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ORIGINAL RESEARCH

Rural and urban disparities in the care of Canadian patients with inflammatory bowel disease: a population-based study

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Background and aims: Canada's large geographic area and low population density pose challenges in access to specialized health care for remote and rural residents. We compared health services use, surgical rate, and specialist gastroenterologist care in rural and urban inflammatory bowel disease (IBD) patients in Canada.

Methods: We used validated algorithms that were applied to population-based health administrative data to identify all people living with the following three Canadian provinces: Alberta, Manitoba, and Ontario (ON). We compared rural residents with urban residents for time to diagnosis, hospitalizations, outpatient visits, emergency department (ED) use, surgical rate, and gastroenterologist care. Multivariable regression compared the outcomes in rural/urban patients, controlling for confounders. Provincial results were meta-analyzed using random-effects models to produce overall estimates.

Results: A total of 36,656 urban and 5,223 rural residents with incident IBD were included. Outpatient physician visit rate was similar in rural and urban patients. IBD-specific and IBD-related hospitalization rates were higher in rural patients (incidence rate ratio [IRR] 1.17, 95% CI 1.02–1.34, and IRR 1.27, 95% CI 1.04–1.56, respectively). The rate of ED visits in ON were similarly elevated for rural patients (IRR 1.53, 95% CI 1.42–1.65, and IRR 1.33, 95% CI 1.25–1.40). There were no differences in surgical rates or prediagnosis lag time between rural and urban patients. Rural patients had fewer IBD-specific gastroenterologist visits (IRR 0.79, 95% CI 0.73–0.84) and a smaller proportion of their IBD-specific care was provided by gastroenterologists (28.3% vs 55.2%, $P<0.0001$). This was less pronounced in children <10 years at diagnosis (59.3% vs 65.0%, $P<0.0001$), and the gap was widest in patients >65 years (33.0% vs 59.2%, $P<0.0001$).

Conclusion: There were lower rates of gastroenterologist physician visits, more hospitalizations, and greater rates of ED visits in rural IBD patients. These disparities in health services use result in costlier care for rural patients. Innovative methods of delivering gastroenterology care to rural IBD patients (such as telehealth, online support, and remote clinics) should be explored, especially for communities lacking easy access to gastroenterologists.

Keywords: inflammatory bowel disease, epidemiology, health services research, access to care, health administrative data, routinely collected health data

Introduction

Canada has a universal health care system, in which all legal residents receive essential medical services paid by provincial governments, including outpatient, emergency, and inpatient services. A founding principle of the Canada Health Act is universality, entitling all Canadians to the same level and quality of health care.[1] Nevertheless, disparities in access to care, health services utilization, and outcomes exist. For example, children

with inflammatory bowel disease (IBD) living in Ontario (ON) were more likely to undergo intestinal resection or colectomy if they lived in lower income households[2] and adults with IBD living in ON with public drug insurance plans were less likely to receive biologics than those with private drug insurance.[3] A population-based study from ON demonstrated that the only statistically significant predictor of need for repeated intestinal resections for Crohn's disease (CD) was rural residence at the time of diagnosis.[4] Describing variation in care in order to identify health disparities is a crucial step toward improving the quality of care to patients and to moving health care toward the principle of universality.[5–7]

Canada is the second largest country in the world (9.985 million km^2) and has one of the lowest population densities (4 people/km).[28] As such, health care providers and policy makers are tasked with providing universal access to health services and equal quality of care to people spread over a very large geographic region. This has led to concern that people living in remote regions may receive worse care than those in large, urban centers.[9] Moreover, persons with complex chronic diseases require access to specialized care generally only available in urban areas. Poor access to specialized care has been associated with suboptimal outcomes in various chronic disease states, including those people with IBD.[10]

IBD and its subtypes CD and ulcerative colitis (UC) are chronic inflammatory diseases of the gastrointestinal tract. IBD can present at any age, but the peak incidence is in the second or third decade of life. As a result, patients with IBD require health care throughout their lives. In addition, Canada is among the highest prevalence and incidence rates of IBD in the world,[11–13] and the incidence is rising rapidly in young children,[14] suggesting an increasing burden on the health system in the future.[15,16] In this study, we used population-based health administrative data to examine disparities in the use of health services and access to care in three Canadian provinces (Alberta [AB], Manitoba [MB], and ON), comprising 53.9% (19.5 million people) of the Canadian population.[17] We assessed whether disparities in care and outcomes (including surgery) existed for rural and urban residences.

Methods
Study design, setting, and participants
This study was approved by research ethics boards of the University of Calgary, University of Manitoba, and Children's Hospital of Eastern Ontario. We conducted a population-based, retrospective cohort study using health administrative data from AB, MB, and ON, Canada, to compare 1)

health services utilization (ie, outpatient physician visits, hospitalizations, and emergency department [ED] visits), 2) risk of surgery, 3) time to diagnosis, and 4) use of specialist gastroenterologists in people with IBD living in rural or urban residences. Health administrative data in Canada contain all residents of the province in question who qualified for universal government health care insurance (>99% of the population). We included all residents who were diagnosed with IBD in fiscal year 1999–2010 (April 1, 1999, to March 31, 2011) (for MB and ON) or 1999–2008 (for AB). We excluded residents without a valid postal code in the year of diagnosis or the year prior to diagnosis. We also excluded residents for whom rural/urban classification of the residence could not be ascertained from postal code. All data are anonymized using encrypted health card numbers to produce a unique identification number for each resident of a province. Individuals are then linked deterministically across health administrative and demographic databases using this unique identifier.

Definition of rural/urban status
Residents were assigned a category of rural/urban status based on their postal code in the year of diagnosis. Different definitions have been used in Canada to classify the population according to rural/urban residence.[18] We chose a definition that was validated to reflect the proportion of people in rural/urban residences in Canada according to Statistics Canada.[19] This definition assigns urban status based on residence in a metropolitan area or in a 'Census Agglomeration Influenced Zone' (MIZ), which incorporates the level of influence that metropolitan areas exert upon nonmetropolitan areas (ie, areas that are outside of cities, but where a substantial proportion of the population commutes to the city for work, are considered urban). Those individuals not residing in a metropolitan area or MIZ were considered to be rural (rural/urban status was considered dichotomous).

Outcomes of interest
Health services utilization
We determined IBD-specific and IBD-related outpatient physician, hospitalization, and ED visit rates. ED utilization data were only available for ON. We evaluated whether health services utilization after diagnosis was associated with rural/urban residence at diagnosis. IBD-specific visits were those associated with ICD codes for CD and UC (ICD-9 555.x/556.x or ICD-10 K50.x/K51.x). IBD-related contacts were those associated with IBD-specific diagnoses or visits with diagnoses of signs and symptoms of IBD (Table S1).

These code lists have been used in previous studies.[20,21] Only hospitalizations in which the CD or UC diagnosis was the reason for, or contributed to, the hospitalization were included.

Surgery

We determined surgical outcomes stratified by IBD subtype, including intestinal resection or colectomy for CD and colectomy for UC patients. In the case of CD patients, we also evaluated the risk of undergoing repeated intestinal resection surgery if one surgery was already performed. We determined whether surgical risk following diagnosis was associated with rural/urban residence at diagnosis. Codes used to identify IBD surgeries from within Canadian hospital data were previously validated (Table S2).[22,23]

Prediagnosis lag time

For prediagnosis contacts, we determined the time (in days) from the first outpatient or inpatient visit associated with a code determined to be likely related to subsequent diagnosis of IBD and the date of diagnosis (assigned as the first outpatient or inpatient visit with an ICD diagnostic code for CD or UC). Time to diagnosis was measured using the health services diagnostic codes in the 5 years prior to diagnosis by determining the time from first IBD-associated diagnosis code to the date of first outpatient or inpatient IBD-specific diagnostic code. Codes used in the prediagnosis period (Supplementary materials) were determined by surveys of expert adult and pediatric gastroenterologists that were used in previous studies.[24]

Specialist gastroenterologist care

Specialist physician visits were classified based on outpatient billing patterns and certification status. We classified visits as those conducted by gastroenterologists or nongastroenterologists (including surgeons, internists, pediatricians, family physicians, and other specialists). Not all physicians functioning as gastroenterologists were certified as such. For example, some internists were trained and worked as gastroenterologists but completed their training before specialist gastroenterology examination and certification were available. Therefore, internists who performed >50 annual colonoscopies and pediatricians who performed >5 annual colonoscopies were classified as gastroenterologists.[20]

In order to determine whether the use of specialist physician care mediated the association between rural/urban residence and disparities in health services utilization, we conducted additional analyses using ON data only. We determined the association between rural/urban residence and risk or rates of health services utilization or surgery following diagnosis while controlling for the following three separate models: 1) specialty of the physician providing most IBD-specific care (gastroenterologist or nongastroenterologist; dichotomous); 2) the proportion of IBD-specific care provided by a gastroenterologist (continuous proportion); and 3) ever having seen a gastroenterologist for IBD-specific care (yes or no; dichotomous).

