Antibiotic dispensation rates among participants in community-driven health research projects in Arctic Canada

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Abstract

Background: Community-driven projects that aim to address public concerns about health risks from *H. pylori* infection in Indigenous Arctic communities (estimated *H. pylori* prevalence = 64%) show frequent failure of treatment to eliminate the bacterium. Among project participants, treatment effectiveness is reduced by antibiotic resistance of infecting *H. pylori* strains, which in turn, is associated with frequent exposure to antibiotics used to treat other infections. This analysis compares antibiotic dispensation rates in Canadian Arctic communities to rates in urban and rural populations in Alberta, a southern Canadian province.

Methods: Project staff collected antibiotic exposure histories for 297 participants enrolled during 2007–2012 in Aklavik, Tuktoyaktuk, and Fort McPherson in the Northwest Territories, and Old Crow, Yukon. Medical chart reviews collected data on systemic antibiotic dispensations for the 5-year period before enrolment for each participant. Antibiotic dispensation data for urban Edmonton, Alberta (average population ~ 860,000) and rural northern Alberta (average population ~ 450,000) during 2010–2013 were obtained from the Alberta Government Interactive Health Data Application.

Results: Antibiotic dispensation rates, estimated as dispensations/person-years (95% confidence interval) were: in Arctic communities, 0.89 (0.84, 0.94); in Edmonton, 0.55 (0.55, 0.56); in rural northern Alberta, 0.63 (0.62, 0.63). Antibiotic dispensation rates were higher in women and older age groups in all regions. In all regions, the highest dispensation rates occurred for β-lactam and macrolide antibiotic classes.

Conclusions: These results show more frequent antibiotic dispensation in Arctic communities relative to an urban and rural southern Canadian population.

Keywords: *Helicobacter pylori*, Antibiotic exposure, Antibiotic resistance, Treatment failure, Arctic Canada

Background

Antibiotic-resistant bacteria are a major public health concern because they limit the effectiveness of therapeutic options available for the treatment of bacterial infections. Much evidence suggests that exposure to antibiotics leads to antibiotic-resistant bacterial infections. In particular, consistent evidence shows an association between frequent exposure to antibiotics for the treatment of unrelated bacterial infections and the prevalence of antibiotic-resistant *Helicobacter pylori* infection [1–6].

The Canadian North *Helicobacter pylori* (CANHelp) Working Group links northern Canadian communities, health care providers and regional health officials with University of Alberta investigators to conduct community-driven research aimed at addressing concerns about health risks from *H. pylori* infection; the ultimate goal is to inform public health policy pertaining to control of *H. pylori* infection [7]. In Canada, northern Indigenous communities are disproportionately burdened by *H. pylori* infection compared to multi-ethnic populations in southern Canada [8–10]. Available data show stomach cancer rates to be elevated in Indigenous Arctic populations as well, [11–13] an occurrence of...
great concern to affected communities and their health care providers.

*H. pylori* is a bacterium that colonizes the lining of the stomach and/or duodenum, [14] where it is nearly always accompanied by gastritis. This infection often persists indefinitely; in persistent cases, it increases the risk of peptic ulcer disease and stomach cancer [15–18]. Treatment to eliminate *H. pylori* infection has been observed to improve peptic ulcer healing, decrease peptic ulcer recurrence and reduce the risk of stomach cancer [19, 20]. Frequent treatment failure in populations with high prevalence of *H. pylori* infection is a major impediment to the development of effective *H. pylori* control strategies for such populations [21]. CANHelp community projects collected data on participants’ exposure to antibiotics as part of inquiry aimed at identifying causes of treatment failure.

Few studies have collected information on antibiotic exposure in geographically defined communities, even though it is known that the frequency of antibiotic use varies by geographic region, as well as other factors including age and sex [22–24]. Geographic differences in prescribing practices or non-prescription access to antibiotics likely contribute to differences in the occurrence of antibiotic-resistant infections across geographic regions [25, 26].

