ORIGINAL ARTICLE

The burden of asthma among South Asian and Chinese populations residing in Ontario

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BACKGROUND: The South Asian and Chinese populations represent a significant portion of the population of Ontario; however, little is known about the burden of respiratory diseases in these populations.
OBJECTIVE: To investigate the prevalence of asthma and the associated health care burden among South Asian and Chinese populations living in Ontario.
METHODS: Using administrative health data for Ontario, the authors identified individuals of South Asian and Chinese descent using a validated surname algorithm and compared the prevalence of asthma in these groups with the general population using an established asthma case definition for the period 2002 to 2010. Also compared were the rates of asthma-specific emergency department visits and hospitalizations among the ethnic groups.
RESULTS: In 2010, the prevalence of asthma in South Asians residing in Ontario was similar to that of the general population (12.1% versus 12.4%), and was increasing at a faster rate than in the general population (0.51%/year versus 0.34%/year). Compared with the general population, the South Asian population had fewer emergency department visits for asthma, whereas the asthma-related hospitalization rate was greatest among the South Asian population (0.45 per 100 person-years). The Chinese population had the lowest asthma prevalence and associated health care use.
CONCLUSION: The burden of asthma among South Asians in Ontario is increasing and warrants further investigation to determine the reasons for this rise.

Key Words: *Asthma; Epidemiology; Ethnicity*

Le fardeau de l'asthme dans les populations sud-asiatique et chinoise de l'Ontario

HISTORIQUE : Les populations sud-asiatique et chinoise représentent une proportion importante de la population ontarienne, mais on ne sait pas grand-chose du fardeau des maladies respiratoires au sein de ces populations.
OBJECTIF : Examiner la prévalence d'asthme et le fardeau qui s'y associe dans le système de santé auprès des populations sud-asiatique et chinoise de l'Ontario.
MÉTHODOLOGIE : Les auteurs ont extrait les personnes d'origine sud-africaine et chinoise des données administratives sur la santé de l'Ontario à l'aide d'un algorithme validé de noms. Ils ont ensuite comparé la prévalence d'asthme de ces groupes avec celle de la population générale au moyen d'une définition établie de cas d'asthme pour 2002 à 2010. Ils ont également comparé le taux de consultations à l'urgence et d'hospitalisations pour l'asthme dans les groupes ethniques.
RÉSULTATS : En 2010, la prévalence d'asthme chez les Sud-Asiatiques de l'Ontario était similaire à celle de la population générale (12,1 % par rapport à 12,4 %), mais augmentait à un taux plus rapide que dans la population générale (0,51 % par rapport à 0,34 % par année). Comparativement à la population générale, la population sud-asiatique consultait moins souvent à l'urgence pour l'asthme, mais son taux d'hospitalisation était le plus élevé (0,45 cas sur 100 personnes-année). La population chinoise présentait la prévalence d'asthme et d'utilisation de soins de santé connexe la plus faible.
CONCLUSION : Le fardeau de l'asthme chez les Sud-Asiatiques de l'Ontario augmente, ce qui justifie d'autres recherches pour en déterminer les raisons.

The South Asian and Chinese populations are the largest (1.26 million) and second largest (1.22 million) nonwhite ethnic groups in Canada, and each represent approximately 4% of the population (1). In Ontario, the South Asian and Chinese populations comprise 6.6% and 4.8% of the population, respectively (1). 'South Asian' refers to individuals who originate from the Indian subcontinent including India, Pakistan, Bangladesh and Sri Lanka, whereas the Chinese population includes individuals who originate from China including Hong Kong and Taiwan. It is well established that South Asians living in Canada, and elsewhere in the world, have higher rates of cardiovascular disease (2-4) and diabetes (5) compared with Caucasians of European origin. The incidence of noncommunicable diseases is also growing in the Chinese population; for example, the incidence of diabetes increased 15-fold between 1996 and 2005 among Canadians of Chinese origins (6). The evidence suggests that this disproportionate burden among ethnic groups is the result of complex interactions between genetic risk and lifestyle factors (7-9).