Data sources

We used health administrative data from the following three Canadian provinces: AB (1999–2008), MB (1999–2010), and ON (1999–2010). We used cohorts of all IBD patients living in each province identified by using validated algorithms of health care contacts to identify patients with IBD and to classify their disease as CD, UC, or IBD type unclassifiable. IBD type unclassifiable represent patients for whom the algorithms based on health services patterns and codes could not effectively distinguish whether they had CD or UC. This group was called unclassifiable in AB and ON only, whereas all patients in MB were considered either CD or UC. Validated washout periods were used to distinguish incident cases from prevalent cases. These cohorts included the Alberta IBD Surveillance Cohort,[25] the University of Manitoba IBD Epidemiology Database,[26] and the Ontario Crohn's and Colitis Cohort.[27,28] The cohorts used algorithms validated in their respective province to identify and classify patients with IBD. Table S3 includes information on each cohort, the accuracy of the algorithms used, and information on the source, database, and study populations. This table also includes information on health administrative data used to identify subjects and derive their socio-demographic characteristics. In all provinces, the entire IBD population was available to investigators for analysis.

Postal codes were taken from Statistics Canada's Postal Code Conversion File (PCCF).[29] Information on hospitalizations and surgeries was derived from reports to the Canadian Institute for Health Information (CIHI), with diagnostic codes 92%–99% accurate.[30] Surgical codes were validated in this database for patients with UC[22,31] and CD.[23] Outpatient physician visit data were obtained from physician billing information from Alberta Health, Manitoba Health, and Ontario Health Insurance Plan (OHIP) data. ED utilization data were derived from OHIP (available only for ON). To control the confounding by socioeconomic status, we used the mean neighborhood income quintile derived from postal codes using the PCCF Plus.[32]

Specialist physician visits were classified using the classification provided by Alberta Health data, Manitoba Health data, and the Institute for Clinical Evaluative Sciences (ICES) Physician Database for Ontario.[33] We classified visits as those

conducted by gastroenterologists or nongastroenterologists (including surgeons, internists, pediatricians, family physicians, and other specialists).

Statistical analysis

Descriptive statistics is presented as mean (with SD) or median (with IQR). Multivariable regression models tested the association between rural/urban residence at diagnosis and outcomes (outpatient visit rates, hospitalization rates, risk of hospitalization, ED visit rates, risk of surgery, likelihood of multiple surgeries, prediagnosis time, and specialist care). All models included the binary rural/urban predictor along with predetermined a priori potential confounders of sex (male or female), age at diagnosis (continuous variable), and mean neighborhood income quintile (categorical variable), a validated proxy for individual-level socioeconomic status.[34]

Outpatient physician visits were modeled assuming a Poisson distribution, with the natural log of years of follow-up as the offset. Due to their low annual rates, hospitalizations and ED visits did not follow a Poisson distribution. Therefore, these were modeled using negative binomial regression. The risks of hospitalization, ED visit, and surgery were estimated using Cox proportional hazard models. The proportionality assumption was considered met when the rural/urban variable was determined not to be a time-dependent covariate even if other covariates violated the assumption.

A multivariable negative binomial regression model was used to test the association between rural/urban residence and specialist care; the latter was measured using the annual number of visits to a gastroenterologist and was determined using the negative binomial regression. The proportion of care provided by gastroenterologists (as compared to other specialties) was compared using a univariate Chi-squared analysis. The likelihood of ever having seen a gastroenterologist for IBD-related reasons in rural/urban patients was compared using the multivariable logistic regression analysis. Due a statistically significant interaction between age at diagnosis and rural/urban status in ON, all specialist care analyses were stratified by age group at diagnosis (overall, <10, 10–17.9, 18–39.9, 40–64.9, and ≥65 years). We did not report models with the interaction term included due to the difficulty reporting the strength of association between rural/urban status and outcome existed.

To test the association between rural/urban residence and the risk of IBD diagnostic delay, we used retrograde multivariable Cox proportional hazard models,[35–37] where date of diagnosis was the start and prediagnosis time to the first related visit was the time to event. The proportionality assumption was met based on the above method of testing.

To determine whether physician specialist care (gastroenterologist or not) mediated the association between rural/urban residence and health services use in ON, regression models (Poisson, Cox proportional hazard, or negative binomial) were repeated, controlling for 1) care provision; 2) rural/urban; 3) age at IBD diagnosis (0–9, 10–17, 18–39, 40–64, and ≥65 years); 4) sex (male or female); and 5) mean neighborhood income quintile. Care provision was defined in the following three ways in three separate models: 1) gastroenterologist or nongastroenterologist as the primary provider of ≥50% of IBD-specific care (dichotomous); 2) proportion of care provided by a gastroenterologist (continuous); and 3) ever having seen a gastroenterologist (dichotomous). For the proportion of IBD care provided by a gastroenterologist (continuous), we assigned each neighborhood (using three-digit postal code as the spatial unit) to a quintile of proportion of care provided by a gastroenterologist within each province. We then constructed a heat map to visualize whether higher proportion of care quintile was associated with urban areas.

In order to report overall associations across multiple provinces, we conducted a meta-analysis across provinces using random-effects models, which provide more conservative estimates than fixed-effect models. Meta-analysis of provincial data used stratified incidence rate ratio (IRR) for count data, OR for dichotomous data, and HR for time-to-event data. This has been demonstrated to be an effective method of combining rate data that accounts for heterogeneity.[38] When pooling the results of the descriptive statistics (median, mean) or regression models, each result was weighted by the inverse of its variance. Heterogeneity was tested using the I^2 statistic and Cochran Chi-squared test (Q test), which describe the percentage of total variation across incidence estimates due to heterogeneity rather than chance. Analyses were conducted using SAS Version 9.3 (SAS Institute Inc., Cary, NC, USA). Meta-analyses were conducted using Stata release 14 (Stata-Corp LP, College Station, TX, USA) and R version 3.4.2 (R Foundation for Statistical Computing, Vienna, Austria) using the "metafor" package.[39] All tests of statistical significance were conducted using a nominal α=0.05.

