The relationship between socio-economic and geographic factors and asthma among Canada’s Aboriginal populations

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ABSTRACT

Objectives. To examine the prevalence, exacerbations and management of asthma among Canada’s Aboriginal populations, and its relationship to socio-economic and geographic factors.

Study design. Secondary analysis of a national cross-sectional questionnaire survey.

Methods. Data were collected in 2000 and 2001 through a survey of Aboriginal children and adults residing on- and off-reserve as part of the 2001 Aboriginal People's Survey (APS). The asthma related outcome variables – physician-diagnosed asthma, attack in past year and regular use of inhalants – were examined in relation to socio-economic and geographic factors such as income, education, housing and location of residence. Statistical analyses were based on weighted univariate and multivariate logistic regressions.

Results. The results show variations in asthma diagnosis, attacks and inhalant use across geographic location, socio-economic and demographic characteristics. Geographic location was found to be significantly associated with asthma for both adults and children, with those living in the northern territories, on-reserve or rural locations being the least likely to be diagnosed. Geographic location and Aboriginal identity were also found to be significantly associated with asthma medication use.

Conclusions. While these findings may suggest a “healthier” population in more remote locations, they alternatively point to a general pattern of under-diagnosis, potentially due to poor health care access, as is typical in more remote locations.

Keywords: asthma, Aboriginal, Indian, SES, geography, Canada
INTRODUCTION

There is a disproportionate disease burden between Aboriginal and non-Aboriginal Canadians for a wide range of conditions, including infectious diseases, diabetes, renal diseases and mental illness (1-6). Lower-than-average Aboriginal life expectancies - ranging from 5 to 12 years - illustrate this disparity (2,7). Unlike many other health conditions, asthma had previously been thought of as relatively uncommon in the Canadian Aboriginal community (1) and has received little attention. Recent evidence now suggests that prevalence of asthma and rates of exacerbation (e.g., asthma attacks and related emergency room visits and hospitalizations) may in fact be higher than previously thought (8,9) and that these outcomes are associated with the geographic and socio-economic circumstances in which Aboriginal people live (10-14). In an effort to better understand these relationships in Canada’s Aboriginal populations, an analysis of the 2001 Aboriginal People’s Survey was conducted.

Research on asthma in Aboriginal populations generally (15-17) and the Canadian Aboriginal population more specifically (8,9,18,19) is limited to only a handful of studies. Senthilselvan et al. (19), using outpatient data for the Canadian province of Saskatchewan, found disproportionately high prevalence rates among Aboriginal populations compared to non-Aboriginal populations as well as a steady increase in prevalence throughout the 1980s and early 1990s. A population-based cohort study by Sin et al. (9), using administrative health data for the province of Alberta, found that Aboriginals were more than twice as likely to visit an emergency department (ED) or physician’s office for asthma as compared to non-Aboriginals. Furthermore, Aboriginals were less likely to undergo spirometry or to receive specialized asthma management care. It is suggested that a disproportionate asthma burden combined with access barriers to quality health care account for these findings. Most recently, Gao et al. (18) compared asthma between Aboriginal and non-Aboriginal children in northern Canada using the National Longitudinal Survey of Children and Youth. Here, Aboriginal children reported asthma and asthma-like symptoms at rates significantly lower than non-Aboriginal children. By comparison, a recent U.S. study by Meng et al. (17) found that American Indians/Alaska Natives had the highest prevalence of active asthma compared to other ethnic groups. In Australia, Valerie et al. (20) found significant variation in asthma prevalence among remote Indigenous communities and that, overall, asthma symptom and prevalence rates were as high as in non-Indigenous communities.