Given the ethnic disparities in cardiovascular outcomes, research investigating similar disparities in respiratory outcomes is also increasing. This increased investigation is warranted given that respiratory diseases follow closely behind cardiovascular disease in terms of the global disease burden (10). In the few studies that have examined ethnic differences in asthma in Western countries, South Asians were reported to have lower rates of asthma compared with other ethnic groups and Caucasians of European origin, but greater asthma-related health care utilization (11,12). A third study involving British children found that children of Bangladeshi origin living in the United Kingdom (UK) had similar rates of asthma compared with Caucasian children of European origin after adjustment for confounders such as socioeconomic status, migration status, language spoken at home, smoking exposure and breastfeeding (13). The prevalence of asthma was found to be lower in Chinese populations compared with non-Chinese in the United States (14,15), Singapore (16) and Australia (17), with nearly all studies demonstrating that increased asthma prevalence was associated with length of residence in the Western country (14,15,18). Two studies comparing Canadian data from the International Study of Asthma and Allergies in Childhood (ISAAC) with ISAAC data collected in South Asia (19) and China (18) found the prevalence of asthma was higher in South Asian and Chinese children living in Canada compared with those living on the Indian subcontinent and China, respectively.

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TABLE 1
Characteristics of the study population with asthma

Characteristic	General population	South Asian	Chinese	Total
With asthma	1,330,835 (9.7)	38,406 (8.0)	36,527 (4.6)	1,405,768 (9.4)
Female sex	712,986 (53.6)	17,609 (45.8)	17,344 (47.5)	747,939 (53.2)
Urban	1,146,284 (86)	37,410 (97.4)	35,739 (97.8)	1,219,433 (86.7)
ON-MARG deprivation quintile (Q)				
Missing	11,575 (0.9)	156 (0.4)	163 (0.4)	11,894 (0.8)
Q1	300,325 (22.6)	7054 (18.4)	9137 (25.0)	316,516 (22.5)
Q2	286,682 (21.5)	8337 (21.7)	8736 (23.9)	303,755 (21.6)
Q3	255,310 (19.2)	9447 (24.6)	7458 (20.4)	272,215 (19.4)
Q4	214,442 (16.1)	7167 (18.7)	5911 (16.2)	227,520 (16.2)
Q5	202,497 (15.2)	5472 (14.2)	4250 (11.6)	212,219 (15.1)

Data presented as n (%). ON-MARG Ontario Marginalization Index

Because the South Asian and Chinese populations represent a significant portion of Ontario's population, and the prevalence of asthma in Canada is one of the highest in the world (20), we aimed to investigate the asthma prevalence and health care burden among the South Asian and Chinese populations living in Ontario.

METHODS

Data sources

Ontario has a universal, single-payer health care system that covers all physician and hospital services. All health care encounters are captured through several population-based databases and merged using anonymized data linkage at the Institute of Clinical Evaluative Sciences (Toronto, Ontario). Physician visits related to asthma were obtained from the Ontario Health Insurance Plan database, which contains information on all fee-for-service billings for physician services rendered. The Canadian Institute for Health Information Discharge Abstract database was used to identify acute-care hospitalizations in which asthma was either the admitting or main diagnosis recorded. Emergency department visits for asthma were captured using the National Ambulatory Care Reporting System. Demographic characteristics were obtained from the Ontario Registered Persons database, which includes information regarding surname, sex, birth date, residential postal code and, if applicable, date of death.

Asthma case definition

The Ontario Asthma Surveillance Information System (OASIS) algorithm is a population-based surveillance system that identifies individuals with asthma based on either two asthma outpatient claims in two consecutive years or at least one hospitalization for asthma (*International Classification of Diseases, 10th Revison* codes J45 and J46) (21-23). The asthma algorithm has previously been validated by chart abstraction and was found to be 89% sensitive and 72% specific in children (<18 years of age) and 84% sensitive and 77% specific in adults ≥18 years of age (24,25).

