Regional variations in not treating diagnosed hypertension in Canada

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BACKGROUND: Improvements in the diagnosis and treatment of hypertension have been documented in Canada following implementation of a national program to improve hypertension management.

OBJECTIVE: To determine whether there are regional variations in not treating diagnosed hypertension with drugs in Canada.

METHODS: Using data from the Canadian Community Health Survey (CCHS) cycle 3.1 (2005), regional variation in drug treatment of diagnosed hypertension was examined. Also, national drug data from the Intercontinental Medical Statistics CompuScript database were analyzed to determine regional trends in total antihypertensive prescriptions in the period before and following the CCHS cycle 3.1.

RESULTS: The overall rate of untreated hypertension among those diagnosed with hypertension in Canada was 12.7%. The highest untreated rate among those diagnosed with hypertension was in the Northern region (29.2%) and the lowest was in the Atlantic region (8.8%). Alberta (16.5%) and British Columbia (BC) (15.4%) also had higher untreated rates, while Ontario (13.2%) was similar to Canada overall. Younger age, single/never married status, larger household size, lack of access to a family physician and daily smoking were all associated with a higher likelihood of not receiving antihypertensive treatment. Adjusting for demographic characteristics, diagnosed hypertensive patients in Alberta (adjusted OR 1.35 [95% CI 1.14 to 1.61]) and BC (adjusted OR 1.64 [95% CI 1.40 to 1.91]) were more likely to be untreated than those in Ontario. The largest overall percentage increase in total antihypertensive prescriptions following the CCHS (ie, 2006) occurred in BC and Ontario. In Alberta, it remained almost unchanged and declined in Manitoba.

CONCLUSIONS: Among adult Canadians diagnosed with hypertension, there were regional variations in the likelihood of not receiving antihypertensive therapy. Further research is required to understand the reasons for these variations to regionally target interventions and improve hypertension management in Canada.

Key Words: Canada; Hypertension; Regional variation; Treatment

High blood pressure (hypertension) is a leading cardiovascular risk factor in Canada and worldwide (1,2). Effective antihypertensive treatment considerably reduces associated cardiovascular morbidity and mortality (3). However, according to most reports (3,4), people with hypertension are often undiagnosed, untreated or inadequately treated. Recently, Leenen et al (5) reported high 2006 treatment (82%) and control (66%) rates for hypertension in Ontario. These rates are substantially different from previous data from the Canadian Heart Health Survey of 1985 to 1992, which reported a nationwide treatment and control rate of 33% and 13%, respectively. Corresponding rates for Ontario in 1992 were 33% and 12% (5,6). The recent Ontario survey marks a quantitative improvement over the previous treatment rates in Ontario. In addition, during this period, noted increases have been

Les variations régionales du non-traitement de l'hypertension diagnostiquée au Canada

HISTORIQUE : Les améliorations au diagnostic et au traitement de l'hypertension sont documentées au Canada depuis l'adoption d'un programme national afin de perfectionner la prise en charge de l'hypertension.

OBJECTIF : Déterminer s'il y a des variations régionales au non-traitement de l'hypertension au moyen de médicaments au Canada.

MÉTHODOLOGIE : À l'aide du cycle 3.1 (2005) de l'Enquête sur la santé dans les collectivités canadiennes (ESCC), les chercheurs ont examiné les variations régionales dans le traitement médicamenteux de l'hypertension diagnostiquée. De plus, ils ont analysé les données nationales sur les médicaments tirées de la base de données *Intercontinental Medical Statistics CompuScript* afin de déterminer les tendances régionales des prescriptions d'antihypertensifs au cours de la période suivant le cycle 3.1 de l'ESCC.