The geographical variability of asthma outcomes in non-Aboriginal populations has been well documented. A national cross-sectional survey by Dales et al. (10) of approximately 18,000 individuals looked at self-reported asthma measures, including past hospitalizations, physician diagnoses and persistent cough, and found rates to be consistently the highest in eastern Canada and the lowest in the province of British Columbia, even after controlling for environmental characteristics. More recent studies have identi-

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1 In Canada, the term “Aboriginal” is used to refer to the descendants of the original inhabitants of Canada. The Constitution Act of Canada (1982) recognizes 3 broad Aboriginal identity groups: North American Indians (i.e., First Nations peoples), Métis and Inuit.
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fied lower asthma prevalence in rural areas (8,21,22) and also among children living on farms (23). Lajoie et al. (24) found strong regional variability of ED visits for asthma in the province of Quebec as did Lougheed et al. (11) in Ontario. In both cases, the authors suggest that ED visit rates are determined not by actual prevalence of asthma but rather by under-diagnosis, access to alternative care and how well asthma is managed in the community. With regards to Aboriginal populations, preliminary tables produced from the 2001 APS show strong provincial variability in asthma prevalence among urban and rural residents (25).

A considerable body of international research now exists on the relationship between socio-economic status (SES) and asthma outcomes, including wheezing, attacks, hospital admissions and emergency department visits among non-Aboriginals. Results typically show that outcomes such as these are more common among low social class groups (12-14,26,27) as well as among ethnic minorities (17,28). It has also been shown that adherence to medications is less common among low SES groups (29). On the other hand, there is considerable uncertainty in the literature with regards to the role SES factors play in determining asthma prevalence. While studies in the U.S. and Europe have found low SES to be an important risk factor (17,30), other studies have found no relationship (31,32). Differences in asthma definitions and SES indicators could partially explain these inconsistencies, as could differences in access to physicians for diagnosis. These relationships have not been examined among Canadian Aboriginals, a population facing numerous socio-economic disparities (33,34). Thus, questions remain as to what role geographical and SES factors such as income, education, location of residence and housing conditions may play in determining asthma outcomes among Aboriginal peoples in Canada.

Examining these geographic and SES relationships to asthma in the context of Canada's Aboriginal population is important for the development of informed policies and programs aimed at reducing this disease burden, and directing health care services towards better asthma management. Thus, the main objectives of this research were (1) to examine the differences in asthma prevalence between Canadian Aboriginal populations; (2) to assess if there are differences in asthma exacerbation and asthma management across these populations; and (3) to explore the SES and geographic factors that may explain identified differences.

MATERIAL AND METHODS

The 2001 Aboriginal Peoples Survey undertaken by Statistics Canada identifies First Nations, on- and off-reserve Aboriginal people, Métis and Inuit respondents residing in private dwellings in Canada's 10 provinces and 3 territories. The survey includes questions on education, health, language, labour activity, income, mobility, housing, perceptions of social problems and connectivity, among others. One of the key components of the 2001 APS was a section on chronic diseases, including asthma.

The APS sample was identified from responses to the 2001 census. For the adult core survey, a total of 60,500 individuals were interviewed. A supplemental Children and Youth Questionnaire aimed at 0 to 14 year-olds residing on- and off-reserve was also admin-
istered to 35,495 respondents. The person most knowledgeable about the child or youth answered the questionnaire on his or her behalf. In the majority of cases, the respondent was a parent (93%). However, grandparents (4%) and other relatives also responded on behalf of children and youth. For the sake of simplicity, the person most knowledgeable about the child will be referred to as the parent. The overall response rate for both surveys was 84.1%. Further details about the survey, sampling methods and sample characteristics can be found at http://www.statcan.ca/english/aboriginal/aps/aps2001-en.htm.

The APS is a post-censal survey, meaning that the potential sample population is drawn from individuals who completed the 2001 Census of Canada. To be eligible to participate in the APS, individuals had to indicate on the 2001 Census that they had one of the following: (1) Aboriginal ancestry; (2) Aboriginal identity; (3) Registered or Treaty Indian Status; or (4) First Nations or Indian band membership. If, for some reason, an individual refused to indicate the above, they were not included in the APS sample. Further, since the APS sample is derived from those who completed the Census, APS data ARE not available for First Nations communities that refused to participate or were incompletely enumerated in the Census. While the number of First Nations communities refusing to participate in the Census of Canada has declined over time, 30 were incompletely enumerated in the 2001 Census, and another 22 communities were incompletely enumerated in the APS (http://dsp-psd.tpsgc.gc.ca/Collection/Statcan/89-591-X/89-591-XIE2003001.pdf).