Classification of ethnic group

The Registered Persons database was used to identify individuals of South Asian and Chinese descent using a previously published surname algorithm (26). The South Asian algorithm has a positive predictive value of 89% and the Chinese surname algorithm has a positive predictive value of 91%. The remaining population was categorized as the 'general population'.

Socioeconomic status

As a measure of socioeconomic status, the Ontario Marginalization Index ON-MARG (27), a census- and geographically based index to understand inequalities in measures of health and social well being was used. The index was calculated based on small, relatively stable populations (2500 to 8000 people) living under similar conditions. The index has four domains and, in the present study, the authors focused on material deprivation (no high school education, lone-parent families, government transfers, unemployment, low income and homes needing major repairs) split into quintiles: the lowest quintile (Q1) represents the least marginalized groups and Q5 represents the most marginalized groups.

Statistical analysis

Using the OASIS algorithm, the authors identified the number of individuals with asthma in each year between 2002 and 2010. The asthma population was divided into three groups according to the surname algorithm (general population, South Asian population, Chinese population). Crude age- and sex-adjusted asthma prevalence was calculated for each of the groups. Linear regression analysis was used to calculate the rate of change in asthma prevalence over the period from 2002 to 2010. Because both the South Asian and Chinese populations in Ontario are concentrated in urban areas, the analyses were repeated using data from only the urban population (communities with >10,000 inhabitants). Trends across the ON-MARG deprivation index were assessed using a nonparametric test for trends.

In addition, the authors identified a cohort of individuals with asthma in 2002 and summarized their health care utilization until 2010. The rate (number of events/years of follow-up) of health care utilization (primary care visits, emergency department [ED] visits and hospitalizations) was then calculated for this period. Times to first hospitalization and first ED visits were evaluated using Cox proportional hazards models adjusted for age, sex and time. Individuals were censored at the end of the observation period or at the date of death, if applicable.

The present study was approved by the Research Ethics Board at the Hospital for Sick Children (REB#000035303), Toronto, Ontario.

RESULTS

Asthma prevalence

In 2002, the prevalence of asthma in the entire population of Ontario was 9.4% (Table 1). Stratified according to ethnic group, 9.7% of the general population, 8.0% of the South Asian population and 4.6% of the Chinese population were classified as having asthma (Table 1). There was no difference observed between the crude and age- and sex-adjusted asthma prevalence. The asthma prevalence was similar among males and females in all three groups. In 2002, the prevalence of asthma was very similar in the urban population compared with the entire population (eg, 10.0% versus 9.7% general population, 8.1% versus 8.0% South Asian and 4.7% versus 4.6% Chinese). Stratified according to age group, the prevalence of asthma was higher in people ≥20 years of age in the general population, whereas the asthma prevalence was highest in children for the South Asian and Chinese populations (Figure 1).

By 2010, the prevalence of asthma in the South Asian population increased to 12.1%, at an annual rate of 0.51% per year. This rate was significantly steeper than in the general population (0.34% per year to 12.4% in 2010) and among the Chinese population (annual rate of

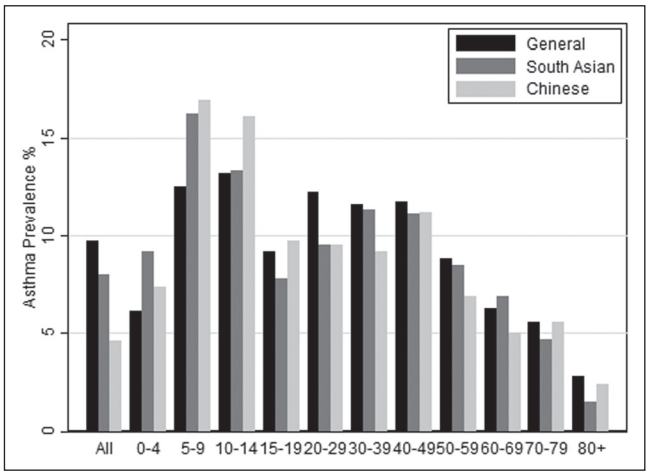

Figure 1) *Asthma prevalence (2002) according to ethnic group and age*

0.27% per year to 6.8% in 2010). In 2010, the prevalence of asthma in the South Asian population (12.1%) was very similar to that in the general population (12.4%).