RÉSULTATS : Le taux total d'hypertension non traitée chez les hypertendus diagnostiqués au Canada s'élevait à 12,7 %. Le taux de non-traitement le plus élevé chez les hypertendus diagnostiqués s'observait dans la Région du Nord (29,2 %), et le moins élevé, dans la région de l'Atlantique (8,8 %). L'Alberta (16,5 %) et la Colombie-Britannique (C.-B.) (15,4 %) présentaient également des taux de non-traitement élevés, tandis que le taux de l'Ontario (13,2 %) était similaire à celui de l'ensemble du Canada. Un âge plus jeune, le statut de célibataire ou n'avoir jamais été marié, un grand nombre de personnes dans le ménage, l'absence d'accès à un médecin de famille et le tabagisme quotidien s'associaient tous à une plus grande probabilité de ne pas recevoir de traitement antihypertensif. Après rajustement compte tenu des caractéristiques démographiques, les hypertendus diagnostiqués de l'Alberta (RRR rajusté 1,35 [95 % IC 1,14 à 1,61]) et de la C.-B. (RRR rajusté 1,64 [95 % IC 1,40 à 1,91]) étaient plus susceptibles de ne pas être traités que ceux de l'Ontario. La plus grande augmentation globale en pourcentages des prescriptions totales d'antihypertensifs après l'ESCC (de 2006) s'est observée en C.-B. et en Ontario. En Alberta, le taux de prescriptions est demeuré presque inchangé, et il a diminué au Manitoba.

CONCLUSIONS : Chez les adultes canadiens atteints d'hypertension diagnostiquée, on constatait des variations régionales de la probabilité de ne pas recevoir de traitement antihypertensif. D'autres recherches s'imposent pour comprendre les raisons de ces variations afin de cibler des interventions et d'améliorer la prise en charge de l'hypertension au Canada.

documented in hypertension diagnosis and antihypertensive prescriptions nationally following implementation of a health care professional program focused on improving hypertension management (7).

Thus, it is important to determine whether the improvements in hypertension treatment and control demonstrated in Ontario are noted in other Canadian provinces as well (5). If there is regional variation in not treating diagnosed hypertension, factors associated with these variations would be important to assess. Identification of potential gaps in care, should they exist, will help facilitate the development of regionally targeted and focused interventions to improve hypertension management. The Canadian Community Health Survey (CCHS) is a valuable source of nationally representative survey data from which to assess the prevalence of diagnosed and treated

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TABLE 1
Prevalence of diagnosed hypertension among adult Canadians in the Canadian Community Health Survey cycle 3.1 (2005)

Age, years	Canada (n=24,670)	Atlantic region (n=3650)	Quebec (n=5369)	Ontario (n=7956)	Manitoba (n=1458)	Saskatchewan (n=1597)	Alberta (n=1883)	British Columbia (n=2488)	Northern region (n=269)
20–39									
Men	3.6	4.4	2.7	4.3	4.5	4.4	3.0	3.0	1.6
Women	2.8	3.6	2.3	3.1	4.3	3.4	2.4	2.0	3.3
40–59									
Men	17.3	21.8	16.0	18.4	17.5	18.2	17.0	13.9	15.4
Women	15.8	22.4	16.9	15.6	15.3	16.4	11.9	13.5	12.5
≥60									
Men	41.4	44.8	39.5	42.3	45.4	40.3	44.7	38.4	27.2
Women	47.0	52.8	46.9	47.9	47.0	48.5	46.5	41.6	49.0

Data presented as %. The percentages were weighted using Statistics Canada's bootstrap method, while the frequencies were not weighted

hypertension. In the present study, we analyzed data from the CCHS cycle 3.1 (2005) to examine regional variation, if any, in not treating hypertension and the factors associated with these variations. In addition, we also analyzed national drug data from the Intercontinental Medical Statistics (IMS) CompuScript database to examine the trends and regional differences, if any, in total antihypertensive prescriptions in the period preceding and following the CCHS cycle 3.1.

METHODS

The CCHS was a cross-sectional survey of household residents 12 years of age and older in all Canadian provinces and territories. It excluded populations living on Indian reserves, Canadian Forces bases, and in some remote areas. The CCHS was funded by the Canadian government and conducted by Statistics Canada from January to December 2005, using trained interviewers through both telephone and in-person contact in the home. Hypertension awareness was defined as those respondents who self-reported currently or ever having high blood pressure. The respondents must have been diagnosed by a health professional and have had the condition for at least six months. Respondents aware of their hypertension status were asked whether they had taken any medications for high blood pressure in the past month. A positive response defined antihypertensive treatment status. Respondents reporting hypertension in the past but not reporting medication use in the past month were excluded from the study population (3.8% of the sample). Furthermore, all respondents 20 years of age or younger (0.2%), pregnant women (0.1%) or those with missing data (1.4%) were excluded. Of the respondents surveyed, 109,108 (87.8%) were included in the study population.