The aims of the current study are to describe antibiotic dispensation rates, as a measure of the frequency of overall exposure to systemic antibiotics, by community, sex, age and antibiotic class, in Canadian Arctic communities and compare these rates to those of urban and rural outpatient populations in the southern Canadian province of Alberta. These results will shed light on whether increased exposure to antibiotics is a potential explanation for reduced effectiveness of antibiotics in Indigenous Arctic populations, thus making them vulnerable to poor infection outcomes.

**Methods**

This analysis includes participants in community *H. pylori* projects conducted by the CANHelp Working Group in 4 hamlets in the western Arctic region of Canada: projects launched in Aklavik, Northwest Territories (NT) in 2007, Old Crow, Yukon (YT) in 2010, Tuktoyaktuk (NT) in 2011, and Fort McPherson (NT) in 2012 [27–38]. Each of these communities is predominantly Indigenous, mainly Gwich’in (Athabaskan First Nations) or Inuvialuit (western Canadian Inuit): Aklavik had 594 residents (2006 census), with 92% identifying as either Inuvialuit or Gwich’in; Old Crow had 245 residents (2011 census), with 90% identifying as Vuntut Gwitch’in; Tuktoyaktuk had 854 residents (2011 census), with 92% identifying as Inuvialuit; and Fort McPherson had 792 residents (2011 census, with 94% identifying as Indigenous (mainly Gwich’in) [39, 40]. Each community project, guided by a planning committee comprised of community leaders, included several components: surveys to collect risk factor data; non-invasive screening for *H. pylori* infection; endoscopy with gastric biopsy for pathological and microbiological assessment; treatment; and ongoing knowledge exchange activities. Diverse outreach strategies sought to encourage all community residents to participate. Project staff obtained informed consent from participants 17 years of age or older, parental consent for children under 17 years of age, and assent from 7 to 16-year-old participants.

The lead author (KW) collected chart review data for her MSc thesis research on factors associated with antibiotic-resistant *H. pylori* infection; [41] specifically, she collected antibiotic exposure history pertaining to CANHelp community project participants who fulfilled either or both of the following criteria for inclusion in this analysis: 1) available *H. pylori* isolates cultured from gastric biopsies and tested for antibiotic susceptibility; 2) completed treatment to eliminate *H. pylori* infection and were tested after treatment to assess post-treatment infection status. We collected each participant’s antibiotic exposure history from their medical chart, housed in community health centres, using a chart review tool to record systemic antibiotics prescribed for any reason during the 5 years before the participant’s enrolment date. This 5-year exposure period spanned different calendar years across communities because community projects were launched sequentially: our chart review recorded medications prescribed primarily during 2002–2007 in Aklavik, 2005–2010 in Old Crow, 2006–2011 in Tuktoyaktuk, and 2007–2012 in Fort McPherson (a few participants enrolled after the launch year, so their antibiotic exposure period began slightly later). Data collected from medical charts included: demographic factors; frequency of antibiotic prescriptions; types of antibiotics prescribed; and the reason for each prescription. An antibiotic prescription was defined as a single prescription of at least one systemic antibiotic regardless of the dose, dosing frequency or duration of the prescription.

As a measure of antibiotic use frequency, we estimated antibiotic dispensation rates, defining dispensation as the process by which a prescribed medication is given to a patient for whom a prescription was written. We used prescriptions as proxies for dispensations because medical charts noted prescriptions rather than dispensations, and because prescriptions given to patients at health centres in participating northern communities are dispensed routinely from locally stocked medication by health centre staff at the time of prescription; thus, in this study population, it can be assumed that each prescription noted in a medical chart was dispensed.
We expressed dispensation rates as the average of the number of antibiotic courses dispensed per person per year during each participant’s 5-year review period. We calculated these rates by dividing the total number of systemic antibiotic courses prescribed for all participants during the 5-year review period by the product of the number of participants and the sum of the number of years reviewed in the medical chart of each participant. We estimated antibiotic dispensation rates by community (Aklavik, Old Crow, Fort McPherson, Tuktoyaktuk), sex, age (categorized in 20-year age groups), and antibiotic class (β-lactams, macrolides, nitroimidazoles, nitrofurans, fluoroquinolones, tetracyclines, rifamycins).