Results
Descriptive characteristics
Among all provinces, 41,879 patients with IBD were included in the study (5,223 from rural residences and 36,656 from urban residences). The descriptive characteristics of the cohort are noted in Table 1. IBD patients in MB were more likely to live in rural residences (24.4%), compared to AB (19.3%) and ON (9.7%) (*P*<0.0001). The IBD population was

Table 1 Descriptive characteristics of rural and urban patients with IBD

Characteristics	Alberta		Manitoba		Ontario		Overall		
	Rural (n=1,613)	Urban (n=6,715)	Rural (n=583)	Urban (n=1,803)	Rural (n=3,027)	Urban (n=28,138)	Rural (n=5,223)	Urban (n=36,656)	P-value[a]
Age at diagnosis (years), mean ± SD	42.8±18.8	40.3±18.8	42.8±18.7	40.6±19.2	45.1±18.7	39.8±18.8	44.1±18.8	39.9±18.8	<0.0001
Female sex, n (%)	823 (51.0)	3,525 (52.5)	302 (51.8)	281 (48.2)	1,585 (53.4)	14,482 (51.6)	2,710 (51.9)	18,288 (49.9)	0.49
Length of follow-up (years), mean ± SD	15.2±2.0	15.2±2.0	7.4±3.5	7.5±3.4	7.1±3.5	7.2±3.4	6.7±3.3	7.0±3.3	<0.0001
Diagnosis, n (%)									
CD	747 (46.3)	3,039 (45.3)	265 (45.5)	809 (44.9)	1,276 (42.2)	12,767 (45.4)	2,288 (43.8)	16,615 (45.3)	<0.0001
UC	524 (32.5)	2,443 (36.4)	318 (54.6)	994 (55.1)	1,561 (51.6)	13,788 (49.0)	2,403 (46.0)	17,225 (47.0)	
Unclassifiable	342 (21.2)	1,233 (18.4)	n/a[b]	n/a[b]	190 (6.3)	1,583 (5.6)	532 (10.2)	2,816 (7.7)	
Mean neighborhood income quintile, n (%)									
1 (lowest)	274 (17.1)	1,486 (22.1)	101 (17.4)	247 (13.8)	592 (19.6)	4,238 (15.1)	1,000 (18.4)	6,317 (17.1)	<0.0001
2	252 (15.6)	1,571 (23.4)	146 (25.1)	282 (15.8)	649 (21.4)	5,403 (19.2)	1,121 (20.6)	7,209 (19.5)	
3	415 (25.7)	1,275 (19.0)	143 (24.6)	366 (20.4)	602 (19.9)	5,754 (20.5)	1,260 (23.2)	7,328 (19.8)	
4	310 (19.2)	1,237 (18.4)	124 (21.3)	402 (22.5)	574 (18.9)	6,194 (22.0)	1,047 (19.2)	7,732 (20.9)	
5 (highest)	273 (16.9)	1,105 (16.5)	68 (11.7)	494 (27.6)	584 (19.3)	6,496 (23.1)	862 (15.9)	8,235 (22.2)	
Unknown	88 (5.5)	41 (0.6)	n/a	n/a	26 (0.86)	53 (0.19)	176 (3.2)	137 (0.4)	

Notes: [a]Comparing patients with rural vs urban residence. [b]Manitoba assigns a diagnosis of CD or UC for all patients. No patient was considered unclassifiable.
Abbreviations: CD, Crohn's disease; IBD, inflammatory bowel disease; n/a, not applicable; UC, ulcerative colitis.

less rural than the general population[19] in MB (24.4% rural IBD population vs 28% rural general population, P=0.0005) and ON (9.7% vs 14%, Chi-squared P<0.0001) but not AB (19.3% vs 17%, P<0.0001). Compared with urban IBD patients, rural patients with IBD were older (44.1±18.7 vs 39.9±18.8, P<0.0001), were less likely to have CD (43.8% vs 45.3%, P<0.0001), and were more likely to be of the lower income quintiles (P<0.0001).

Health services utilization

Rates of IBD-specific outpatient physician visits were not significantly different in rural and urban patients for overall IBD (IRR 0.99, 95% CI 0.94–1.04), CD (IRR 1.04, 95% CI 0.99–1.09), or UC (IRR 0.94, 95% CI 0.88–1.01) (Figure 1). There was no significant statistical heterogeneity when data from the three provinces were meta-analyzed (I² 50.0%, P=0.13). Rates of IBD-related outpatient visits were not significantly different in rural and urban patients (OR 0.99, 95% CI 0.92–1.07) with significant heterogeneity (I² 83.1%, P<0.01); this was driven primarily by lower visit rates for ON rural UC patients (OR 0.87, 95% CI 0.84–0.91).

Hospitalization rates were significantly higher in rural patients than in urban patients, for both IBD-specific (IRR 1.17, 95% CI 1.02–1.34) and IBD-related (IRR 1.27, 95% CI 1.04–1.56) hospitalizations (Figure 2). This difference was significant for CD (IBD-specific: IRR 1.15, 95% CI 1.08–1.22; IBD-related: IRR 1.28, 95% CI 1.09–1.49) but not for UC (IBD-specific: IRR 1.15, 95% CI 0.92–1.44; IBD-related:

IRR 1.23, 95% CI 0.96–1.58). There was significant heterogeneity across provinces (IBD-specific: I² 82.1%, P<0.01; IBD-related: I² 92.9%, P<0.01), with higher IBD-specific hospitalization rates in rural Albertans (IRR 1.11, 95% CI 1.11–1.33) and Manitobans (IRR 1.31, 95% CI 1.11–1.55) compared with those in rural ON patients (IRR 1.04, 95% CI 0.97–1.11). The risk of ever being hospitalized for IBD-specific reasons was not significantly different in rural and urban patients (HR 1.09, 95% CI 0.95–1.25) but was higher in rural patients for IBD-related reasons (HR 1.17, 95% CI 1.02–1.33) (Figure 3).

In ON, ED visit rate was significantly higher in rural patients compared to that in urban patients for both IBD-specific reasons (IBD: IRR 1.53, 95% CI 1.42–1.65; CD: IRR 1.74, 95% CI 1.57–1.92; UC: IRR 1.26, 95% CI 1.12–1.41) and IBD-related reasons (IBD: IRR 1.33, 95% CI 1.25–1.40; CD: IRR 1.47, 95% CI 1.36–1.59; UC: IRR 1.18, 95% CI 1.09–1.28). Similarly, the risk of ever having visited the ED was higher in rural patients than in urban patients for IBD-specific reasons (IBD: IRR 1.23, 95% CI 1.16–1.31; CD: IRR 1.26, 95% CI 1.16–1.37; UC: IRR 1.21, 95% CI 1.10–1.33) and IBD-related reasons (IBD: IRR 1.16, 95% CI 1.11–1.21; CD: IRR 1.16, 95% CI 1.08–1.24; UC: IRR 1.15, 95% CI 1.08–1.23).

Surgical outcomes

The risk of requiring intestinal resection for CD was not different in rural and urban patients (HR 0.98, 95% CI