The variables examined were respondents' sociodemographic characteristics (provincial residence, age, sex, marital status, household income, household size and immigration status), reported health (self-rated health and number of comorbid chronic health conditions), lifestyle factors (body mass index, smoking and physical activity) and health care use (reported number of physician consultations in the year before the survey and access to a family physician).

The IMS CompuScript database compiles dispensing records from a nationally representative sample of more than 4700 pharmacies. Although the data are not patient specific, they can be used to estimate drug use trends at provincial and national levels. The total number of antihypertensive medications (diuretics, beta-blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors and angiotensin receptor blockers) dispensed from January 1, 2003, to December 31, 2006, were analyzed to obtain regional and national drug use trends. All fixed-dose combinations were counted only once to calculate total antihypertensive prescriptions. The methodology has been described in detail elsewhere (8).

Statistical analysis

In the CCHS, household residents were identified across 126 health regions using a multistage sampling methodology. The sampling frame

and design methodology are available at http://130.15.161.74/webdoc/ssdc/cdbksnew/cchs/2005/GUIDE_E.pdf (9). The sampling method required reweighting the health regions to obtain unbiased estimates. The proportion of respondents not receiving antihypertensive treatment among aware hypertensive patients was stratified by demographic factors and region. The regions were defined based on their provincial boundaries, except for the smaller provinces, which were combined to form the Atlantic (Prince Edward Island, New Brunswick, Nova Scotia, and Newfoundland and Labrador) and Northern (Yukon, Northwest Territories and Nunavut) regions. Differences between proportions were tested using the χ^2 test. Among aware hypertensive respondents, factors associated with not receiving antihypertensive treatment were examined using logistic regression, with the ORs weighted to account for Statistics Canada's multistage sampling method.

Using the IMS data, the percentage increase in total antihypertensive prescriptions was calculated for each of the years (2003 to 2006), with 2003 as the baseline year. This was undertaken for all regions except the Northern region, for which data were unavailable. Yearly prescriptions were calculated based on the monthly prescription data and adjusted using the Canadian population 20 years of age or older from Statistics Canada's 2005 census.

RESULTS

Overall, the national prevalence of diagnosed hypertension was 17.9%. The prevalence of diagnosed hypertension was significantly different among the regions ($P<0.001$). The Atlantic region had the highest prevalence at 22.4% and the Northern region had the lowest at 11.9%, while the prevalence in Ontario was close to the national figure. In those younger than 60 years of age, more men than women were diagnosed with hypertension in most regions, while the opposite was observed among those 60 years of age or older (Table 1).

Table 2 shows the effect of demographic factors on regional variations in not receiving treatment for diagnosed hypertension. The overall rate of not treating those diagnosed with hypertension with drugs was 12.7% (treatment rate 87.3%). However, this rate was significantly different between regions ($P<0.001$). The highest rate of not treating those diagnosed with hypertension was in the Northern region (29.2%) and the lowest was in the Atlantic region (8.8%). Ontario had a rate (13.2%) similar to the national rate (12.7%), while the western provinces Alberta (16.5%) and British Columbia (BC) (15.4%) had higher nontreated rates than either Ontario or Canada overall. When other demographic variables were compared within and between regions, most were statistically significant ($P<0.001$).

Compared with Ontario or Canada, a higher percentage of young (20 to 39 years of age) diagnosed hypertensive patients were not receiving antihypertensive treatment in the Northern region, BC and Alberta, while in the Atlantic region and Manitoba, a smaller percentage were untreated. More men were not receiving treatment compared with women in the Northern region and Manitoba relative to Ontario

TABLE 2

The percentage of aware adult hypertensive respondents not receiving antihypertensive treatment according to region and demographic characteristics in the Canadian Community Health Survey cycle 3.1 (2005)