To put the antibiotic dispensation rates observed in the western Arctic communities in perspective, we compared them to rates observed in Alberta, a western Canadian province located directly south of the Northwest Territories. We estimated antibiotic dispensation rates for the outpatient populations of urban Edmonton (Alberta’s capital) and rural northern Alberta using the online Alberta Government Interactive Health Data Application (IHDA), [42] which incorporates data from the following sources: the Pharmaceutical Information Network (PIN) database; the Alberta Health Care Insurance Plan Adjusted Mid-Year Population Registry Files; and the Alberta Health and Wellness Postal Code Translation File. The PIN captures all drug dispensation events occurring in community pharmacies across Alberta. Aggregate PIN data are available through the IHDA by geography, age group, sex, year, and antibiotic class. We restricted estimates of the Edmonton antibiotic dispensation rate to the population residing within the city limits (subzones Z4.1–Z4.4) and the rural northern Alberta rate to residents of the Alberta North Zone (subzones Z5.1–Z5.5); when we accessed data for both regions in March 2017, the only available data covered 2010 through 2013.

We estimated the outpatient antibiotic dispensation rates by dividing the number of antibiotic courses dispensed by the sum of the population during each year from 2010 through 2013. For statistical comparison, we used an estimation approach, presenting 95% confidence intervals (CI) for all estimated rates, rather than statistical significance testing, following best practice in statistical methods for epidemiology [43, 44]. To compare the Arctic community population to each of the two Alberta populations, we estimated rate differences and 95% CIs.

Results
We collected antibiotic exposure histories from medical charts of CANHelp community project participants: 164 from Aklavik; 67 from Old Crow; 52 from Fort McPherson; and 14 from Tuktoyaktuk. Table 1 presents the demographic characteristics of the study population.

Table 1 Demographic characteristics of study population

| Four Arctic Communities | n | Age Distribution | Proportion Female |
|------------------------|---|-----------------|------------------|
|                        |   | Age Group* (years) | %           |
| Aklavik                | 164 | 4–19 | 12.8 | 51.1 |
|                        |   | 20–39 | 30.0 |          |
|                        |   | 40–59 | 41.1 |          |
|                        |   | 60–81 | 16.2 |          |
| Old Crow               | 67  | 5–19 | 7.5 | 52.2 |
|                        |   | 20–39 | 32.8 |          |
|                        |   | 40–59 | 43.3 |          |
|                        |   | 60–77 | 16.4 |          |
| Tuktoyaktuk            | 14  | 6–19 | 7.1 | 71.4 |
|                        |   | 20–39 | 14.3 |          |
|                        |   | 40–59 | 50.0 |          |
|                        |   | 60–78 | 28.6 |          |
| Fort McPherson         | 52  | 15–19 | 3.9 | 59.6 |
|                        |   | 20–39 | 15.4 |          |
|                        |   | 40–59 | 55.8 |          |
|                        |   | 60–81 | 25.0 |          |
| Edmonton Outpatients*  | ~865,000 | 0–19 | 22.5 | 49.5 |
|                        |   | 20–39 | 33.6 |          |
|                        |   | 40–59 | 27.9 |          |
|                        |   | 60–90+ | 16.1 |          |
| Rural Northern Alberta Outpatients* | ~460,000 | 0–19 | 27.8 | 47.8 |
|                        |   | 20–39 | 31.7 |          |
|                        |   | 40–59 | 27.5 |          |
|                        |   | 60–90+ | 13.0 |          |

*Age category labels for Edmonton and rural Alberta outpatients do not indicate the minimum and maximum age values; age categories labels for the upper and lower age groups vary across communities to indicate the minimum and maximum age values.