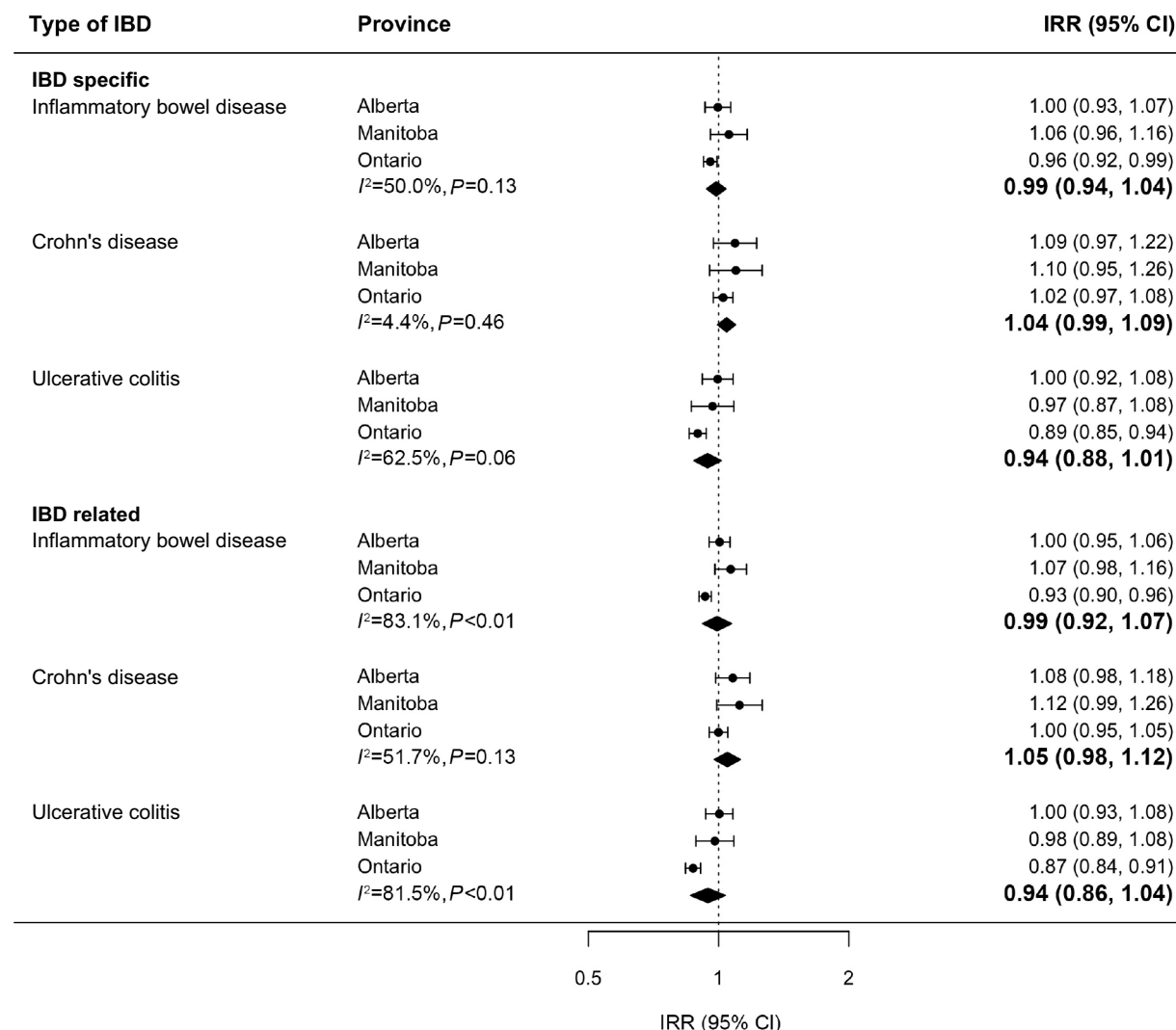| Type of IBD	Province		IRR (95% CI)
IBD specific			
Inflammatory bowel disease	Alberta		1.00 (0.93, 1.07)
	Manitoba		1.06 (0.96, 1.16)
	Ontario		0.96 (0.92, 0.99)
	I^2=50.0%, P=0.13		**0.99 (0.94, 1.04)**
Crohn's disease	Alberta		1.09 (0.97, 1.22)
	Manitoba		1.10 (0.95, 1.26)
	Ontario		1.02 (0.97, 1.08)
	I^2=4.4%, P=0.46		**1.04 (0.99, 1.09)**
Ulcerative colitis	Alberta		1.00 (0.92, 1.08)
	Manitoba		0.97 (0.87, 1.08)
	Ontario		0.89 (0.85, 0.94)
	I^2=62.5%, P=0.06		**0.94 (0.88, 1.01)**
IBD related			
Inflammatory bowel disease	Alberta		1.00 (0.95, 1.06)
	Manitoba		1.07 (0.98, 1.16)
	Ontario		0.93 (0.90, 0.96)
	I^2=83.1%, P<0.01		**0.99 (0.92, 1.07)**
Crohn's disease	Alberta		1.08 (0.98, 1.18)
	Manitoba		1.12 (0.99, 1.26)
	Ontario		1.00 (0.95, 1.05)
	I^2=51.7%, P=0.13		**1.05 (0.98, 1.12)**
Ulcerative colitis	Alberta		1.00 (0.93, 1.08)
	Manitoba		0.98 (0.89, 1.08)
	Ontario		0.87 (0.84, 0.91)
	I^2=81.5%, P<0.01		**0.94 (0.86, 1.04)**

Figure 1 Association between rural and urban (reference) residences and IBD-specific and IBD-related outpatient visit rates (multivariable Poisson regression models).
Abbreviations: IBD, inflammatory bowel disease; IRR, incidence rate ratio; CI, confidence interval.

0.88–1.07), nor or was the risk of colectomy for UC (HR 0.92, 95% CI 0.78–1.06). The risk of surgery for CD and UC at 1, 3, 5, and 10 years following diagnosis is displayed in Figure 4. For CD patients, there were significantly increased odds of having multiple (two or more) intestinal resection surgeries in rural patients compared with urban patients in ON only (OR 1.55, 95% CI 1.16–2.08). There was no association between rural/urban and multiple surgeries in other provinces (AB: OR 1.14, 95% CI 0.73–1.80; MB: OR 0.80, 95% CI 0.39–1.66), resulting in no significantly increased risk overall (pooled OR 1.21, 95% CI 0.79–1.63) and no significant statistical heterogeneity (I^2 45.6%, P=0.16).

Prediagnosis lag time

For CD patients, there was no significant difference in diagnosis lag time between rural and urban patients (mean 187.4±235.0 vs 175.8±229.4 days; HR 1.01, 95% CI

0.94–1.07), nor there was significant heterogeneity among provinces (I^2 0%, P=0.72) (Figure 5). Rural UC patients also did not have significantly longer prediagnosis lag time compared to urban patients on multivariable regression analysis (HR 1.18, 95% CI 0.97–1.45), and there was no significant heterogeneity (I^2 66.1%, P=0.08) (Figure 5). The mean time to diagnosis was also similar (130.4±210.9 vs 132.3±215.5 days).