Health care utilization

A cohort of individuals with asthma was identified in 2002 and health care utilization in the subsequent eight years in each ethnic group was compared using three outcomes: primary care visits, hospitalizations and ED visits. The rate of primary care visits, specifically for asthma in the South Asian population, was 7.2 per person-year and was higher than that of the general (6.1 per person-year) and Chinese (3.7 per person-year) populations. Over the eight-year observation period, the rate of hospitalizations per 100 person-years was greater in the South Asian group (Figure 2A). After adjusting for age, sex and time, South Asians had a greater risk for hospitalization for asthma (HR 1.11 [95% CI 1.04 to 1.18]) than the general population. The Chinese population had a lower risk of hospitalizations for asthma (HR 0.43 [95% CI 0.39 to 0.47]). Among the South Asian population, hospitalization rates were greatest in adults >50 years of age compared with all other age groups (Figure 2A).

During the same period, the rate of ED visits was greatest in the general population (Figure 2B). In contrast to the risk for hospitalizations, both Chinese (HR 0.34 [95% CI 0.33 to 0.36]) and South Asian (HR 0.72 [95% CI 0.70 to 0.75]) patients were less likely to have an ED visit compared with the general population. When stratified according to age group, South Asians >50 years of age had the highest rate of ED visits (Figure 2B).

These results are in contrast to health services utilization rates for all causes: individuals in the general population had the highest rates of hospitalizations and ED visits, whereas primary care visit rates were slightly higher for the South Asian population (8.0% in the South Asian population, 6.9% in the general population and 7.2% in the Chinese population).

Socioeconomic status

To better understand inequalities in asthma outcomes, asthma prevalence and health care utilization according to the ON-MARG deprivation index were compared (Table 2). In the general population, asthma prevalence was greatest in the least-deprived population, whereas the most deprived group had the greatest number of hospitalizations, ED visits and primary care visits (P=0.046 [nonparametric test for trend]). In the South Asian population, there was no socioeconomic gradient observed for asthma prevalence, but a trend toward greater health care utilization among the most deprived populations (Table 2). Conversely, in the Chinese population, there was a trend toward greater asthma prevalence in the least-deprived population but no health services trends were observed.