**Alberta Government Interactive Health Data Application Edmonton City Centre population including both sexes and all ages ranged from 830,213 to 903,256 during 2010–2013.

**Alberta Government Interactive Health Data Application North Zone population including both sexes and all ages ranged from 440,406 to 476,886 during 2010–2013.

Boldface data are set to differentiate the values in the total row from values in other rows, which represent subsets of the total.

Among the 297 participants, the median number of systemic antibiotic prescriptions during the 5-year review period was 3 (IQR, 1–6; range, 0–38; mean, 4.3; SD, 4.6).

Table 2 presents estimated antibiotic dispensation rates in CANHelp community project participants and the outpatient populations of Edmonton and rural northern Alberta. The overall antibiotic dispensation rate was notably higher in the CANHelp community project study population (8.9 courses per 10 person-years) than in northern rural Alberta (6.3 courses per 10 person-years) or Edmonton (5.5 courses per 10 person-years). The estimated antibiotic dispensation rate in western Arctic communities was 3.3 (95% CI: 2.9, 3.8) courses per 10 person-years higher than the Edmonton outpatient population rate and 2.6 (95% CI: 21, 31) courses per 10 person-years higher than the rural northern Alberta outpatient rate.
Northern Alberta is a large geographic region with two small cities and vast sparsely populated areas. Table 3 presents estimated antibiotic dispensation rates for sub-zones of this region. Of note, the two cities have antibiotic dispensation rates slightly lower than Edmonton’s, while rates in the sparsely populations zones range from 5.9 to 7.3 per 10 person-years, all substantially lower than the estimated rates in the Arctic communities.

Table 4 presents estimated antibiotic dispensation rates for the Arctic communities and the outpatient populations of Edmonton and rural northern Alberta by sex, age and antibiotic class. Across all populations, the estimated dispensation rate was higher in woman than in men, the highest rates occurred in senior adults, and β-lactam antibiotics were dispensed at a substantially higher rate than other antibiotic classes. Stratification by age group and sex shows that dispensation rates were substantially higher in the Arctic communities within each age group and in both sexes. Of note, compared to the Alberta populations, dispensation rates in the Arctic communities were similar for β-lactams and macrolides, lower for fluoroquinolones and tetracyclines, higher for nitrofurans, and substantially higher for nitroimidazoles.

Discussion
Evidence from this study suggests that antibiotics are dispensed more frequently to western Arctic Canadians than to either urban or rural residents of the southwestern Canadian province of Alberta, independently of age and sex. This study showed additionally that antibiotics were dispensed more frequently to women relative to men and to the elderly relative to other age groups in each of the 3 settings investigated. Dispensation rates for the most frequently dispensed antibiotic classes, β-lactams and macrolides, was similar in the 3 populations, while fluoroquinolones and tetracyclines were dispensed less frequently and nitrofurans and nitroimidazoles were dispensed more frequently in the Arctic communities.

In the present study, the dispensation rate for systemic antibiotic prescriptions among participants in CANHelp Working Group community projects was 8.9 prescriptions per 10 person-years; an even higher antibiotic prescription rate of 15 per 10 person-years was estimated for an Alaska Native population in 2003 [2]. The urban antibiotic dispensation rates we estimated for Edmonton and the two small northern Alberta cities ranged from 5.2–5.5 per 10 person-years; a slightly lower antibiotic dispensation rate of 4.4 per 10 person-years was estimated from a 1992 study of United States physician practices [45]. More frequent use of antibiotics in rural and remote Arctic regions of North America relative to urban settings in this region is compatible with diverse explanations including higher incidence of infectious diseases, more limited access to diagnostic technology used to confirm bacterial infections leading to more frequent dispensation of antibiotics without a confirmed diagnosis, and different prescription practices resulting from more frequent provision of health care by nurses in phone consultation with physicians rather than by physicians directly [46, 47].