Outpatient care by gastroenterologists

In all analyses, rural patients were less likely to receive outpatient care from gastroenterologists for IBD-specific and IBD-related reasons. They had a lower odds of ever having an outpatient visit with a gastroenterologist after diagnosis (IBD-specific: OR 0.46, 95% CI 0.32–0.65; IBD-related: OR 0.50, 95% CI 0.37–0.68) (Figure 6). For IBD-specific visits, this association was not present for children <10 years at diagnosis
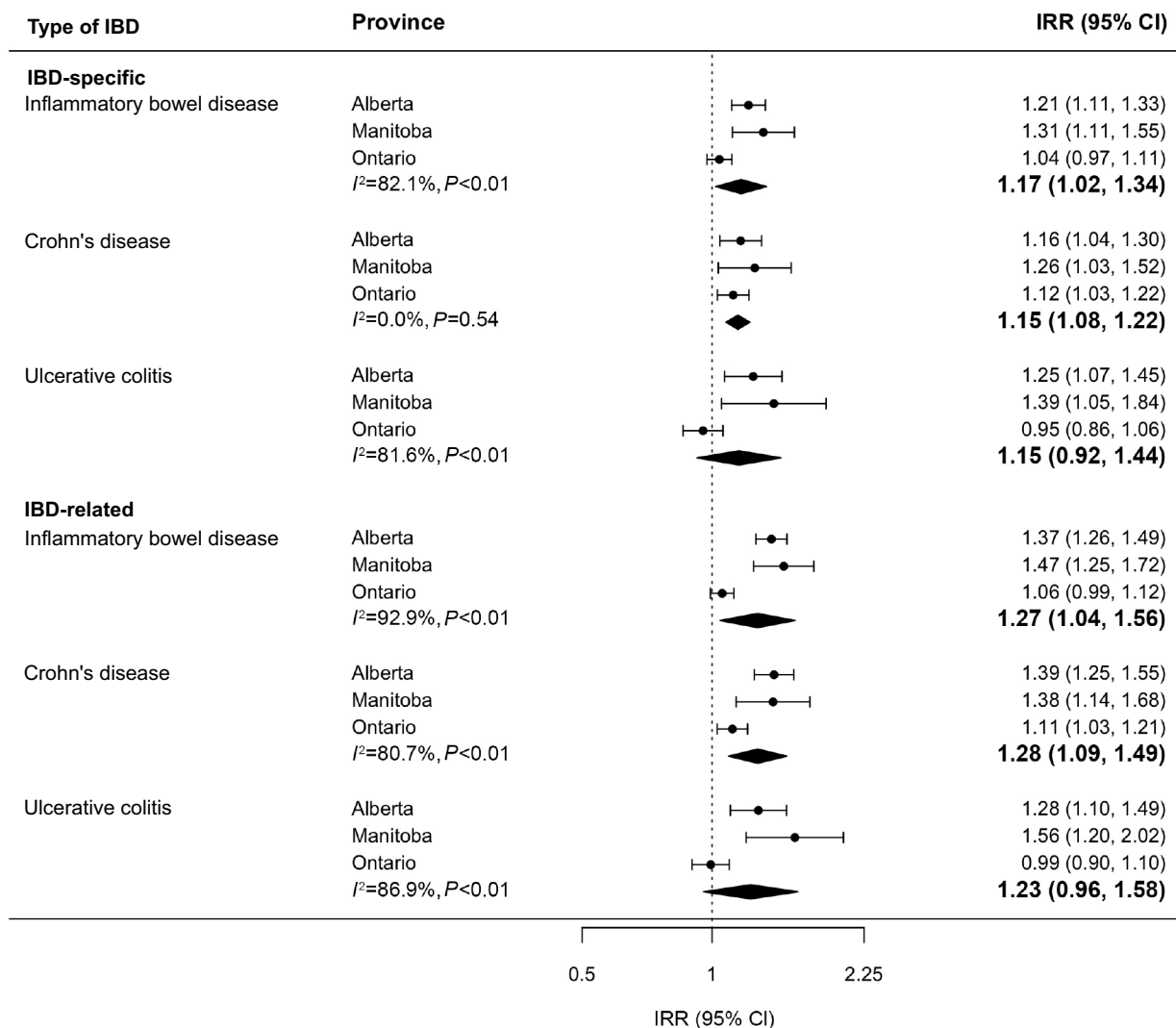
Type of IBD	Province		IRR (95% CI)
IBD-specific			
Inflammatory bowel disease	Alberta		1.21 (1.11, 1.33)
	Manitoba		1.31 (1.11, 1.55)
	Ontario		1.04 (0.97, 1.11)
	I^2=82.1%, P<0.01		**1.17 (1.02, 1.34)**
Crohn's disease	Alberta		1.16 (1.04, 1.30)
	Manitoba		1.26 (1.03, 1.52)
	Ontario		1.12 (1.03, 1.22)
	I^2=0.0%, P=0.54		**1.15 (1.08, 1.22)**
Ulcerative colitis	Alberta		1.25 (1.07, 1.45)
	Manitoba		1.39 (1.05, 1.84)
	Ontario		0.95 (0.86, 1.06)
	I^2=81.6%, P<0.01		**1.15 (0.92, 1.44)**
IBD-related			
Inflammatory bowel disease	Alberta		1.37 (1.26, 1.49)
	Manitoba		1.47 (1.25, 1.72)
	Ontario		1.06 (0.99, 1.12)
	I^2=92.9%, P<0.01		**1.27 (1.04, 1.56)**
Crohn's disease	Alberta		1.39 (1.25, 1.55)
	Manitoba		1.38 (1.14, 1.68)
	Ontario		1.11 (1.03, 1.21)
	I^2=80.7%, P<0.01		**1.28 (1.09, 1.49)**
Ulcerative colitis	Alberta		1.28 (1.10, 1.49)
	Manitoba		1.56 (1.20, 2.02)
	Ontario		0.99 (0.90, 1.10)
	I^2=86.9%, P<0.01		**1.23 (0.96, 1.58)**

0.5   1   2.25

IRR (95% CI)

Figure 2 Association between rural and urban (reference) residences and IBD-specific and IBD-related hospitalization rates (multivariable negative binomial regression models). Bolded values represent meta-analysis results.
Abbreviations: IBD, inflammatory bowel disease; IRR, incidence rate ratio; CI, confidence interval.

(OR 0.97, 95% CI 0.77–1.20) or adolescents 10–18 years at diagnosis (OR 0.70, 95% CI 0.47–1.04), but the association became much more prominent in older patients, especially those diagnosed ≥65 years (OR 0.35, 95% CI 0.26–0.46). Rural patients also had lower annual outpatient visit rates to gastroenterologists (IBD-specific: IRR 0.79, 95% CI 0.73–0.84; IBD-related: IRR 0.77, 95% CI 0.69–0.85). This association was present across all age groups.

The proportion of IBD-specific outpatient visits to gastroenterologists was lower in rural patients than in urban patients (28.3% vs 55.2%, Chi-squared P<0.0001). This was true across age groups but was less pronounced in children <10 years at diagnosis (59.3% vs 65.0%, P<0.0001). The gap was most wide in patients >65 years (33.0% vs 59.2%, P<0.0001). The heat map also demonstrates that

neighborhoods with a higher proportion of care provided by gastroenterologists were more likely to be urban (Figure 7). Similarly, the proportion of IBD-related outpatient visits to gastroenterologists was lower in rural patients than in urban patients (30.8% vs 47.7%, P<0.0001).

Determination of whether specialist care mediates the relationship between rural/urban residence and health services disparities

In ON, physician specialist care (gastroenterologist or not) did not mediate the association between rural/urban residence and health services use, no matter which of the three definitions of specialist care was used. The results of analyses are presented in Table 2. In all cases, including measures of
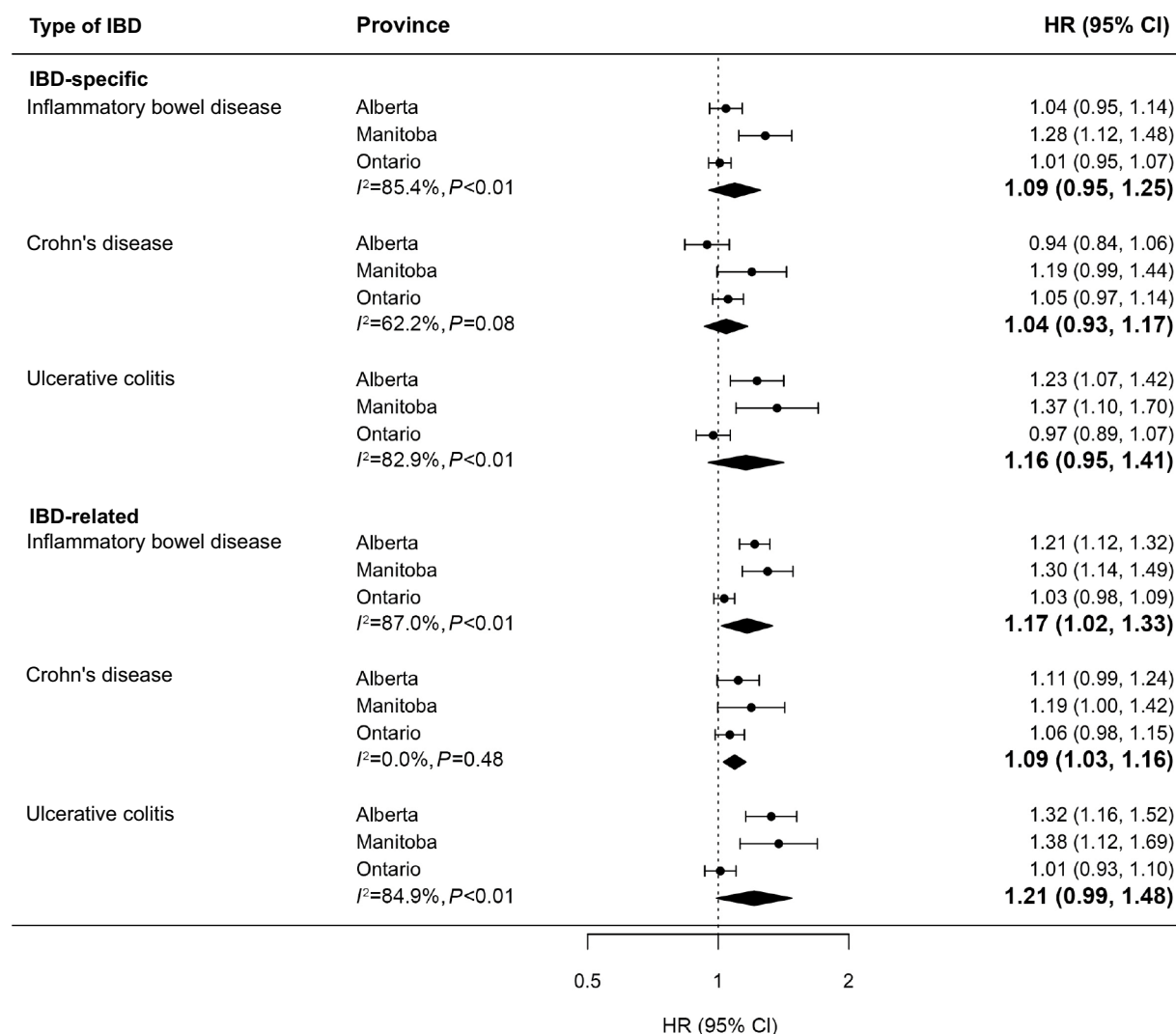
Figure 3 Association between rural and urban (reference) residences and risk of IBD-specific and IBD-related hospitalization (multivariable Cox proportional hazard models). Bolded values represent meta-analysis results.
Abbreviations: IBD, inflammatory bowel disease; IRR, incidence rate ratio.

specialist care changed the magnitude (IRR, OR, or HR) of association between rural/urban residence and health services utilization by <10%.