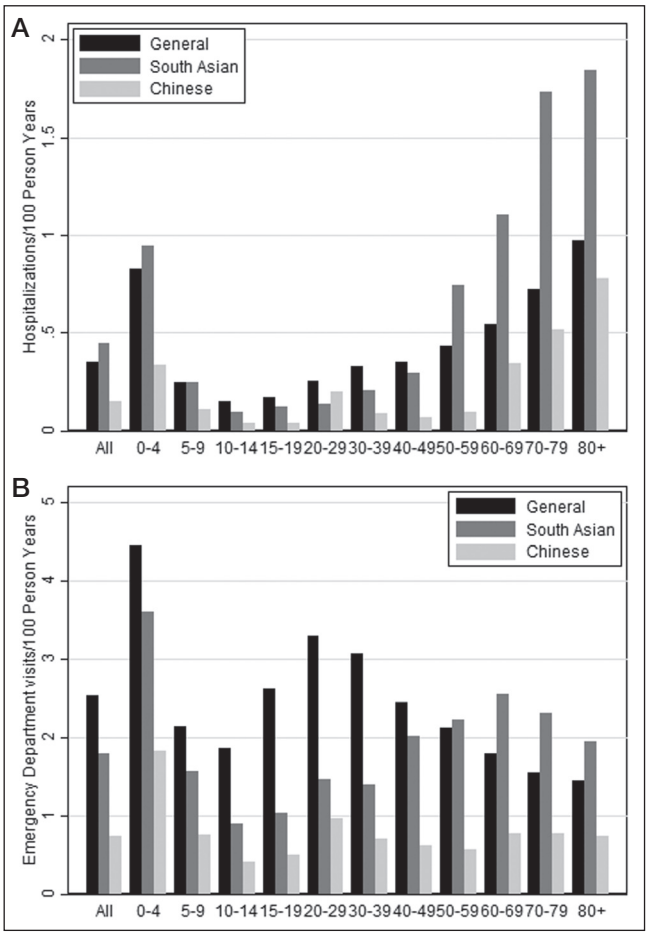

Figure 2) A *Hospitalization rates per 100 person-years*. **B** *Emergency department visits per 100 person-years stratified according to population and age group*

DISCUSSION

In the present study, we observed important ethnic differences in trends in the prevalence of asthma and its associated health care burden in Ontario. Specifically, the prevalence of asthma in South Asians residing in Ontario is increasing at a much faster rate than in other ethnic groups. The South Asian population also had greater asthma-specific health care utilization, particularly greater rates of hospitalizations. In contrast, the prevalence of asthma and health care utilization was lowest in the Chinese population. We also found that the burden of asthma disproportionately affected these populations across levels of deprivation but in different directions according to ethnicity.

Our findings concering the South Asian population are consistent with studies conducted in the UK (11,13). In addition, our data suggest the higher hospitalization rates for asthma are not necessarily explained by health-seeking behaviour because all-cause hospitalizations were much lower in the South Asian group. Whether patterns in physician practices explain some of these observations is worth investigating in the future. The greater disease severity in the South Asian population may be explained by cultural attitudes toward asthma treatment (28). In the UK, two separate studies have shown that South Asians with asthma are less likely to adhere to medications (29,30). In addition, the inequalities in asthma observed in the present study contribute to the hypothesis that new immigrants may have barriers to accessing health care. For a disease such as asthma, inadequate access to primary care physicians may lead to poor symptom control and, therefore, more ED visits and hospitalizations. Poorer living conditions in more deprived populations may also contribute to asthma through greater exposures to risk factors such as dust, mould

TABLE 2
Asthma prevalence and health care utilization stratified according to deprivation index quintile (Q)

	Deprivation index*					
	Q1	Q2	Q3	Q4	Q5	P (for trend)†
Asthma prevalence, %						
General population	22.6	21.5	19.2	16.1	15.2	0.046
South Asian	18.4	21.7	24.6	18.7	14.2	0.549
Chinese	25.0	23.9	20.4	16.2	11.6	0.046
Hospitalization rate/100 person-years						
General population	0.27	0.30	0.34	0.40	0.47	0.046
South Asian	0.36	0.43	0.43	0.45	0.49	0.051
Chinese	0.17	0.11	0.10	0.18	0.17	0.538
Emergency visit rate/100 person-years						
General population	1.75	2.16	2.53	3.12	3.60	0.046
South Asian	1.44	1.63	1.72	1.86	2.53	0.046
Chinese	0.81	0.63	0.60	0.84	0.91	0.230
Primary care visit rate/person-years						
General population	0.55	0.56	0.58	0.59	0.67	0.046
South Asian	0.69	0.77	0.76	0.72	0.77	0.356
Chinese	0.37	0.36	0.31	0.31	0.40	0.918

**Q1 is the least deprived population whereas Q5 is the most deprived; †Nonparametric test for trend*

and dampness. In the context of this evidence, further investigation into the social and ethnographic reasons for poor disease management and greater health care utilization in this population is warranted.

The lower asthma prevalence and health services utilization observed in the Chinese population living in Ontario are also consistent with previous literature (14-18). The lower asthma prevalence in this population may, in part, be explained by population differences in gene frequencies (31). A recent study be Leung et al (31) found discrepancies in the frequencies of single nucleotide polymorphisms and haplotype blocks for asthma genes comparing Chinese with white European, African and Puerto Rican populations. (31). While this may partially explain the lower asthma rates in China compared with Chinese migrant populations, differences in environmental exposures and treatments are likely more influential.