Variation in the use of antibiotics for the treatment of common bacterial infections may contribute to variation

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Table 2: Estimated antibiotic dispensation rates in western Arctic communities, Edmonton and rural northern Alberta

| Antibiotic Courses Dispensed per person-year | 95% CI     |
|---------------------------------------------|-----------|
| Four Arctic Communities                     | 0.89      |
| Aklavik                                     | 0.84      |
| Old Crow                                    | 0.90      |
| Fort McPherson & Tuktoyaktuk                | 0.99      |
| Edmonton Outpatients                         | 0.55      |
| Rural Northern Alberta Outpatients           | 0.63      |

Boldface data are set to differentiate the values in the total row from values in other rows, which represent subsets of the total.

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Table 3: Estimated antibiotic dispensation rates in the rural northern Alberta sub-zones

| Northern Alberta Subzone | Population during 2010–2013a | Antibiotic Courses Dispensed per Person/Year | 95% CI     |
|--------------------------|-----------------------------|---------------------------------------------|-----------|
| Total                    | 440,406                     | 0.63                                        | 0.62, 0.63|
| SW                       | 92,750                      | 0.61                                        | 0.60, 0.61|
| SE                       | 83,677                      | 0.71                                        | 0.71, 0.72|
| Central West             | 36,836                      | 0.59                                        | 0.58, 0.59|
| NW                       | 92,752                      | 0.73                                        | 0.73, 0.73|
| NE                       | 4761                        | 0.66                                        | 0.65, 0.67|
| Fort McMurray (city)     | 65,457                      | 0.53                                        | 0.52, 0.53|
| Grande Prairie (city)    | 64,007                      | 0.52                                        | 0.52, 0.53|

aAlberta Government Interactive Health Data Application North Zone population including both sexes and all ages during 2010–2013

Boldface data are set to differentiate the values in the total row from values in other rows, which represent subsets of the total.
in antibiotic-resistant infection across geographic regions and sociodemographic groups [25, 26]. For example, the frequency of clarithromycin-resistant H. pylori infection has been reported to be higher in children than in adults, with evidence suggesting that this contrast is due to more frequent use of macrolide antibiotics in children for the treatment of respiratory tract infections [1, 48]. The frequency of metronidazole-resistant H. pylori infection has been reported to be higher in women than in men, [49] perhaps due to widespread use of nitroimidazole antibiotics for the treatment of gynaecological infections [2, 49–54]. For example, in a study conducted in the United Kingdom, nitroimidazole antibiotics were prescribed more frequently to women than to men, and the prevalence of metronidazole-resistant H. pylori infection was also higher in women relative to men [4]. Similarly, reports of higher prevalence of tetracycline-resistant H. pylori infection in women relative to men may be due to more frequent use of tetracycline in women for the treatment of urogenital infections [55]. Higher prevalence of fluoroquinolone-resistant H. pylori infection in women relative to men and in youth relative to adults may be associated with more frequent use of fluoroquinolone antibiotics for the treatment of urogenital and respiratory tract infections, respectively [55].

An important limitation of the present analysis is the potential underestimation of antibiotic use among participants in the Arctic Canadian community H. pylori projects. Participants’ medical charts only capture antibiotics dispensed at their community health centre. Many residents of the project communities spend time away from home and may receive health care in other locations. Most residents of northern Canadian communities, however, receive most of their health care at their community health centre; it is, therefore, likely that most antibiotics dispensed during the review period for this study were captured by our chart review. The data sources used for the Alberta populations would similarly miss prescriptions dispensed outside Alberta; however, given that Albertans are all entitled to health care provided by the provincial government, they are not likely to seek outpatient care for infections outside the province.

Another limitation pertains to our differential strategy for capturing dispensation events across territorial and provincial populations. In the northern communities included here, prescription events equate with dispensations. In Alberta, however, primary nonadherence is possible: an individual may be prescribed a drug but may not fill the prescription, precluding its dispensation.