	Canada	Atlantic region	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Northern region
Total, n (%)	2508 (12.7)	277 (8.8)	494 (10.7)	827 (13.2)	144 (14.2)	128 (12.0)	253 (16.5)	328 (15.4)	57 (29.2)
Age, years									
20–39	54.9	37.5	53.0	55.0	55.1	45.6	64.4	66.1	74.8
40–59	17.3	12.3	14.1	16.9	15.3	19.6	23.6	25.2	28.1
≥60	4.6	2.7	4.7	4.8	7.2	3.3	5.1	4.6	10.4
Sex									
Male	16.3	11.5	13.7	17.6	19.3	15.9	17.7	18.3	34.9
Female	9.5	6.6	8.2	9.1	9.6	8.9	15.2	12.7	23.2
Marital status									
Married/common law	12.5	8.9	9.8	12.8	15.9	11.9	17.2	14.9	24.2
Widowed/separated/divorced	8.6	5.2	8.5	9.7	5.7	6.6	8.1	10.0	14.9
Single/never married	26.8	18.4	22.0	27.9	21.8	30.2	38.4	35.7	66.6
Education									
<Secondary	11.3	7.4	9.1	12.4	14.9	11.1	14.5	12.9	22.8
Secondary or higher	14.2	10.4	12.5	14.0	13.5	13.4	18.3	17.8	33.8
Household income									
<\$30,000	9.5	8.1	8.1	10.6	6.3	7.3	12.1	11.7	11.8
\$30,000–\$79,999	13.3	9.8	11.9	12.7	23.0	17.4	16.6	15.0	35.0
≥\$80,000	18.4	16.8	12.7	17.4	16.6	23.4	24.7	26.2	35.2
Household size									
1	9.6	6.5	10.1	9.1	8.5	7.2	10.4	12.6	15.1
2	8.5	7.0	7.6	8.6	8.5	6.5	10.7	10.0	25.4
3	19.3	12.8	15.7	19.7	24.5	30.4	26.8	23.6	35.0
≥4	23.7	13.0	20.2	22.5	32.8	34.4	32.5	29.1	52.8
Immigration status									
Canadian born	12.8	9.0	10.3	14.0	12.3	11.6	17.7	15.9	32.4
<10 years in Canada	26.3	5.6	32.0	25.5	22.2	0	28.0	28.0	77.4
≥10 years in Canada	11.0	4.5	11.6	9.6	22.7	18.3	10.9	13.3	3.5
Self-rated health									
Excellent	17.1	11.6	16.6	16.9	19.2	13.3	20.0	19.6	14.8
Very good	15.3	10.4	13.3	15.2	20.0	16.1	18.4	19.3	40.6
Good	12.0	7.6	9.1	13.1	14.0	10.1	15.5	15.3	37.6
Fair	9.6	7.9	8.3	9.0	8.4	12.4	15.8	10.5	11.6
Poor	10.0	8.9	10.1	11.2	2.9	5.1	11.3	10.4	4.5
Number of chronic health conditions									
None*	19.7	14.0	15.7	21.1	20.7	20.4	27.1	21.3	39.2
≥1	7.5	6.0	7.1	7.2	9.0	6.9	9.0	10.7	14.7
Body mass index, kg/m ²									
<25	12.8	6.1	10.9	13.5	17.6	16.8	16.4	14.6	34.9
25–30	13.1	9.2	11.7	13.2	13.8	13.5	16.9	14.7	24.1
>30	12.1	10.9	8.6	12.7	12.5	7.2	16.0	17.0	31.4
Smoking									
Daily	22.2	11.6	20.2	24.8	22.9	22.3	25.7	23.0	37.3
Occasional	21.5	13.3	15.0	21.8	7.2	31.8	33.9	25.8	32.9
Never	10.8	8.2	8.8	11.0	12.9	9.6	13.9	13.9	25.7
Physical activity									
Active	16.1	13.5	15.5	15.5	15.5	14.6	18.9	18.2	55.2
Moderate	12.7	8.7	10.0	12.8	14.7	13.6	16.7	16.4	21.9
Inactive	11.7	8.0	9.5	12.6	13.8	10.7	15.7	13.4	24.9
Number of physician consultations in past year									
0	28.2	21.6	21.0	28.7	36.8	39.8	42.4	45.0	49.7
1	19.1	16.1	10.4	24.1	26.3	14.1	32.6	32.9	34.8
2	16.0	12.3	8.3	21.2	24.1	16.0	18.9	22.8	31.0
3	10.7	8.5	8.0	9.5	20.9	16.8	15.1	13.8	33.7
4	5.9	5.6	7.9	6.3	3.0	5.1	4.7	4.6	15.6
≥5	8.9	5.7	9.3	8.5	7.7	8.2	11.8	11.2	21.9
Access to family doctor									
Yes	11.5	8.5	9.0	12.1	13.4	10.7	14.2	14.5	29.4
No	37.0	16.7	35.3	37.2	29.5	37.6	53.8	42.1	28.8

