrated that 
testing milk bottle temperature by taking a few sucks directly and using the same cutlery to feed 
young children would result in a slight but significant increased risk of *H. pylori* infection. This 
implies that *H. pylori* exists in the human oral cavity and can be transmitted from an infected 
individual to another person via the oral-oral route (Yee 2017). Hence to reduce the infection risk 
in children, whoever is the primary carer at home for the young children should exercise good 
personal hygiene to avoid any food that is to be served to children being cross-contaminated by 
his/her saliva, especially one who knows him/herself is a *H. pylori* carrier.

In a previous investigation conducted in Peru, children were exposed to greater risk of *H. pylori* 
infestation due to increased consumption of food from street vendors (Begue et al. 1998). 
Similarly, in the present study, frequent dining out was significantly associated with the 
acquisition of *H. pylori* infection in children, which could be attributed to the preparation of 
food by food handlers who did not practice good personal hygiene.
While washing and peeling help to remove surface bacteria from fruits and vegetables to reduce the risk of foodborne illness, intriguingly, eating peeled fruits would increase the risk of *H. pylori* infection in this study. As our data showed that consumption of unboiled water is not associated with *H. pylori* infection, we therefore ruled out our initial thought that the cause of this increased risk might be due to contaminated water source. Unfortunately, we did not question what the fruit was being consumed. Could it possibly be that the fruit peel contains anti-*H. pylori* property and eating the fruit without its skin had therefore resulted in an elevated infection risk? This warrants further investigation. Also, interestingly, children who seemed to snack had a greater chance of acquiring *H. pylori* infection. Again, it was not specified further within the questionnaire on what snacks were being consumed to allow us making a better assumption on the underlying cause.

We concede that there are limitations in our study. Firstly, to assess the risk factors of *H. pylori* infection among children, a cohort study or a case-control study should be conducted, rather than a cross-sectional study which is not the most appropriate option. However, it is important to mention that the basic findings of a cross-sectional study could serve as the foundation for preparing and designing further in-depth case-control studies, cohort studies or randomized controlled trial studies (Mann 2003). Another limitation lies within the questionnaire design as there were questions not explicit and detailed enough to examine the fundamental cause of some risk factors for *H. pylori* infection identified in this study, this warrants improvement before
conducting a future cohort study to validate our current findings.

Conclusions

There is a high prevalence of *H. pylori* among children aged 6-12 years in Shenzhen City, China. Larger living space at home and parent(s) with tertiary education level were protective factors against *H. pylori* infection in children. Testing milk bottle temperature by taking a swig, not using individual cutlery set when feeding young children and snacking were associated with lower risks for *H. pylori* infection. Only eating fruits peeled than unpeeled and frequent dining out for at least 5 times a week could lead to higher risks for *H. pylori* infection.
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Table 1 (on next page)

Demographic characteristics and anthropometric measurements of 1355 children recruited in this study.

Note: Data are presented as n (%) or mean ± standard deviation. BMI: body mass index.
Table 1. Demographic characteristics and anthropometric measurements of 1355 children recruited in this study.

| Age (years) | H. pylori positive | H. pylori negative | P    |
|-------------|--------------------|--------------------|------|
| 6 (n = 160) | 10.6 (5.7-15.5)    | 89.4 (84.5-94.3)   | 0.032|
| 7 (n = 231) | 16.5 (11.6-21.4)   | 83.5 (78.6-88.4)   |      |
| 8 (n = 207) | 23.2 (17.3-29.1)   | 76.8 (70.9-82.7)   |      |
| 9 (n = 260) | 18.1 (13.3-22.9)   | 81.9 (77.1-86.7)   |      |
| 10 (n = 223)| 12.6 (8.2-17)      | 87.4 (83-91.8)     |      |
| 11 (n = 202)| 17.8 (12.4-23.2)   | 82.2 (76.8-87.6)   |      |
| 12 (n = 72) | 16.7 (7.9-25.5)    | 83.3 (74.5-92.1)   |      |

Gender

| Gender       | H. pylori positive | H. pylori negative | P    |
|--------------|--------------------|--------------------|------|
| Male (n = 747)| 16.3 (13-19)      | 83.7 (81-86.4)     | 0.704|
| Female (n = 608)| 17.1 (14-20.2)    | 82.9 (79.8-86)     |      |

Birthplace

| Birthplace   | H. pylori positive | H. pylori negative | P    |
|--------------|--------------------|--------------------|------|
| Dapeng       | 15.7 (13-18.4)     | 84.3 (81.6-87)     | 0.265|
| Others       | 17.9 (14.8-21)     | 82.1 (79-85.2)     |      |