### Table 4: Estimated antibiotic dispensation rates in western Arctic communities, Edmonton and rural northern Alberta by sex, age and antibiotic class

|                           | Western Arctic Communities | Edmonton† | Rural Northern Alberta‡ |
|---------------------------|---------------------------|-----------|-------------------------|
|                           | n     | Rate/Person/Year | 95% CI | Rate/Person/Year | 95% CI | Rate/Person/Year | 95% CI |
| Total Population          | 297   | 0.89          | 0.84, 0.94 | 0.555  | 0.554, 0.556 | 0.625  | 0.624, 0.627 |
| Sex                       |       |               |         |               |         |               |         |
| Female                    | 163   | 1.09          | 1.02, 1.17 | 0.662  | 0.661, 0.664 | 0.772  | 0.770, 0.774 |
| Male                      | 134   | 0.64          | 0.58, 0.71 | 0.450  | 0.449, 0.451 | 0.491  | 0.489, 0.492 |
| Age Group                 |       |               |         |               |         |               |         |
| < 20 years                | 38    | 0.75          | 0.63, 0.89 | 0.493  | 0.492, 0.495 | 0.626  | 0.624, 0.629 |
| 20–39 years               | 89    | 0.88          | 0.79, 0.97 | 0.464  | 0.462, 0.465 | 0.543  | 0.541, 0.544 |
| 40–59 years               | 122   | 0.85          | 0.78, 0.93 | 0.591  | 0.590, 0.593 | 0.606  | 0.604, 0.608 |
| ≥ 60 years                | 48    | 1.11          | 0.98, 1.26 | 0.768  | 0.765, 0.770 | 0.862  | 0.859, 0.866 |
| Antibiotic Class          |       |               |         |               |         |               |         |
| β-lactams                 | 178   | 0.31          | 0.28, 0.33 | 0.259  | 0.258, 0.259 | 0.312  | 0.311, 0.313 |
| Macrolides                | 100   | 0.11          | 0.09, 0.13 | 0.097  | 0.097, 0.097 | 0.107  | 0.107, 0.108 |
| Nitroimidazoles           | 60    | 0.06          | 0.05, 0.07 | 0.001  | 0.001, 0.001 | 0.001  | 0.001, 0.001 |
| Nitrofurans               | 22    | 0.04          | 0.03, 0.05 | 0.023  | 0.023, 0.023 | 0.024  | 0.024, 0.024 |
| Fluoroquinolones          | 29    | 0.03          | 0.03, 0.04 | 0.077  | 0.077, 0.077 | 0.081  | 0.080, 0.081 |
| Tetracyclines             | 16    | 0.02          | 0.01, 0.02 | 0.043  | 0.043, 0.043 | 0.036  | 0.036, 0.036 |
| Rifamycins                | 1     | 0.0007        | 0.000, 0.004 | §      | –       | §      | –       |

†Alberta Government Interactive Health Data Application Edmonton City Centre population including both sexes and all ages during 2010–2013
‡Alberta Government Interactive Health Data Application North Zone population including both sexes and all ages during 2010–2013
§Rifamycin antibiotic usage was not reported in the IHDA dataset

Boldface data are set to differentiate the values in the total row from values in other rows, which represent subsets of the total.
While this is unlikely to impact our ability to assess differences in dispensation patterns, it does limit our ability to investi
gate plausible explanations for results. Similarly, we were unable to assess whether a per
to who was dispensed an antibiotic used the medi
cation as prescribed. As a result, we are restricted to
reporting differences in potential exposure to antibiotics
across these populations.

In this study, the time periods for which antibiotic
dispensation rates were estimated differ in each of the
Arctic communities (2002–2007, 2005–2010, 2006–
2011, 2007–2012) due to the sequential conduct of these
projects. These periods overlap to different degrees with
the time period captured by the publicly accessible
Alberta data, which was 2010–2013 at the time of data
analysis. We would not, however, expect substantial
changes in antibiotic dispensation during 2002 to 2013
based on studies of outpatient populations in Ontario,
Canada and in the United States, which suggest that
antibiotic dispensation rates remained relatively stable
across age groups during this time period [58, 59].