Data presented as % unless otherwise indicated. The percentages were weighted using Statistics Canada's bootstrap method, while the frequencies were not weighted. *In chronic conditions, 'none' does not include hypertension

TABLE 3
ORs for not receiving antihypertensive treatment among aware adult hypertensive respondents in the Canadian Community Health Survey cycle 3.1 (2005)

Variables	OR (95% CI)	
	Crude	Adjusted
Region		
Ontario	Reference	Reference
Atlantic region	0.64 (0.63–0.64)	0.75 (0.64–0.88)
Quebec	0.79 (0.78–0.79)	0.68 (0.59–0.78)
Manitoba	1.09 (1.07–1.11)	1.03 (0.84–1.27)
Saskatchewan	0.90 (0.89–0.92)	0.86 (0.69–1.07)
Alberta	1.31 (1.29–1.32)	1.35 (1.14–1.61)
British Columbia	1.20 (1.19–1.21)	1.64 (1.40–1.91)
Northern region	2.72 (2.59–2.87)	1.00 (0.70–1.42)
Age, years		
20–39	25.11 (24.86–25.36)	15.16 (12.72–18.07)
40–59	4.30 (4.27–4.34)	3.54 (3.14–3.98)
≥60	Reference	Reference
Sex		
Male	Reference	Reference
Female	0.54 (0.54–0.55)	0.77 (0.70–0.85)
Marital status		
Married/common law	Reference	Reference
Widowed/separated/divorced	0.66 (0.66–0.67)	1.22 (1.03–1.45)
Single/never married	2.58 (2.56–2.60)	1.50 (1.26–1.79)
Education		
<Secondary	Reference	Reference
Secondary or above	1.30 (1.29–1.30)	0.94 (0.85–1.04)
Household income		
<\$30,000	Reference	Reference
\$30,000–\$79,999	1.46 (1.44–1.47)	0.89 (0.81–1.10)
≥\$80,000	2.15 (2.12–2.17)	0.97 (0.81–1.15)
Household size		
1	Reference	Reference
2	0.87 (0.86–0.88)	0.99 (0.83–1.17)
3	2.25 (2.22–2.27)	1.35 (1.10–1.65)
≥4	2.93 (2.90–2.96)	1.48 (1.19–1.84)
Immigration status		
Canadian born	Reference	Reference
<10 years in Canada	2.44 (2.40–2.48)	1.14 (0.79–1.66)
≥10 years in Canada	0.85 (0.84–0.85)	1.04 (0.91–1.20)
Self-rated health		
Excellent	Reference	Reference
Very good	0.88 (0.87–0.89)	0.87 (0.73–1.04)
Good	0.66 (0.65–0.67)	0.83 (0.69–0.99)
Fair	0.52 (0.51–0.52)	0.84 (0.69–1.03)
Poor	0.54 (0.53–0.55)	1.13 (0.87–1.47)
Number of chronic health conditions		
None*	Reference	Reference
≥1	0.33 (0.32–0.33)	0.77 (0.66–0.89)
Body mass index, kg/m ²		
<25	Reference	Reference
25–30	1.02 (1.01–1.02)	0.94 (0.84–1.05)
>30	0.94 (0.93–0.94)	0.81 (0.71–0.91)
Smoking		
Daily	2.35 (0.33–2.36)	1.59 (1.42–1.79)
Occasional	2.25 (2.22–2.29)	1.21 (0.94–1.56)
Never	Reference	Reference
Physical activity		
Active	Reference	Reference
Moderate	2.35 (2.33–2.36)	0.84 (0.73–0.96)
Inactive	2.25 (2.22–2.29)	0.82 (0.72–0.93)
Number of physician consultations in past year		
0	Reference	Reference
1	0.60 (0.60–0.61)	0.76 (0.64–0.89)
2	0.49 (0.48–0.49)	0.58 (0.49–0.68)
3	0.31 (0.30–0.31)	0.40 (0.33–0.48)
4	0.16 (0.16–0.16)	0.23 (0.19–0.28)
≥5	0.25 (0.25–0.25)	0.31 (0.26–0.36)
Access to family doctor		
Yes	Reference	Reference
No	4.52 (4.48–4.56)	2.14 (1.84–2.50)