Discussion

In this multiprovince population-based study of health services utilization in patients with IBD living in Canada, we found selected disparities in care of patients living in rural and urban residences. Rural patients had higher hospitalization and ED visit rates compared with urban patients. In part, higher hospitalization and ED visits may be explained by rural patients being less likely to visit a gastroenterologist; as well, a smaller proportion of their care was provided by gastroenterologists as compared to urban residents. Limited access to specialist was observed across all ages but became

more pronounced in older adults. In contrast, prediagnosis lag time and rates of outpatient visits were similar for rural and urban patients with IBD. While risk of first surgery was similar between urban and rural residents, ON patients with CD were more likely to undergo multiple surgical resections if they lived in rural communities. Collectively, these data highlight that access to specialist care is an important contributor to health care utilization and outcomes.

Very few studies have examined disparities in outcomes or health services use in rural and urban IBD patients. A recent study from the USA found that increased distance of IBD patients' home to a referral IBD center was associated with increased odds of surgery, biological use, and immunomodulator use.[40] Every increase of 10 miles from the patients' home to the center resulted in a 9% increase

in surgical risk and a 14% increase in the use of biological therapy.[40] Similarly, German patients with IBD were seen less frequently, were prescribed fewer medications, and were less likely to undergo surveillance colonoscopy if they lived in low-density or rural areas.[41]

We did not find similar disparities in remote patients in Canada, although population-based medication utilization data were not available for our population. We did not measure distance specifically; however, rural patients in Canada

Figure 4 (**A**) Likelihood of resection or colectomy in rural and urban CD patients and (**B**) likelihood of colectomy in rural and urban UC patients.
Abbreviations: CD, Crohn's disease; UC, ulcerative colitis.

typically live a greater distance to tertiary specialist care.[42] In Canada, pediatric IBD care is more centralized than adult care, with urban pediatric health care centers housing the only pediatric gastroenterologists in most provinces. This may have resulted in less disparity in access to gastroenterologists in children compared with older adults, implying that there may be benefit to centralization in the pediatric IBD population (at least in terms of accessing specialist gastroenterologists). Alternatively, families with children with IBD may be more willing to travel long distances to receive specialist care. Conversely, elderly rural patients had very low rates of visits to gastroenterologists. These patients may be less willing to travel long distances to see gastroenterologists, or they may have less severe disease. This finding is a concern, considering that previous studies have demonstrated improved outcomes in adults with IBD who receive most of their care by gastroenterologists.[43,44] However, we assessed whether various measures of gastroenterologist care provided for IBD mediated the association between rural/urban residence and health services utilization in ON. Including measures of gastroenterologist care provision in the models did not seem to alter the association (or lack thereof) for outpatient visits, hospitalization, or ED utilization.

Little is known about rurality as a predictor of disparities of care in chronic diseases. Remote ON diabetes patients were demonstrated to have increased rates of admissions and ED visits.[10] General health care use was noted to be different for all residents of Saskatchewan in a study where residents were asked whether they experienced difficulties with access to medical or surgical specialist care. Rural residents reported between 16% and 45% increased perceived difficulties with access to care.[45] Consistent with our findings, a review of the literature suggested that rural residence
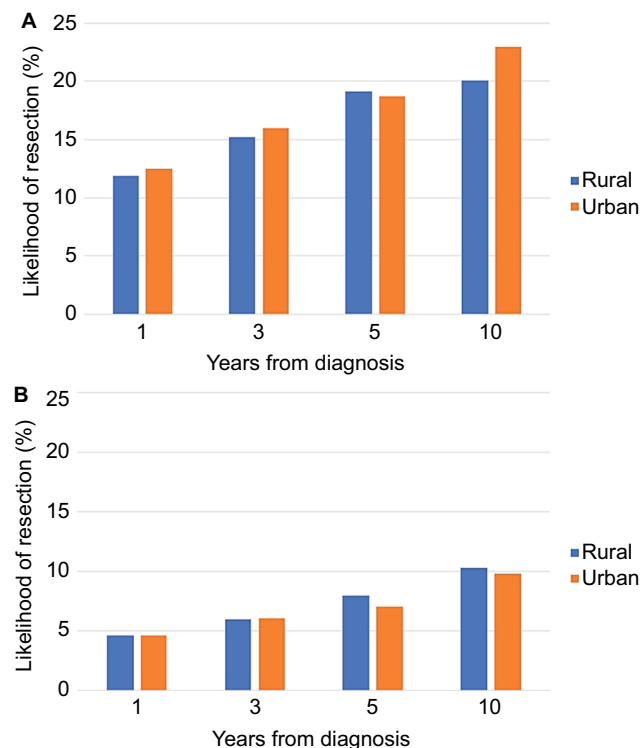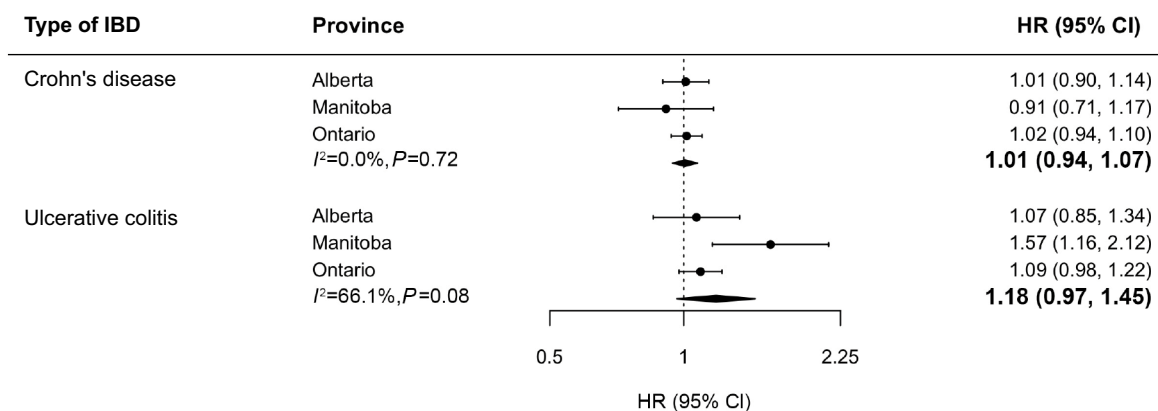