From the Children and Youth Survey, the following questions related to asthma were examined:

1. Which, if any, of the following long-term conditions or health problems does ____ have that have been diagnosed by a doctor, nurse or health professional? Asthma? (yes/no)
2. Has ____ had an attack of asthma in the past 12 months? (yes/no)
3. Does ____ take any of the following medications on a regular basis: Ventolin, inhalers or puffers for asthma? (yes/no)

From the Adult Core Survey, the following questions were examined:

1. Have you ever been told by a doctor, nurse or other health professional that you have asthma? (yes/no)
2. Do you take any treatment or medication for this condition? (yes/no)

From these questions, the following dependent variables were derived: ever diagnosed with asthma, attack in past year (children only) and regular use of medication.

Explanatory variables examined in this study relate primarily to geographic, socio-economic and demographic factors that come from both the APS and from linked 2001 Canadian Census data. The choice of explanatory variables was informed by the population health framework (35) and more specifically by the determinants of asthma literature (12,14,23,26-29,36-38) as well as by some practical considerations pertaining to APS data availability, quality and confidentiality. We considered the following SES variables in our analysis: economic family income, year home was built, home in need of major repairs, highest level of education (adults) and highest level of education of primary caregiver (children) and number of parents in the household (children). Three geographic variables were examined: living in an urban or rural location, on- or
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off-reserve residency and province of residence. More refined geographic coding was limited for reasons of confidentiality. Demographic variables include age, gender and Aboriginal identity (North American Indian, Inuit, Métis and those reporting multiple identities). Recent use of health care services defined as a visit to a doctor, nurse practitioner or nurse in the past year were also considered. Chronic bronchitis, emphysema (adults only) and BMI (body mass index; adults only), smoking status (adults only), birth weight (children only) and attack in past year (children only) were included in the regression analysis as potential confounders of the associations of interest.

Statistical analyses
We analysed the data with SPSS v.16 (SPSS Inc., Chicago) and Stata v.9. (StataCorp LP, College Station, Texas) using bivariate and multivariate techniques. The bivariate descriptive analysis was used to identify potential explanatory variables for each outcome of interest. Multivariate logistic regression analysis was then applied to assess the association between outcome variables and potential predictors, while adjusting for other identified explanatory variables including gender, age, chronic health conditions and smoking (adults only). Sample weights were applied for the descriptive analysis and bootstrap weights for the regression analysis.

RESULTS
In all, 12% of Aboriginal children were reported as having been diagnosed with asthma. Asthma prevalence was statistically significantly higher among boys and in the oldest age group (10-14 year-olds; Table I). Inuit children had the lowest asthma prevalence at just over 5%, as compared to approximately 12%-13% for all other Aboriginal identity groups. Significant geographic differences were also seen with those living off-reserve, in urban areas and in the province of Ontario having the highest prevalence. The biggest differences in the SES variables were seen in income, where 19% of children in the lowest income group were reported to have asthma as compared to 11% in the highest income group. Children living in older homes, homes in need of major repairs or in single-parent households were also reported as having a significantly higher prevalence of asthma.

When parents were asked about asthma attacks in the past year, 43.7% reported that their children had experienced an attack. While there was no difference by gender, rates were significantly higher among 0-4 year-olds (49.3%) as compared to 5-9 year-olds (40.8%) and 10-14 year-olds (43.7%). By identity group, findings were similar across groups, ranging from 40%-41%, with the exception of the Métis identity group, where rates were reported as higher. Children living on-reserve reported lower rates than those living off-reserve, and those living in Quebec had dramatically lower rates than other regions. In Quebec, 17.4% of children were reported to have had an asthma attack in the past year as compared to British Columbia at 59.1%. Among the SES factors examined, only the relationship between recent attacks and parents’ education was found to be significant, with the highest rates reported among children whose parents’ education were lower. With regards to health care, rates of asthma attacks in the past year were more than double among those children who had not recently seen a physician or nurse.
Table 1. Asthma prevalence, recent attacks and asthma management among those diagnosed with asthma by select characteristics for Aboriginal children (0-14 years).

