**Helicobacter pylori** infection in Ontario: Prevalence and risk factors

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**BACKGROUND:** *Helicobacter pylori* has been classified by the World Health Organization as a type I carcinogen. Nearly 50% of the world’s population is estimated to be infected with *H. pylori*. Prevalence patterns of the infection are different between developing and developed countries. The present study had two objectives – to estimate the prevalence of *H. pylori* infection in Ontario, and to evaluate the relationship between the infection and various demographic characteristics and selected lifestyle factors.

**METHODS:** Ten microlitres of plasma were aliquoted from stored blood of 1306 men and women, 50 to 80 years of age, from Ontario. The blood samples belonged to control patients of a colorectal cancer population-based study group. Serological testing was used to detect *H. pylori* infection; information was obtained on dietary intake and lifestyle habits, as well as past and present medical history, education, income, number of siblings, ethnicity and place of birth.

**RESULTS:** The overall weighted seroprevalence of *H. pylori* was 23.1% (95% CI 17.7% to 29.5%), with men having higher infection rates (29.4%, 95% CI 21.1% to 39.3%) than women (14.9%, 95% CI 10.1% to 21.4%). Seroprevalence of the infection increased significantly with age and number of siblings. Increased risk was also associated with being nonwhite, being born outside of Canada and immigrating at 20 years of age or older. An inverse association with seroprevalence was found for education and alcohol consumption.

**CONCLUSION:** The prevalence of *H. pylori* infection in Ontario is comparable with that of other developed countries. Age, sex, number of siblings, ethnicity, place of birth and age at immigration are among the factors associated with *H. pylori* infection.

**Key Words:** Age; Helicobacter pylori; Seroprevalence; Sex

**In Canada, few studies have estimated the prevalence of** *H. pylori* **infection. In Nova Scotia, the seroprevalence of this infection increased from 21% for subjects in their thirties, to 50% for those in their eighties (7). However, there are certain populations in Canada with much higher infection rates. One study found that 95% of a First Nations community in Manitoba was infected (8), and 67% of children from this community tested positive for *H. pylori* by two years of age (9). The Canadian Adult Dyspepsia Empiric Treatment – Prompt Endoscopy (CADET-PE) study found that approximately 30% of dyspeptic patients were infected (10). The results of the aforementioned studies could not be applied to the general Canadian population due to their limitations in sample size and the types of populations studied.**

**Among the risk factors associated with** *H. pylori* **infection, poor socioeconomic status, crowded living conditions, smoking, alcohol ingestion,**

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TABLE 1

|                  | Total, n | % positive (95% CI) | % positive* (95% CI) |
|------------------|----------|---------------------|----------------------|
| **Men**          |          |                     |                      |
| Age, years^1     |          |                     |                      |
| <60              | 218      | 29.4 (23.7–35.8)    | 27.7 (17.6–41.0)     |
| 60 to 70         | 321      | 32.1 (27.2–37.4)    | 31.96 (27.0–37.4)    |
| >70              | 194      | 38.7 (32.0–45.7)    | 38.7 (32.0–45.6)     |
| Total            | 733      | 33.0 (29.7–36.5)    | 29.4 (21.1–39.3)     |
| **Women**        |          |                     |                      |
| Age, years^1     |          |                     |                      |
| <60              | 191      | 17.3 (12.5–23.3)    | 10.5 (5.9–18.0)      |
| 60 to 70         | 243      | 24.3 (19.3–30.1)    | 24.3 (19.3–30.1)     |
| >70              | 139      | 36.0 (28.4–44.3)    | 36.8 (29.3–45.3)     |
| Total            | 573      | 24.8 (21.4–28.5)    | 14.9 (10.1–21.4)     |

*Weighted values presented; ^Average age of the population studied was 64.04 years, with men being slightly older than women: 64.7±8.0 years versus 63.2±9.4 years, respectively

The relationships between the prevalence of infection and the various sociodemographic factors were assessed by calculating age-adjusted ORs and 95% CIs, using logistic regression with incidence of infection as the outcome measure. In all the regression analyses, age was used as a categorical variable because the reference population that was used for weighting the estimates was weighted by age and sex.

In multivariate analyses, the dependent variable was seropositivity for H pylori, and covariate variables included available sociodemographic and lifestyle factors. The stepwise solution was used, which combined forward and backward solutions and therefore overcame the limitations associated with each. Stratified analyses suggested potential effect modification by sex on the association between H pylori seropositivity and various factors; thus, interaction terms for such factors were tested in multivariate logistic models. Intervariable correlations were evaluated before modeling. Place of birth and age at immigration were significantly correlated (r^2=0.98) and were combined. The new variable had three categories: born in Canada, immigrated to Canada at younger than 20 years of age and immigrated to Canada at 20 years of age or older. The associations between H pylori infection and the various factors considered in the present study were not weighted.