BMI

| BMI          | H. pylori positive | H. pylori negative | P    |
|--------------|--------------------|--------------------|------|
| Underweight  | 16.5 (10.2-22.8)   | 83.5 (77.2-89.8)   | 0.404|
| Normal       | 15.8 (13.4-18.2)   | 84.2 (81.8-86.6)   |      |
| Overweight   | 18.8 (12.5-25.1)   | 81.2 (74.9-87.5)   |      |
| Obese        | 21.8 (13.6-30)     | 78.2 (70-86.4)     |      |

Height (cm)

| Height (cm) | H. pylori positive | H. pylori negative | P    |
|-------------|--------------------|--------------------|------|
| 134.2 ± 11.8| 134.5 ± 11.9       | 0.76               |      |

Weight (kg)

| Weight (kg) | H. pylori positive | H. pylori negative | P    |
|-------------|--------------------|--------------------|------|
| 30.6 ± 9.6  | 30.2 ± 8.9         | 0.596              |      |

Head circumference (cm)

| Head circumference (cm) | H. pylori positive | H. pylori negative | P    |
|-------------------------|--------------------|--------------------|------|
| 52.5 ± 1.7              | 52.6 ± 2.2         | 0.381              |      |

Chest circumference (cm)

| Chest circumference (cm) | H. pylori positive | H. pylori negative | P    |
|--------------------------|--------------------|--------------------|------|
| 65.8 ± 36.8              | 63.5 ± 20.5        | 0.369              |      |

Note: Data are presented as % (95% confidence interval) or mean ± standard deviation. BMI: body mass index. The age, gender, birthplace and BMI differences between H. pylori-positive and negative children were compared using the chi-square test. For differences involving continuous parameters including height, weight, head circumference and chest circumference, the comparison was performed using the unpaired Student’s t-test.
**Table 2** (on next page)

List of sociodemographic, lifestyle and clinical variables that had significant influence on *H. pylori* infection status in 1355 children.
Table 2. List of sociodemographic, lifestyle and clinical variables that had significant influence on *H. pylori* infection status in 1355 children.

| Variables                              | *H. pylori* positive | *H. pylori* negative | p     |
|----------------------------------------|----------------------|---------------------|-------|
| Number of children                     |                      |                     | 0.027 |
| 1 (n = 341)                            | 12.6 (9-16.2)        | 87.4 (83.8-91)      |       |
| 2 or 3 (n = 918)                       | 17.5 (15-20)         | 82.5 (80-85)        |       |
| > 3 (n = 96)                           | 22.9 (14.3-31.5)     | 77.1 (68.5-85.7)    |       |
| Parents education level                |                      |                     | 0.001 |
| Both were high school graduates (n = 843) | 19.2 (16.5-21.9)    | 80.8 (78.1-83.5)    |       |
| Either one or both had completed tertiary education (n = 512) | 12.5 (9.6-15.4)    | 87.5 (84.6-90.4)    |       |
| Living space (m2/person)               |                      |                     | 0.037 |
| ≤ 40 (n = 1249)                        | 17.3 (15.2-19.4)     | 82.7 (80.6-84.8)    |       |
| > 40 (n = 106)                         | 9.4 (3.7-15.1)       | 90.6 (84.9-96.3)    |       |
| How to test the temperature of milk bottle before feeding? |                      |                     | < 0.001 |
| Wrist method (n = 1149)                | 15.1 (13-17.2)       | 84.9 (82.8-87)      |       |
| Mouth testing (n = 164)                | 27.4 (20.4-34.4)     | 72.6 (65.6-79.6)    |       |
| Thermometer (n = 42)                   | 16.7 (5.2-28.2)      | 83.3 (71.8-94.8)    |       |
| Infant feeding method                  |                      |                     | 0.002 |
| Pre-mastication (n = 43)               | 25.6 (12.3-38.9)     | 74.4 (61.1-87.7)    |       |
| Sharing cutlery with the feeder (n = 158) | 24.7 (17.8-31.6)   | 75.3 (68.4-82.2)    |       |
| Using child-only cutlery (n = 1150)    | 15 (12.9-17.1)       | 85 (82.9-87.1)      |       |
| Fruits were peeled before eating       |                      |                     | 0.036 |
| No (n = 143)                           | 10.5 (5.4-15.6)      | 89.5 (84.4-94.6)    |       |
| Yes (n = 1212)                         | 17.4 (15.2-19.6)     | 82.6 (80.4-84.8)    |       |
| Sharing toothbrush                     |                      |                     | 0.014 |
| No (n = 1218)                          | 15.8 (13.7-17.9)     | 84.2 (82.1-86.3)    |       |
| Yes (n = 137)                          | 24.1 (16.8-31.4)     | 75.9 (68.6-83.2)    |       |
| Frequency of eating out                |                      |                     | 0.002 |
| ≤ 1 time per week (n = 1074)           | 15.8 (13.6-18)       | 84.2 (82-86.4)      |       |
| 2-4 times per week (n = 248)           | 17.3 (12.5-22.1)     | 82.7 (77.9-87.5)    |       |
| ≥ 5 times per week (n = 33)            | 39.4 (22.4-56.4)     | 60.6 (43.6-77.6)    |       |
| Snacking habit                         |                      |                     | 0.032 |
| No (n = 398)                           | 13.3 (9.9-16.7)      | 86.7 (83.3-90.1)    |       |
| Yes (n = 957)                          | 18.1 (15.6-20.6)     | 81.9 (79.4-84.4)    |       |