Figure 5 Association between rural and urban (reference) residences and prediagnostic lag time (multivariable Cox proportional hazard models). Bolded values represent meta-analysis results.
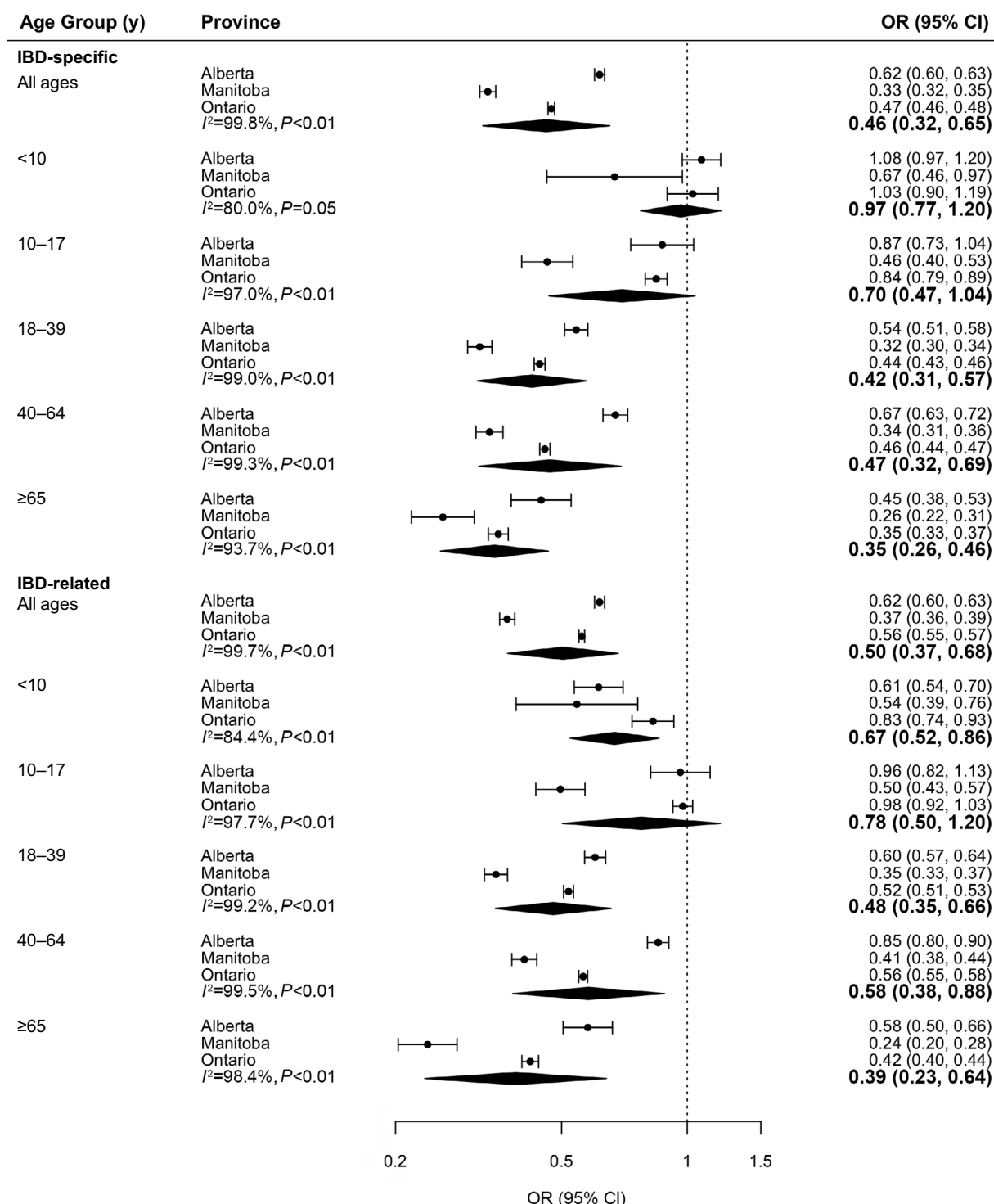**Abbreviation:** IBD, inflammatory bowel disease.

Age Group (y)	Province		OR (95% CI)
IBD-specific			
All ages	Alberta		0.62 (0.60, 0.63)
	Manitoba		0.33 (0.32, 0.35)
	Ontario		0.47 (0.46, 0.48)
	I^2=99.8%, P<0.01		**0.46 (0.32, 0.65)**
<10	Alberta		1.08 (0.97, 1.20)
	Manitoba		0.67 (0.46, 0.97)
	Ontario		1.03 (0.90, 1.19)
	I^2=80.0%, P=0.05		**0.97 (0.77, 1.20)**
10–17	Alberta		0.87 (0.73, 1.04)
	Manitoba		0.46 (0.40, 0.53)
	Ontario		0.84 (0.79, 0.89)
	I^2=97.0%, P<0.01		**0.70 (0.47, 1.04)**
18–39	Alberta		0.54 (0.51, 0.58)
	Manitoba		0.32 (0.30, 0.34)
	Ontario		0.44 (0.43, 0.46)
	I^2=99.0%, P<0.01		**0.42 (0.31, 0.57)**
40–64	Alberta		0.67 (0.63, 0.72)
	Manitoba		0.34 (0.31, 0.36)
	Ontario		0.46 (0.44, 0.47)
	I^2=99.3%, P<0.01		**0.47 (0.32, 0.69)**
≥65	Alberta		0.45 (0.38, 0.53)
	Manitoba		0.26 (0.22, 0.31)
	Ontario		0.35 (0.33, 0.37)
	I^2=93.7%, P<0.01		**0.35 (0.26, 0.46)**
IBD-related			
All ages	Alberta		0.62 (0.60, 0.63)
	Manitoba		0.37 (0.36, 0.39)
	Ontario		0.56 (0.55, 0.57)
	I^2=99.7%, P<0.01		**0.50 (0.37, 0.68)**
<10	Alberta		0.61 (0.54, 0.70)
	Manitoba		0.54 (0.39, 0.76)
	Ontario		0.83 (0.74, 0.93)
	I^2=84.4%, P<0.01		**0.67 (0.52, 0.86)**
10–17	Alberta		0.96 (0.82, 1.13)
	Manitoba		0.50 (0.43, 0.57)
	Ontario		0.98 (0.92, 1.03)
	I^2=97.7%, P<0.01		**0.78 (0.50, 1.20)**
18–39	Alberta		0.60 (0.57, 0.64)
	Manitoba		0.35 (0.33, 0.37)
	Ontario		0.52 (0.51, 0.53)
	I^2=99.2%, P<0.01		**0.48 (0.35, 0.66)**
40–64	Alberta		0.85 (0.80, 0.90)
	Manitoba		0.41 (0.38, 0.44)
	Ontario		0.56 (0.55, 0.58)
	I^2=99.5%, P<0.01		**0.58 (0.38, 0.88)**
≥65	Alberta		0.58 (0.50, 0.66)
	Manitoba		0.24 (0.20, 0.28)
	Ontario		0.42 (0.40, 0.44)
	I^2=98.4%, P<0.01		**0.39 (0.23, 0.64)**

OR (95% CI)

Figure 6 Association between rural and urban (reference) residences and likelihood of ever having seen a gastroenterologist for IBD-specific or IBD-related care (multivariable logistic regression models). Bolded values represent meta-analysis results.
Abbreviation: IBD, inflammatory bowel disease.

played a significant role in determining the nature and level of access to health services, but it did not always translate into health disadvantages, especially when controlling for other sociodemographic factors.[46]

A recent Canadian study demonstrated that people living in rural residence were less likely to develop IBD, with a particularly strong protective effect of rurality in childhood.[47] Any study related to disease incidence using health
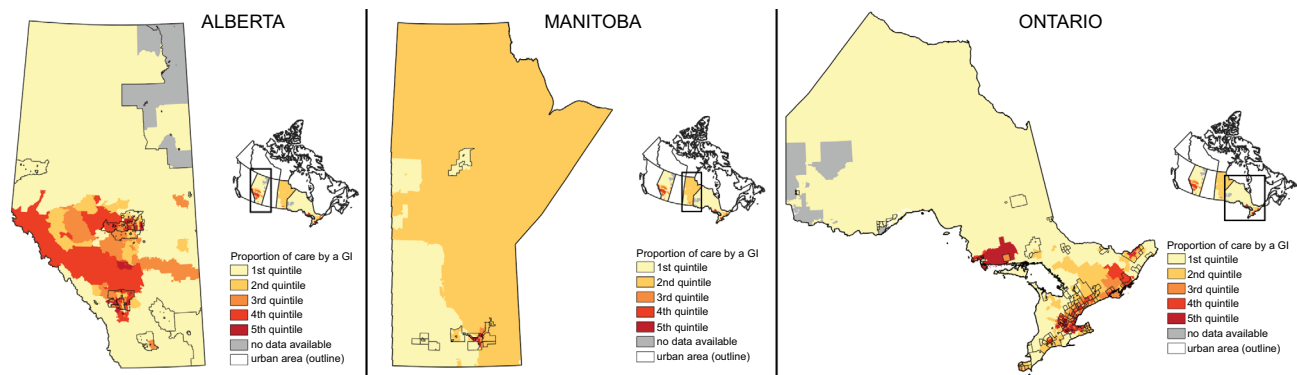
Figure 7 Heat map demonstrating that higher proportion of IBD care provided by gastroenterologists (darker colors) was more likely to be located in urban regions (outlined boxes).
Abbreviation: GI, gastroenterologist; IBD, inflammatory bowel disease.