*In chronic conditions, 'none' does not include hypertension

TABLE 4
The percentage increase in total antihypertensive prescriptions according to region from 2004 to 2006, using 2003 as the baseline*

Region	2004	2005	2006
Quebec	6.91	10.83	16.82
Ontario	8.60	15.88	25.46
British Columbia	9.18	18.06	30.84
Alberta	5.36	7.12	7.31
Saskatchewan	–1.71	3.83	10.77
Manitoba	4.71	–0.61	–2.67
Atlantic	3.72	7.32	11.89
Canada	6.80	11.53	18.21

*Data for the Northern region are unavailable

or Canada. The Northern region and Alberta had a higher percentage of single/never married untreated diagnosed hypertensive patients, while the Atlantic region had a smaller number compared with Ontario or Canada.

In the multivariate analysis (Table 3) that adjusted for all selected correlates, compared with diagnosed hypertensive patients in Ontario, those in Alberta (adjusted OR [aOR] 1.35 [95% CI 1.14 to 1.61]) and BC (aOR 1.64 [95% CI 1.40 to 1.91]) had significantly higher odds of being untreated, while those in the Atlantic region (aOR 0.75 [95% CI 0.64 to 0.88]) and Quebec (aOR 0.68 [95% CI 0.59 to 0.78]) had lower odds. Although the Northern region had a high proportion of not treating those diagnosed with hypertension, in adjusted analyses, the odds of not being treated in the Northern region were similar to the rest of Canada. Younger (20 to 39 years of age) diagnosed hypertensive patients were more likely to be untreated (aOR 15.16 [95% CI 12.72 to 18.07]) compared with those older than 60 years of age. Other factors associated with a higher likelihood of not receiving antihypertensive treatment included marital status (single or never married), being in a household with four or more residents, daily smoking and no access to a family physician.

During the period before and after the CCHS 3.1 (2003 to 2006), total antihypertensive prescriptions per 10,000 Canadian adults (adjusted for population size) increased by 7% to 31% in all regions except Manitoba (Table 4). The largest overall increase in prescriptions following the CCHS (ie, 2006) occurred in BC and Ontario, while in Alberta, it remained almost unchanged and declined in Manitoba.

DISCUSSION

Hypertension treatment and control rates are suboptimal worldwide. However, there is wide variation in national control rates, with some developing countries (Cuba and Barbados) having higher rates of hypertension control than many developed countries (USA and the United Kingdom) (10). In recent years, considerable increases in hypertension diagnosis and treatment prescriptions have been documented in Canada (7). Furthermore, the latest data from Ontario indicate substantial improvement in hypertension treatment and control rates (5). Based on the fact that the prevalence of diagnosed hypertension, the treatment rate and the ratio of aware hypertensive patients who were treated were similar in Ontario compared with Canada as a whole in this analysis, it may be fair to infer that the aforementioned findings of improved management may imply likely secular changes in the rest of the country as well with regard to treatment and possibly control despite differences in the methodologies used in both studies.

Even though most hypertensive patients were being treated, we found regional variations in receiving antihypertensive therapy among adult Canadians diagnosed with hypertension. Compared with diagnosed hypertensive patients in Ontario, those in Alberta, BC and the Northern region were more likely to be untreated, while those in Atlantic Canada and Quebec were more likely to be treated. Younger age (20 to 39 years), single/never married status, household size of

four or more, lack of access to a family physician and daily smoking status of diagnosed hypertensive patients were all associated with a higher likelihood of not receiving antihypertensive treatment (11).