Most of the data analyses were performed using SPSS version 12.1 (SPSS Inc, USA). STATA version 8.0 (StataCorp LP, USA) was used to calculate the weighted prevalence estimates and their 95% CIs.

RESULTS

In the study sample, the overall H pylori seroprevalence was 29.4% (95% CI 27.5% to 31.9%). Seroprevalence rates were different between sexes; male subjects had significantly higher seroprevalence rates (33.0% 95% CI 29.7% to 36.5%) than female subjects (24.8%, 95% CI 21.4% to 28.5%). Weighted analysis yielded an overall lower estimate than the unweighted analysis (23.1%, 95% CI 17.7% to 29.5%), with male subjects still having higher prevalence (29.4%, 95% CI 21.1% to 39.9%) than female subjects (14.9%, 95% CI 10.1 to 21.4). For both sexes, prevalence rates increased with age and peaked after 70 years of age (Table 1).

Analysis of the factors associated with infection is shown in Table 2. With regard to place of birth, prevalence rates were higher among male subjects born outside Canada than those born in Canada (OR 2.2, 95% CI 1.6 to 3.0). Furthermore, the pattern of H pylori prevalence in relation to age was different in regions, with higher prevalence in those born in Canada (OR 2.2, 95% CI 1.6 to 3.0) compared to those born in the Middle East and Asia. Low

higher number of siblings and a lower consumption of fruits are the most cited in the literature (11-13).

The present study had two objectives – to estimate the prevalence of H pylori infection in Ontario, and to evaluate the relationship between H pylori infection and a number of demographic characteristics and selected lifestyle habits.

METHODS

The present study was approved by the Research Ethics Boards of the University of Toronto (Toronto, Ontario) and Mount Sinai Hospital (Toronto, Ontario). Blood samples from the Ontario Familial Colon Cancer Registry (OFCCR) were used to estimate the prevalence of H pylori infection. The OFCCR collects family history information, epidemiologic data and blood samples from a population-based sample of colorectal cancer patients and controls. Population controls are identified using random selection through Info-direct (Bell Canada, Canada), a service of Bell Canada that provides a listing of residential telephone numbers in Ontario. If there is more than one eligible household member (matched by sex and five-year age group with OFCCR case distribution), then one person is randomly selected and asked to participate. The methodology for the OFCCR has been described in detail elsewhere (14). For the purpose of the present study, the blood samples taken from the control population, which were stored in the biospecimen repository of Mount Sinai Hospital, were used. Ten microlitres of plasma were aliquoted from each of the 1306 samples (adults aged 50 to 80 years). H pylori-specific immunoglobulin G antibody titres were measured by a validated ELISA using the DRG kit (DRG International Inc, USA) in the robotics laboratory at Mount Sinai Hospital. Performance data for this kit showed a sensitivity and specificity of 99% and 97%, respectively (A Azad, personal communication).

Using family history and epidemiologic questionnaires, information was obtained on past and present medical history, smoking and drinking habits, socioeconomic status, number of siblings, education level, ethnicity and place of birth, as well as the consumption of fruits, vegetables and meat. Nonwhites included blacks (from Africa, the Caribbean and North America) and those from the Middle East and Asia. Low education levels corresponded to completion of high school or lower, moderate education levels corresponded to completion of technical school or college, and higher education levels corresponded to completion of bachelor's degree or higher. Data on fruit, vegetable and meat intake referred to patient diets two years before completion of the questionnaire. The alcohol consumption for patients between 30 and 40 years of age, 41 and 59 years of age and 60 years of age or older referred to the consumption during their 20s, 30s and 40s, and since they had turned 50 years of age, respectively.

The prevalence of H pylori infection was estimated separately for each sex. Weighted prevalence estimates were obtained using sampling weights calculated as the inverse of the sampling fractions to correct for the sampling strategy. In weighting, the distribution of the 2003 Ontario population by sex and five-year age group was used as a reference (Statistics Canada, 2003).

The relationships between the prevalence of infection and the various sociodemographic factors were assessed by calculating age-adjusted ORs and 95% CIs, using logistic regression with incidence of infection as the outcome measure. In all the regression analyses, age was used as a categorical variable because the reference population that was used for weighting the estimates was weighted by age and sex.