Conclusions
This study reveals more frequent dispensation of antibi
otics in Arctic Canada relative to urban and rural popula
tions in southern Canada. These results suggest that
increased exposure to antibiotics is a potential explana
tion for reduced effectiveness of antibiotics in Indigene
ous Arctic populations for treating infections such as H.
pylori infection. More generally, Indigenous Arctic popula
tions may be particularly vulnerable to antibiotic-
resistant infections associated with frequent exposure to
antibiotics. The evidence generated by this analysis will
be useful for developing strategies aimed at reducing
health disparities arising from inequitable health care in
Indigenous Arctic populations relative to other North
American populations.

Abbreviations
CANHelp Working Group; Canadian North Helicobacter pylori Working Group;
CI: Confidence interval; H. pylori: Helicobacter pylori; IHDA: Alberta Interactive
Health Data Application; IQR: Interquartile Range; NT: Northwest Territories;
PPI: Pharmaceutical Information Network; PPI: Proton-pump inhibitor;
SD: Standard deviation; YT: Yukon Territory

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This research was previously presented as a poster presentation at the 2016
Epidemiology Congress of the Americas in Miami, Florida, USA [62].

Authors’ contributions
KW is the submission’s guarantor. KW designed the research study,
performed the research, collected and analysed the data, and drafted the
manuscript. KG contributed to and supervised the research design, data
analysis, and manuscript preparation. RM contributed to the design of data
collection methods in northern community health centres, assessment of
data quality, and manuscript review. AC contributed to the design and analysis
of Alberta data, assessment of data quality, and manuscript review. Other
members of the CANHelp Working Group (www.canhelpworkinggroup.ca)
contributed in numerous ways to the design and implementation of the
community H. pylori projects. All authors read and approved the final version of
this article, including the authorship list.

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analysis, or interpretation of data, or in writing the manuscript.

Availability of data and materials
Antibiotic dispensation data collected from community project participants
are not available through open access due to terms stipulated in
community-university partnership agreements. Data requests are reviewed
according to a process outlined in the Statement on Stewardship and
Dissemination of Knowledge Generated Collaboratively in CANHelp Working
Group Community Projects available at http://canhelpworkinggroup.ca/rese
arch-program/collaborative-partnerships/. To initiate the data request
process, contact the corresponding author. The interactive health data
application (IHDA) dataset analysed for the current study are available at the
following url: www.ahw.gov.ab.ca/IHDA_Retrieval/.

Ethics approval and consent to participate
The CANHelp community projects maintain ethical approval from the
University of Alberta Health Research Ethics Board and additional
licences through the Aurora Research Institute (NT) and the Yukon Scientists
and Explorers Act, with approval from the Inuvialuit Regional Corporation,
the Aklavik Health Committee, the Hamlet of Aklavik council, the Aklavik
Community Corporation (Inuvialuit governance), the Aklavik Gwich’in council,
the Old Crow Vuntut Gwich’in government, and the Fort McPherson chief
and council. Our research program adheres to the Ethical Principles for the
Conduct of Research in the North of the Association of Canadian Universities
for Northern Studies [60] as well as the standards elaborated in Research
Involving the First Nations, Inuit and Métis Peoples of Canada, Chapter 9 of the
2014 Tri-Council Policy Statement on the Ethical Conduct for Research Involving
Humans issued by the Canadian Secretariat on Responsible Conduct of Research
[61]. Study staff obtained informed consent during in-person conversations,
during which the staff read to participants study information sheets approved by the
university ethics board, addressed participants’ questions, and secured signatures
on consent forms approved by the university ethics board; staff obtained written
parental consent for children under 17 years of age and written assent from
children aged 7–16 years or deemed old enough to assent by their parents.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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