| Characteristics          | Diagnosed asthma (n=35 500) % | Attack in past year1 (n=3260) % | Regular use of medications† (n=3320) % |
|--------------------------|-------------------------------|---------------------------------|----------------------------------------|
| Total                    | 12.0                          | 43.9                            | 60.1                                   |
| Gender                   |                               |                                 |                                        |
| Male                     | 14.6                          | 45.2                            | 59.9                                   |
| Female                   | 9.4                           | 41.7                            | 60.4                                   |
| Age (years)              |                               |                                 |                                        |
| 0-4                      | p<0.001                       | ns                              | ns                                     |
| 5-9                      | 8.8                           | 49.3                            | 63.6                                   |
| 10-14                    | 13.5                          | 43.7                            | 59.1                                   |
| Identity                 |                               |                                 |                                        |
| NA                       | 12.4                          | 41.5                            | 65.3                                   |
| Metis                    | 12.9                          | 50.6                            | 60.2                                   |
| Inuit                     | 5.2                           | 40.0                            | 50.0                                   |
| other/mixed              | 11.8                          | 41.3                            | 51.6                                   |
| Reserve residence        | p<0.001                       | p<0.05                          | ns                                     |
| On                       | 9.5                           | 36.7                            | 56.3                                   |
| Off                      | 12.4                          | 44.4                            | 60.3                                   |
| Urban/rural residence    | p<0.001                       | ns                              | p<0.001                                |
| Urban                    | 13.1                          | 43.6                            | 61.9                                   |
| Rural                    | 10.1                          | 43.9                            | 56.0                                   |
| Region of residence      | p<0.001                       | p<0.001                         | p<0.001                                |
| Atlantic                 | 13.7                          | 43.5                            | 56.5                                   |
| Quebec                   | 9.2                           | 17.4                            | 41.7                                   |
| Ontario                  | 16.9                          | 41.1                            | 60.2                                   |
| Prairies                 | 11.1                          | 45.5                            | 60.6                                   |
| British Columbia         | 10.6                          | 59.1                            | 68.9                                   |
| Northern territories     | 4.4                           | 40.0                            | 60.0                                   |
| Education                | p<0.05                        | p<0.05                          | p<0.05                                 |
| High school or higher    | 11.5                          | 42.6                            | 58.4                                   |
| < high school            | 12.5                          | 46.9                            | 62.2                                   |
| Home in need of major repairs | p<0.001                     | ns                              | p<0.001                                |
| Yes                      | 13.8                          | 40.6                            | 67.6                                   |
| No                       | 11.6                          | 44.7                            | 58.1                                   |
| Year house built         | p<0.001                       | ns                              | p<0.001                                |
| 1981-2001                | 10.6                          | 42.5                            | 63.2                                   |
| 1961-1981                | 11.8                          | 45.8                            | 64.2                                   |
| <1961                    | 14.8                          | 41.9                            | 52.6                                   |
| Income                   | p<0.001                       | ns                              | p<0.05                                 |
| <20,000                  | 19.0                          | 44.4                            | 57.6                                   |
| 20,000 to <40,000        | 12.8                          | 45.5                            | 62.2                                   |
| 40,000 to 60,000         | 10.3                          | 43.9                            | 64.4                                   |
| >60,000                  | 11.1                          | 41.4                            | 57.5                                   |
| Recent health care visit2 | p<0.001                       | p<0.001                         | p<0.001                                |
| Yes                      | 13.4                          | 19.6                            | 62.8                                   |
| No                       | 7.5                           | 47.8                            | 43.7                                   |

1 Refers to respondents who reported a diagnosis of asthma.
2 Recent health care visit refers to having seen a family physician (or pediatrician), other medical doctor or nurse in the past 12 months.
Overall, 60.1% of the Aboriginal children who were reported to have been diagnosed with asthma use asthma medications such as Ventolin puffers or inhalers regularly (Table I). While no significant differences were reported by gender or age, medication use rates were significantly higher among North American Indians as compared to other groups. By place of residence, rates were higher in urban areas compared to rural areas; however, no significant differences were identified between those living on- and off-reserve. By region, the lowest rates were seen in Quebec (41.7%) and the highest in British Columbia (68.9%), a finding consistent with the asthma attack data described above. Significant differences in medication use is apparent when comparing across SES variables, with higher use occurring among children of less-educated respondents, those who live in homes in need of major repairs, those living in more recently built homes and those in the middle-income groups. Rates were also significantly higher among those who have had a recent health care visit (62.8%) as compared to those who had not (43.7%).