In multivariate analyses, the dependent variable was seropositivity for H pylori, and covariate variables included available sociodemographic and lifestyle factors. The stepwise solution was used, which combined forward and backward solutions and therefore overcame the limitations associated with each. Stratified analyses suggested potential effect modification by sex on the association between H pylori seropositivity and various factors; thus, interaction terms for such factors were tested in multivariate logistic models. Intervariable correlations were evaluated before modelling. Place of birth and age at immigration were significantly correlated (r^2=0.98) and were combined. The new variable had three categories: born in Canada, immigrated to Canada at younger than 20 years of age and immigrated to Canada at 20 years of age or older. The associations between H pylori infection and the various factors considered in the present study were not weighted.

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### TABLE 2

Frequency distribution, percentage seropositivities, age-adjusted OR estimates and 95% CIs in men and women

| Age, years | Men | Women |
|------------|-----|-------|
| <60        | 218 | 191   |
| 60 to 70   | 321 | 243   |
| >70        | 194 | 139   |

| Marital status | Men | Women |
|----------------|-----|-------|
| Not married    | 90  | 194   |
| Married        | 633 | 374   |

| Place of birth | Men | Women |
|----------------|-----|-------|
| Canada         | 462 | 396   |
| Other          | 271 | 177   |

| Ethnicity | Men | Women |
|-----------|-----|-------|
| White     | 676 | 534   |
| Nonwhite  | 56  | 38    |

| Age of immigration, years | Men | Women |
|--------------------------|-----|-------|
| <20                      | 111 | 62    |
| ≥20                      | 152 | 111   |

| Education | Men | Women |
|-----------|-----|-------|
| Low       | 281 | 225   |
| Middle    | 232 | 215   |
| High      | 212 | 123   |

| Income | Men | Women |
|--------|-----|-------|
| <20,000| 185 | 207   |
| 20,000 to 40,000 | 230 | 159   |
| >40,000 | 19  | 24    |
| Missing | 299 | 183   |

| Number of siblings | Men | Women |
|--------------------|-----|-------|
| <2                 | 316 | 255   |
| 2 to 4             | 180 | 139   |
| >4                 | 158 | 116   |
| Missing            | 79  | 63    |

| Regular use of antacids | Men | Women |
|-------------------------|-----|-------|
| No                      | 620 | 480   |
| Yes                     | 100 | 88    |

| Regular use of multivitamins | Men | Women |
|-----------------------------|-----|-------|
| No                          | 445 | 317   |
| Yes                         | 278 | 247   |

| Regular use of aspirin | Men | Women |
|------------------------|-----|-------|
| No                     | 393 | 385   |
| Yes                    | 327 | 180   |

| Regular use of acetaminophen | Men | Women |
|------------------------------|-----|-------|
| No                           | 638 | 455   |
| Yes                          | 81  | 111   |

| Fruit intake/day | Men | Women |
|------------------|-----|-------|
| <1               | 190 | 76    |
| 1 to 2           | 424 | 327   |
| >2               | 90  | 151   |

| Vegetable intake/day | Men | Women |
|----------------------|-----|-------|
| <1                   | 116 | 34    |
| 1 to 2               | 478 | 298   |
| >2                   | 122 | 232   |

| Red meat intake servings/week | Men | Women |
|-------------------------------|-----|-------|
| <3                            | 252 | 241   |
| 3 to 5                        | 309 | 224   |
| >5                            | 158 | 98    |

Continued on next page
TABLE 2 – CONTINUED
Frequency distribution, percentage seropositivities, age adjusted OR estimates and 95% CIs in men and women