Being young and diagnosed with hypertension was found to influence the likelihood of receiving treatment in both Alberta and BC, where the percentage of such diagnosed hypertensive patients was high compared with Ontario. This may also be a reflection of large-scale intracountry migration in the past few years to western Canada for employment opportunities. Such migrants are also more likely to be young and some are already diagnosed with hypertension. Although the prevalence of diagnosed hypertension was lower in this age group, it warrants serious attention because over time, untreated hypertension can considerably elevate cardiovascular risk in this group. Daily smoking, which in itself is an important cardiovascular risk factor, was associated with higher odds of not receiving treatment. It is, therefore, imperative to promote smoking cessation among smokers diagnosed with hypertension as well as target those who are young and diagnosed with hypertension during routine contact with health care professionals as a strategy to increase the treatment rate. The lack of access to a family physician was particularly evident among untreated hypertensive patients in Northern Canada, Alberta and BC. However, the reason for this is unclear given that similar health system functions across Canada and these regions have a much better physician per population ratio in contrast to the Northern region where it is clearly not the case.

The lower untreated rate in Atlantic Canada and Quebec is perhaps reassuring given that the Atlantic region had the most diagnosed hypertensive patients and also indicates the possibility of achieving higher treatment rates than in Ontario. This may be due to easier access to family physicians or initiatives by respective hypertension societies.

It is worth noting that some of the differences observed in the unadjusted analysis were not found in the adjusted analysis. For instance, in the unadjusted analysis, we found that those diagnosed with hypertension and living in the Northern region had higher odds of not receiving antihypertensive treatment relative to those in Ontario, but this difference did not persist after adjustment for all correlates. This could likely be attributable to the limited number of physicians in the Northern region, where more than one-third of diagnosed hypertensive patients reported no access to a family physician. Similarly, residing in Manitoba, having less than secondary education, incomes of \$30,000 or greater, and being an immigrant were associated with having an increased likelihood of being untreated in unadjusted analysis but were not observed after adjustment, unlike in Alberta and BC, where differences remained after adjustment. This possibly indicates that the variations in the likelihood of receiving treatment observed across regions may not be fully explained by the study variables and that there could be other unmeasured variables that may contribute to a better understanding of factors underlying the observed differences.

More recent drug prescription data suggest that BC experienced the greatest per cent increase in total antihypertensive prescriptions since the CCHS survey in 2005. Whether this translates into improvements in treatment of hypertension remains to be determined. In Alberta, where the proportion of patients diagnosed with hypertension and treated was also lower than the rest of Canada, increases in antihypertensive drug prescriptions were not seen. This may indicate that specific interventions to increase treatment there may be required. However, these data are ecological and not patient specific; hence, more detailed studies including the measurement of blood pressure are required for confirmation. Nevertheless, the increasing prescription rates in Canada and Ontario may also imply that increases in hypertension control are occurring.

Some limitations of the present study need to be addressed. Diagnosis of hypertension and antihypertensive treatment status were based on respondent self-reports, and may be less accurate than actual blood pressure measurement and treatment assessment. The exclusion of pregnant women, those 20 years of age or younger, individuals with missing values for the variables and those reporting hypertension in the past but not medication use in the past month could potentially

have resulted in selection bias. However, we only excluded a small proportion of the large sample, and that could reduce bias due to exclusion of these respondents. These potential biases could likely result in an underestimation of diagnosed hypertension and treatment status. Access to a family physician among those who indicate they have a family physician may also have different meanings in different regions. For example, in a region with stable or reducing patient load per physician, the access may be considerably better than in another region experiencing substantial immigration resulting in increasing patient load per physician. Finally, the IMS CompuScript database includes total prescriptions rather than individual patient-level data; therefore, it is not possible to assess trends in drug use in different patient subgroups or for different drug combinations.

CONCLUSIONS

We found that among adult Canadians diagnosed with hypertension, there were regional variations in the likelihood of not receiving antihypertensive therapy. Further research is required to understand the reasons for these variations to regionally target interventions and improve hypertension management in Canada.

COMPETING INTERESTS: Norm Campbell has received honoraria for advising and speaking from most major pharmaceutical companies that produce antihypertensive drugs. Sailesh Mohan, Guanmin Chen and Brenda Hemmelgarn have no conflicts of interest to declare.

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