Note: Data are presented as % (95% confidence interval). The differences between *H. pylori*-positive and negative children were compared using the chi-square test.
Table 3 (on next page)

Univariate and multivariable logistic regression analyses of variables associated with *H. pylori* infection status.

Note: OR, odds ratio; CI, confidence interval.
Table 3. Univariate and multivariable logistic regression analyses of variables associated with *H. pylori* infection status.

| Variables                        | Univariate          |          |          | Multivariable       |          |
|----------------------------------|---------------------|----------|----------|---------------------|----------|
|                                  | OR (95% CI)         | P        | OR (95% CI) | P        |
| Number of children               |                     |          |          |                     |          |
| 1                                | Reference           |          |          |                     |          |
| 2-3                              | 1.44 (1-2.07)       | 0.05     |          |                     |          |
| > 3                              | 2.06 (1.16-3.66)    | 0.013    |          |                     |          |
| Parents education level          |                     |          |          |                     |          |
| Both were high school graduates  | Reference           |          |          | Reference           |          |
| Either one or both had           | 0.59 (0.43-0.81)    | 0.001    | 0.64 (0.46-0.89) | 0.008    |
| completed tertiary education     |                     |          |          |                     |          |
| Living space (m²/person)         |                     |          |          |                     |          |
| ≤ 40                             | Reference           |          |          | Reference           |          |
| > 40                             | 0.51 (0.26-0.99)    | 0.047    | 0.54 (0.28-1.07) | 0.078    |
| Milk bottle temperature test method |                   |          |          |                     |          |
| Wrist method                     | Reference           |          |          | Reference           |          |
| Mouth testing                    | 2.05 (1.39-3.01)    | < 0.001  | 1.79 (1.19-2.68) | 0.005    |
| Thermometer                      | 1.13 (0.5-2.59)     | 0.766    | 1.06 (0.45-2.46) | 0.899    |
| Infant feeding method            |                     |          |          |                     |          |
| Using child-only cutlery         | Reference           |          |          | Reference           |          |
| Pre-mastication                  | 1.96 (0.97-3.95)    | 0.062    | 1.69 (0.81-3.54) | 0.163    |
| Using feeder’s cutlery           | 1.86 (1.25-2.77)    | 0.002    | 1.84 (1.22-2.78) | 0.004    |
| Frequency of eating out          |                     |          |          |                     |          |
| ≤ 1 time per week                | Reference           |          |          | Reference           |          |
| 2-4 times per week               | 1.1 (0.76-1.6)      | 0.606    | 1.2 (0.82-1.77) | 0.347    |
| ≥ 5 times per week               | 3.23 (1.55-6.73)    | 0.002    | 3.13 (1.46-6.68) | 0.003    |
| Fruits were peeled before eating |                     |          |          |                     |          |
| No                               | Reference           |          |          | Reference           |          |
| Yes                              | 2.06 (1.14-3.71)    | 0.017    | 2.56 (1.4-4.71) | 0.002    |
| Sharing toothbrush               |                     |          |          |                     |          |
| No                               | Reference           |          |          |                     |          |
| Yes                              | 1.6 (1.04-2.46)     | 0.032    |          |                     |          |
| Snacking habit                   |                     |          |          |                     |          |
| No                               | Reference           |          |          | Reference           |          |
| Yes                              | 1.44 (1.03-2.01)    | 0.034    | 1.43 (1.01-2.01) | 0.043    |

Note: OR, odds ratio; CI, confidence interval. Both univariate and multivariable logistic regression analyses were performed to identify risk factors associated with *H. pylori* infection.