Among Aboriginal adults (Table II), 11.2% of respondents reported having been diagnosed with asthma. Prevalence was significantly higher for women than for men, and for the very oldest and youngest age groups as compared to the middle-age groups. Inuit adult respondents reported a significantly lower prevalence of asthma (5.4%) as compared to other Aboriginal identity groups, while North American Indians, Métis and mixed identity groups all reported comparable prevalence. With regards to geographic factors, the highest prevalence was found among those individuals living off-reserve, in urban areas and in the province of Ontario. These differences were all found to be

| Characteristics | Diagnosed asthma (n=59,209) | Use of medications\(^1\) (n=5,167) |
|-----------------|-----------------------------|-----------------------------------|
| Total           | 11.2                        | 76.2                              |
| Gender          |                             |                                  |
| Male            | 8.5                         | 73.3                              |
| Female          | 13.6                        | 77.7                              |
| Age (years)     |                             |                                  |
| 15-24           | 12.1                        | 67.6                              |
| 25-34           | 9.7                         | 75.0                              |
| 35-44           | 11.5                        | 77.2                              |
| 45-54           | 10.5                        | 81.0                              |
| 55 and over     | 12.3                        | 84.9                              |
| Identity        |                             |                                  |
| NA              | 11.5                        | 75.9                              |
| Métis           | 11.7                        | 73.5                              |
| Inuit           | 5.4                         | 87.5                              |
| Other/mixed     | 10.6                        | 78.2                              |
| Reserve residence |                             |                                  |
| On              | 7.3                         | 73.3                              |
| Off             | 11.6                        | 76.2                              |
| Urban/rural residence |               |                                  |
| Urban           | 12.5                        | 76.1                              |
| Rural           | 8.7                         | 75.8                              |
| Region of residence |                     |                                  |
| Atlantic        | 11.0                        | 74.4                              |
| Quebec          | 9.9                         | 75.0                              |
| Ontario         | 14.9                        | 79.3                              |
| Prairies        | 10.2                        | 73.5                              |
| British Columbia | 9.9                        | 76.0                              |
| Northern territories | 5.2                       | 75.0                              |
| Education\(^2\) |                             |                                  |
| High school or higher | 10.9                      | 75.8                              |
| Currently in high school | 13.7                  | 75.9                              |
| < high school   | 11.1                        | 77.7                              |
| Home in need of major repairs | 12.1     | 76.9                              |
| Yes             | 11.0                        | 75.9                              |
| No              |                             |                                  |
| Year house was built |                         |                                  |
| 1981-2001       | 9.8                         | 77.5                              |
| 1961-1981       | 10.5                        | 76.3                              |
| < 1961          | 13.9                        | 74.6                              |
| Income          |                             |                                  |
| < 20,000        | 13.8                        | 77.7                              |
| 20,000 to < 40,000 | 10.3                    | 75.7                              |
| 40,000 to 60,000 | 11.2                        | 75.7                              |
| > 60,000        | 10.2                        | 75.5                              |
| Recent health care visit\(^3\) |                 |                                  |
| Yes             | 12.9                        | 78.6                              |
| No              | 5.5                         | 55.2                              |

\(^1\) Refers to respondents who reported a diagnosis of asthma.
\(^2\) This category was deemed necessary given the number of “adults” in the sample within the school-age range (i.e., 15-19 years).
\(^3\) “Recent health care” visit refers to having seen a family physician, other medical doctor or nurse in the past 12 months.
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Those living in homes in need of major repairs, those living in the oldest homes and those in the lowest income groups all reported significantly high asthma prevalence. Prevalence of asthma was higher among respondents who reported having a recent health care visit as compared to those who had not.