| Smoking, years | Total, n | % positive (95% CI) | OR (95% CI) | Total, n | % positive (95% CI) | OR (95% CI) |
|---------------|---------|---------------------|------------|---------|---------------------|------------|
| Never smoked  | 259     | 32.4 (27.4–39.0)   | 1          | 293     | 24.6 (20.0–29.8)   | 1          |
| <10           | 82      | 29.0 (19.1–41.5)   | 0.8 (0.5–1.6) | 53      | 17.0 (9.1–29.6)   | 0.7 (0.3–1.4) |
| 10 to 25      | 164     | 34.1 (27.3–41.7)   | 1.1 (0.7–1.6) | 70      | 25.7 (16.8–37.2)   | 1.2 (0.6–2.2) |
| 26 to 40      | 134     | 35.1 (27.5–43.5)   | 1.1 (0.7–1.7) | 83      | 26.5 (18.1–37.0)   | 1.3 (0.7–2.2) |
| >40           | 68      | 30.9 (21.1–42.8)   | 0.8 (0.5–1.5) | 50      | 36.0 (23.0–50.1)   | 1.4 (0.7–2.7) |
| Number of cigarettes/day |        |                     |            |         |                     |            |
| Never smoked  | 259     | 32.4 (27.4–38.4)   | 1          | 293     | 24.6 (20–29.8)     | 1          |
| <10           | 130     | 32.3 (24.8–40.8)   | 0.9 (0.6–1.5) | 113     | 18.6 (12.4–26.9)   | 0.7 (0.4–1.2) |
| 10 to 20      | 189     | 36.0 (29.4–43.1)   | 1.1 (0.8–1.7) | 88      | 30.7 (21.9–41.1)   | 1.4 (0.8–2.5) |
| >20           | 124     | 29.8 (22.4–38.5)   | 0.9 (0.5–1.4) | 57      | 28.1 (17.9–41.1)   | 1.4 (0.7–2.7) |
| Alcohol intake, drinks/week |        |                     |            |         |                     |            |
| Never         | 140     | 45 (32.0–48.9)     | 1          | 237     | 31.2 (27.6–39.4)   | 1          |
| <10           | 362     | 28.7 (24.4–34.9)   | 0.5 (0.3–0.7) | 172     | 19.1 (13.7–26.6)   | 0.5 (0.4–0.8) |
| >10           | 187     | 30.5 (22.9–36.7)   | 0.5 (0.3–0.8) | 43      | 20.9 (2.3–30.0)    | 0.6 (0.3–1.4) |
| Polyps        |         |                     |            |         |                     |            |
| No            | 629     | 32.8 (29.2–36.5)   | 1          | 497     | 23.9 (20.4–27.9)   | 1          |
| Yes           | 89      | 30.6 (26.7–40.4)   | 1.1 (0.7–1.8) | 56      | 35.7 (24.3–49.0)   | 1.6 (0.9–3)  |

Smoking, fruit and vegetable intake, and incidence of diabetes were included because they were associated with *H pylori* seropositivity in other studies. None of these variables had an effect, and the models discussed above were not changed.

**DISCUSSION**

To our knowledge, the present study is the first of its kind to offer an estimate of *H pylori* prevalence in an adult, asymptomatic population in Ontario. We found an overall weighted seroprevalence of 23.1%, with men having higher rates of infection than women (29.4% versus 14.9%). The unweighted seroprevalence was 29.4%, which was comparable with prevalence estimates from other developed countries, such as 32.5% in the United States (15) and 32% in Australia (16). In Canada, the CADET-PE study found that approximately 30% of dyspeptic patients were infected (13).

Our results indicated a significant effect of sex on prevalence. Men were found to have significantly higher infection rates than women. The literature regarding the relationship between sex and *H pylori* infection is conflicting (17-22). It is possible that women are more likely to have infection eradicated with antimicrobials used for other illnesses (23,24). In British Columbia, women consumed 17% more antibiotics than men (25).

Worldwide, two characteristic, age-specific patterns of *H pylori* seroprevalence have been described. In developing countries, infection appears to occur early in life with chronic infection continuing into adulthood, while in developed countries, the prevalence among children is low but rises in proportion throughout adult life at a rate of approximately 1% per year (26). In our study, seroprevalence rates followed the pattern of other developed countries and increased with age to peak after 70 years. This increase may be explained by a constant infection rate over time or by a birth cohort effect, with decreasing rates in subsequent generations. When considering place of birth, we
found that prevalence rates were higher among immigrants. These findings resonate with findings from the United States, where it was shown that being born outside the country increased infection odds 2.53-fold (15). When we looked at the effect of age at immigration, we found that higher prevalence estimates were observed in those who immigrated at 20 years of age or older. This finding points to the importance of age at immigration, we found that higher prevalence rates were higher among immigrants. Educational programs could be planned and implemented on topics such as personal hygiene, nutritional hygiene, transmission routes of *H pylori* and relevant preventive measures. Further research is needed to study the effectiveness of screening and treating immigrants upon landing in Canada.

Whether the observed increase of infection rates with age is a result of a higher rate of acquisition or a birth cohort effect is still to be determined. Future cohort studies looking at infection rates over time may answer the question. Women tend to have lower infection rates and lower gastric cancer incidence; however, to date, we have no explanation for this observation. Therefore, research on both physiological and behavioural levels is warranted.

**CONCLUSION AND RECOMMENDATIONS**

The weighted prevalence of *H pylori* infection in a sample of Ontario adults aged 50 to 80 years was 29.4% for men and 14.9% for women.

Given its complications (eg, atrophic gastritis and gastric cancer), *H pylori* infection endangers public health. The results of the present study helped to define a high-risk population of older immigrants from large families. Educational programs could be planned and implemented on topics such as personal hygiene, nutritional hygiene, transmission routes of *H pylori* and relevant preventive measures. Further research is needed to study the effectiveness of screening and treating immigrants upon landing in Canada.

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