Table 2 Models to determine whether specialist care provision mediated the relationship between rural/urban residence and disparities in health services utilization in Ontario IBD patients

Health services measure	Original model, adjusted IRR/OR/HR (95% CI)	Specialist care definition # 1, adjusted IRR/OR/HR (95% CI)	Specialist care definition # 2, adjusted IRR/OR/HR (95% CI)	Specialist care definition # 3, adjusted IRR/OR/HR (95% CI)
Outpatient visit rate				
IBD-specific	**0.96 (0.92–0.99)**	0.97 (0.93–1.00)	0.97 (0.93–1.00)	1.005 (0.97–1.04)
IBD-related	**0.93 (0.90–0.96)**	0.92 (0.89–0.95)	0.92 (0.89–0.95)	0.95 (0.91–0.98)
Hospitalization rate				
IBD-specific	1.04 (0.97–1.11)	1.01 (0.95–1.08)	1.00 (0.94–1.07)	**1.08 (1.01–1.15)**
IBD-related	1.06 (0.99–1.12)	1.02 (0.96–1.09)	1.01 (0.95–1.07)	**1.07 (1.01–1.14)**
Risk of hospitalization				
IBD-specific	1.01 (0.95–1.07)	0.97 (0.92–1.03)	0.97 (0.91–1.03)	1.04 (0.98–1.10)
IBD-related	1.03 (0.98–1.09)	0.99 (0.94–1.05)	0.98 (0.93–1.04)	1.04 (0.99–1.10)
ED visit rate				
IBD-specific	**1.53 (1.42–1.65)**	**1.47 (1.36–1.59)**	**1.45 (1.34–1.56)**	**1.55 (1.44–1.67)**
IBD-related	**1.33 (1.25–1.40)**	**1.26 (1.19–1.33)**	**1.24 (1.17–1.31)**	**1.30 (1.23–1.38)**
Risk of ED visit				
IBD-specific	**1.23 (1.16–1.31)**	**1.19 (1.12–1.26)**	**1.18 (1.11–1.25)**	**1.25 (1.17–1.32)**
IBD-related	**1.16 (1.11–1.21)**	**1.11 (1.06–1.17)**	**1.10 (1.05–1.15)**	**1.15 (1.09–1.21)**

Notes: Bolded results: statistically significant. Original model: no specialist care measure included as independent variable. Specialist care definition # 1: included whether patient had gastroenterologist as primary IBD care provider (>50% of IBD-specific visits) as independent variable. Specialist care definition # 2: included the proportion of IBD-specific care provided by a gastroenterologist as independent variable. Specialist care definition # 3: included whether patient had ever seen a gastroenterologist within the first 6 months of diagnosis as independent variable. Bolded results were statistically significant ($P<0.05$).
Abbreviations: ED, emergency department; HR, hazard ratio; IBD, inflammatory bowel disease; IRR, incidence rate ratio; OR, odds ratio.

administrative data is subject to potential risk of bias related to access to health services. Our finding that rural and urban IBD patients had similar outpatient health services utilization both before and after diagnosis is reassuring, as it implies that the difference in incidence among rural and urban patients was not secondary to lower outpatient visit rates in the rural population.

The use of health administrative data, while population-based and allowing for a large cohort size, may have resulted in some limitations. While we used identification algorithms

to identify IBD patients validated in AB,[25] MB,[26] and ON,[27,28] the risk of misclassification is possible, especially resulting from differential accuracy of these algorithms in rural or urban patients. The algorithms were validated in a variety of populations, including in communities remote from urban centers. Considering the lower incidence of IBD in rural residence described in previous research,[47] it is unlikely that the algorithms resulted in differential misclassification of rural people as having IBD when they did not. However, codes used to identify prediagnostic health care contacts

related to IBD were based on expert opinion of clinicians and researchers and were not validated. Based on the opinion of the experts, we chose only codes that were highly related to subsequent diagnosis with IBD and limited prediagnostic time to 5 years. This may have resulted in misclassification of time to diagnosis. Other potential confounders such as tobacco smoking status, disease extent, and severity were not available within health administrative data. Finally, there may be other social, cultural, or clinical factors, which may have contributed to our findings.

Some of our results underscore other limitations of using health administration data for research purposes. One important limitation is the lack of phenotype, severity, or other clinical characteristics of IBD. Rural residents may still experience poor access to care and outcomes, but they may also have more severe disease, resulting in a masking of disparities in access. However, we have no indication that people in rural residence have a different phenotype or severity from those living in urban communities. In addition, it is uncertain if the increased rates of hospitalization or ED visits in rural Canada reflect increased disease severity or an inappropriate use of hospitalizations in the management of IBD. The similar rates of IBD-related surgeries and multiple surgeries support the possibility that there is a potentially unnecessary excess in rural hospitalizations for IBD. However, the visits may be related to the model of care in underserviced communities. For example, patients may access care by their family physician working in the ED, as many rural family physicians also cover ED shifts in local hospitals. While this would not result in inappropriate primary care, the visit would still be excessively expensive since it would require the resources provided to EDs. This requires further consideration by health care administrators concerned with limiting expenditures.

Furthermore, care provision by a gastroenterologist did not mediate the association between rural residence and increased ED visits. Since these ED visits did not result in increased hospitalization in rural patients, they were more likely of lower acuity and thus manageable in the outpatient setting. This suggests that specialist care has not reduced expensive, undesirable health care utilization. However, it is possible that gastroenterologists saw the most ill of IBD patients. Hence, these patients are more likely to use the ED; yet they are no more likely to be hospitalized because of the proactive care provided. In a separate study using MB health administrative data, visits with a gastroenterologist within the prior year significantly reduced ED attendance among incident cases.[48] Incident cases typically have more severe illness, and hence this supports the notion that gastroenterologist care can reduce health care utilization in IBD. In the MB study, gastroenterologist care did not reduce ED attendance by prevalent IBD cases, nor did it reduce hospitalization among those who did attend the ED. These findings are confounded by issues of disease severity that could not be addressed within the limits of either study. Future research should combine qualitative and quantitative methods in specific groups in rural communities that may experience poor access to care or different outcomes from urban patients. In addition, future research should focus on elderly patients with IBD to determine why differences in use of gastroenterologist care were so pronounced in rural/urban patients of that age group.

Conclusion

Rural residents of Canada with IBD had increased hospitalization and ED visit rates compared to urban patients; yet they had similar outpatient visit rates, surgical risk, and diagnostic delay compared to urban residents. There were lower rates of gastroenterologist physician visits in rural patients, particularly by older people. Therefore, rural patients had decreased use of specialist care. While this did not result in long-term clinical outcomes (surgery), this may be associated with more expensive use of the health system (ED visits and hospitalizations). In studying a universal health care system, we remove insurance access as a crucial factor. This study implies that clinicians and health policy makers should consider ways in which to avoid expensive, undesirable health services utilization in rural IBD patients. Innovative methods of delivering care to these patients (such as telehealth, online care by IBD specialists, and remote clinics) should be explored.

Data sharing statement

The ON data set from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet prespecified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros that are unique to ICES.

Acknowledgments

Disclosure

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