Overall, 76.2% of Aboriginal adults who reported having been diagnosed with asthma indicated that they use asthma medications. Rates of medication use were found to be significantly high among females, older age groups and the Inuit identity group (Table II). By place of residence, significant differences were seen between

Table III. Factors associated with reported diagnosis of asthma and use of asthma medications among Aboriginal children and adults.

| Characteristics | Children (0-14 years) | Regular use of medications | Adults (15+ years) | Use of medications |
|-----------------|----------------------|----------------------------|--------------------|-------------------|
|                 | Diagnosed asthma†    | Use of medications‡        | Diagnosed asthma‡  | Use of medications‡ |
|                 | OR 95% CI            | OR 95% CI                  | OR 95% CI          | OR 95% CI         |
| Gender (male)   | 1.63*** 1.34-1.99    | 0.76 0.50-1.16             | 0.65*** 0.55-0.76  | 0.79 0.17-1.10    |
| Age (years)     | 1.03*** 1.01-1.05    | 0.97 0.92-1.03             | 0.98*** 0.98-0.99  | 1.01* 1.00-1.02   |
| Identity        |                      |                            |                    |                   |
| NA              | 1.00 - 1.00          | 1.00 -                      | 1.00 -             | 1.00 -            |
| Métis           | 0.93 0.73-1.17       | 0.66 0.42-1.01             | 0.92 0.78-1.09     | 0.89 0.47-1.21    |
| Inuit           | 0.70 0.46-1.05       | 0.32* 0.12-0.88            | 0.85 0.44-1.66     | 1.72 0.16-3.68    |
| Other/mixed     | 0.79 0.59-1.07       | 0.48*** 0.27-0.86          | 0.86 0.69-1.07     | 1.11 0.63-1.73    |
| Off-reserve residence | 1.25 1.04-1.50 | 1.49*** 1.22-1.82          |                    |                   |
| Rural residence | 1.00 0.80-1.27       | 0.63* 0.42-0.94            | 0.80* 0.66-0.95    |                   |
| Region          |                      |                            |                    |                   |
| Atlantic        | 1.00 - 1.00          | 1.00 -                      | 1.00 -             | 1.00 -            |
| Quebec          | 0.67 0.41-1.10       | 0.62 0.25-1.58             | 0.99 0.73-1.36     | 0.93 0.84-1.85    |
| Ontario         | 1.18 0.80-1.73       | 1.01 0.45-2.27             | 1.25 0.92-1.69     | 1.45 0.22-2.61    |
| Prairies        | 0.74 0.53-1.02       | 0.90 0.45-1.78             | 0.91 0.71-1.16     | 1.04 0.87-1.66    |
| British Columbia| 0.67*** 0.47-0.95    | 1.23 0.53-2.88             | 0.78 0.59-1.03     | 1.04 0.89-1.82    |
| Northern territories | 0.38*** 0.26-0.56 | 1.45 0.59-3.55             | 0.62*** 0.43-0.89  | 0.64 0.14-1.17    |
| Education††     |                      |                            |                    |                   |
| High school or more | 1.00 - 1.00          | 1.00 -                      | 1.00 -             | 1.00 -            |
| No diploma but in school | 1.36*** 1.04-1.79 | 1.00 -                      | 1.00 -             | 1.00 -            |
| Less than high school | 0.95 0.77-1.18    | 1.29 0.84-1.99             | 1.10 0.90-1.33     |                   |
| Home needs major repair | 1.31*** 1.01-1.70 | 1.74 0.98-3.13             | 1.13 0.92-1.38     |                   |
| Year house built | <1961 1.16 0.87-1.56 | 1.34 0.76-2.36             | 1.07 0.86-1.33     |                   |
| 1961-1980       | 0.97 0.78-1.20       | 1.55* 1.00-2.40            | 0.88 0.73-1.07     |                   |
| >1980           | 1.00 - 1.00          | 1.00 -                      | 1.00 -             | 1.00 -            |
| Income ($ CAD)  |                      |                            |                    |                   |
| <20,000         | 1.20 0.90-1.60       | 0.63 0.35-1.14             | 1.19 0.96-1.49     |                   |
| 20,000 - <40,000| 1.21 0.93-1.57       | 0.88 0.49-1.58             | 0.87 0.71-1.08     |                   |
| 40,000 to 60,000| 0.88 0.66-1.18       | 1.25 0.71-2.18             | 1.03 0.83-1.27     |                   |
| >60,000         | 1.00 - 1.00          | 1.00 -                      | 1.00 -             | 1.00 -            |
| Recent health care visit | 1.01* 1.00-1.02 | 1.57 0.86-2.86             | 2.09*** 1.69-2.60  | 2.36*** 1.49-3.73 |
| % correct       | 65.3                 | 60.1                        | 89.1               | 76.8              |
| Pseudo r-square | 0.176                | 0.243                       | 0.168              | 0.088             |