In both nonwhite ethnic groups, previous studies have shown that length of residence in a Western country and acculturation play an important role in the development of asthma (12,13,18,32). South Asian woman born in the UK, or who migrated before five years of age had similar asthma prevalence to Caucasians of European decent, whereas those who migrated after five years of age had lower asthma prevalence. Similarly, studies conducted in the United States, Canada and Australia have all consistently shown that Chinese children born in the respective Western country, or who resided there for >10 years had greater risk for developing asthma than children who were born in China. In fact, length of residence in a Western culture appears to be an important mediator for the development of many chronic conditions (13,33-35). Migration may influence the development of asthma both through environmental exposures (eg, microbial exposure at critical periods of growth and development [36]) as well as acculturation and adaptation of behaviours (eg, smoking [34]). In Ontario, however, the rates of smoking in both the South Asian and Chinese populations are much lower than in the general population (5). In the present study, we were not able to evaluate length of time in Canada or generational status using the available data. Nonetheless, the ethnic differences, rising prevalence rate and inequalities observed further support the concept that asthma is caused by complex gene-environment interactions.

Strengths and limitations

One of the advantages of the present study was its use of a large population-based administrative health database. The classification of patients according to ethnic group and whether they have asthma was based on previously developed and validated algorithms, both of which have their recognized limitations. The OASIS cohort is a comprehensive and validated registry of asthma cases in Ontario; however, it may be prone to ethnic-specific diagnosis bias. For example, asthma is difficult to diagnosis in young children, and it is possible that wheezing symptoms in early childhood have been misclassified as asthma. This may be of particular relevance for our observations if small airways disease misclassification occurs disproportionally among the three groups. At the other end of the age spectrum, our estimates of health care utilization may be either over- or underestimated because we only identified asthm-specific primary care visits, which may be misclassified coronary heart disease events. In addition, there is considerable overlap in the symptoms for asthma and chronic obstructive pulmonary disease; therefore, misclassification could have occurred in both directions.

We did not investigate whether there were ethnic differences in specific risk factors, or whether population trends observed in the general population (ie, sex differences in asthma prevalence [37,38]) exist in the South Asian or Chinese populations. Additional studies that collect detailed information regarding risk factors are needed to further clarify the observed difference in asthma prevalence and health care utilization.

The surname algorithm was based on common surnames that were specific to South Asians to maximize the positive predictive value and, thus, excluded surnames that were in common with other ethnic groups (such as Arab, Persian and Portuguese populations who may share common surnames through religious or cultural ties). In addition, the algorithm could have misclassified people of mixed ethnicity or those who changed surnames after marriage. Importantly, our classification of 'South Asian' was based on surname, and does not capture important differences in diet, culture, and lifestyle among different South Asian populations and religions. Both the South Asian and Chinese populations are concentrated in the metropolitan regions of Toronto (1), and factors specific to Toronto (eg, air pollution, smoking rates) could have influenced the observed rates. While the population included in our study represents a large proportion of Canadian South Asians, our estimates of disease burden may not be generalizable to other parts of Canada or elsewhere in the world.

CONCLUSION

We observed important ethnic differences in the prevalence of asthma in Ontario. In particular, the burden of asthma among the South Asian population in Ontario is increasing and warrants further investigation to determine the reasons for this rise.

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AUTHOR CONTRIBUTIONS: Sanja Stanojevic designed the study, conducted analysis and drafted the manuscript. Baiju Shah designed the study, supervised data analysis and revised the manuscript. Sonia S Anand designed the study and revised the manuscript. Malcolm R Sears designed the study and revised the manuscript. Jiandong Su conducted the analysis and revised the manuscript. Padmaja Subbarao designed the study and revised the manuscript.

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