OR = adjusted odds ratios; CI = confidence interval
*p<0.05; **p<0.01; ***p<0.001
†Refers to respondents who reported a diagnosis of asthma.
††For the Children model, education refers to education of caregiver - the reference category is high school or more.
1Model adjusted for chronic bronchitis and birth weight as well as variables where model results are displayed.
2Model adjusted for chronic bronchitis, birth weight and asthma attack in past year as well as for variables where model results are displayed.
3Model adjusted for BMI, smoking status, chronic bronchitis and emphysema as well as for variables where model results are displayed.
regions, with the highest reported rates occurring in Ontario (79.3%), and the lowest in the Prairie provinces (73.5%). No significant differences in rates were seen between those living on- and off-reserve or in urban and rural areas. There were also no differences in rates of medication use within any of the SES variables examined. Rates were, however, significantly higher among those who had had a recent health care visit (78.6%) as compared to those who had not (55.2%).

Adjusted odds ratios and 95% confidence intervals for the regression analyses are presented in Table III. For Aboriginal children, the likelihood of being diagnosed with asthma was higher for males with each year that age increased, for those living in homes in need of major repairs and for those who have had a recent health care visit. The likelihood was also higher for those living off-reserve, while it was lower among those living in the province of British Columbia and the northern territories. The likelihood of reporting regular use of medications for asthma was lower for Inuit and other/mixed Aboriginal identity groups as well as for those living in rural areas, and it was higher for those living in older homes.

For adults (Table III), the likelihood of being diagnosed with asthma was higher for those with no high school diploma but still in school and for those who had had a recent health care visit. The likelihood was lower for males, younger respondents, those living on-reserve, those living in rural areas and those living in the northern territories. In the final model, it was found that the likelihood of Aboriginal adults taking asthma medication increased with each year of age and was higher among those reporting having had a recent health care visit.

**DISCUSSION**

The goal of this exploratory analysis was to examine asthma prevalence, exacerbations and management among Canada's Aboriginal populations, and its relationship to socio-economic and geographic factors. Before discussing the significance of the findings, a few limitations of the study must be addressed. First, the APS is a cross-sectional study, making it impossible to determine the directionality of relationships observed. Secondly, although the sample is large, it is not representative of the Canadian Aboriginal populations. Data are not available for communities that refused to participate in the 2001 Census, or for individuals that did not indicate in the Census that they were of Aboriginal ancestry/identity, had Treaty Status or band membership. Related to this is the problem of systematic exclusion of some of the smaller and more remote First Nations communities, many of which could be expected to have very different socio-economic and health care circumstances. Thus, the APS should not be considered a representative sample. Thirdly, due to reasons of confidentiality and anonymity, specific bands or communities could not be identified. As a result, only crude geographic measures have been employed. Further, as is common with national health survey data, the data collected are based on self-reports and are therefore dependent upon the ability of respondents to recall information (39) as well as on the accuracy of the initial diagnosis. It has been found, for example, that community physicians commonly do not diagnose asthma according to recommended guidelines (e.g., spirometry testing) leading to misdiagnoses (40). Such misdiagnoses could be more common in the context of
remote on-reserve or hamlet nursing stations. Finally, health is only 1 small component of the Aboriginal People's Survey and, as a result, data for several key variables including asthma medication use among adults and measures of second-hand smoke exposure are lacking. It is recommended that future iterations of the survey attempt to address some of these shortcomings.

The results of the analysis show that a total of 12% of Aboriginal children were reported to have been diagnosed with asthma, a finding just below the 13.4% reported for Canadian children and youth overall as found in the nationally representative National Longitudinal Survey of Children and Youth conducted in the same year (NLSCY) (see 41). For Aboriginal adults, 11.2% reported having been diagnosed with asthma as compared to 8.4% in the Canadian population as a whole, based on findings from the 2003 Canadian Community Health Survey (25,42). While caution is required in making direct comparisons between these surveys, they suggest that either asthma prevalence among Aboriginal populations may be slightly lower, or that there is poorer case detection in Aboriginal populations. Asthma and other chronic conditions are measured in the APS by a question that asks respondents to identify physician-diagnosed conditions. Those in rural and northern locations are known to experience limited physician and other health care access (43,44), thus poor case detection could be expected. It was found here that those who live on reserves, in rural areas and in the northern territories were all significantly less likely to have had a recent health care visit as compared to their more urban or southern counterparts (data not shown).

With respect to geographic determinants of asthma, we note some interesting findings. Our results demonstrate that place of residence is a significant predictor of asthma diagnoses among both children and adults. Specifically, those living on reserves, in the northern territories and in rural areas (adults only) have a lower likelihood of being diagnosed with asthma. These findings may reflect the environmental characteristics of these areas. Outdoor air pollution, which has been found to be associated with various negative asthma outcomes (45,46), is typically less of a problem in Canada's northern and rural areas. Further, higher rates of microbial exposure associated with, for example, growing up around animals or on farms, has been shown to influence the development of the immune system and potentially reduce the likelihood of developing allergies and asthma - this is known as the hygiene hypothesis (47). Alternatively, the findings also point to poor case detection associated with lower levels of health care access, a long-recognized problem faced by Aboriginal populations living in northern and rural areas (9,43,44). Where individuals with less severe cases of asthma might seek health care if it were readily available, cases might otherwise go undiagnosed. Evidence of poor case detection comes from Gao et al. (18), who compared Aboriginal and non-Aboriginal children in northern Canada who had not been diagnosed with asthma and found that wheezing, a symptom associated with asthma, was significantly higher in Aboriginal children. Related to this is the finding that Inuit and rural children diagnosed with asthma were significantly less likely to report regular use of asthma medications. This finding suggests that either Inuit and rural children have less
access to appropriate health care and doctor-patient communication, a factor which has been shown to lead to lower levels of medication adherence in other contexts (48), or that these populations simply have less severe disease requiring less pharmacological treatment. Given the health care access issues faced by many remote Aboriginal communities (9,43,44) and existing evidence that links low SES to low medication adherence (29), the former explanation for low regular use of asthma medication in this context seems most appropriate.

Socio-economic factors were found to be significantly associated with asthma outcomes in the descriptive analysis. In the case of children, it was found that there were higher reported rates of physician-diagnosed asthma among those living in homes in need of major repairs, in the lowest income groups and in single-parent households. Similar relationships have been identified in other populations, often being explained by factors including obesity (49,50), second-hand smoke exposure (30) and chronic maternal stress (51), issues more commonly facing low SES groups (52). Nevertheless, in the multivariate models here, the relationships between asthma diagnosis and SES did not typically hold. While this may indicate that low SES does not, for example, equate with greater risk of asthma, it may alternatively suggest that the SES measures used in this study are not sufficiently sensitive.

The results revealed that demographic characteristics play an important role in determining asthma diagnoses. Among Aboriginal children, increased age and male gender were both found to be independently associated with increased risk of reporting physician-diagnosed asthma, whereas among Aboriginal adults these relationships were reversed. These findings are consistent with studies of other non-Aboriginal populations in Canada as well as in Australia and other international contexts (20,41,53-56). The positive relationship between age and asthma prevalence in children may be explained simply by the fact that older children have had more time to develop the disease. Explanations for gender differences are more complex, although higher prevalence of adult onset asthma has been explained by such things as underlying hormonal (55,56) and psychosocial factors (54).

Findings from this research suggest that asthma is more of a health issue among Aboriginal populations than has previously been thought (1), and that there may be a general pattern of under-diagnosis due to poor access to health care and health professionals. This implies a need for better access to health care services, particularly in northern locations and remote rural reserves. This study demonstrates a clear need for research that defines asthma prevalence through indicators that are not dependent on past health care access. Further research employing more refined socio-economic and geographic measures is also recommended.

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