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ORIGINAL ARTICLE

Incidence, cardiovascular complications and mortality of hypertension by sex and ethnicity

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ABSTRACT

Objective To compare ethnic and sex difference in the incidence of newly diagnosed hypertension, and subsequent risk of cardiovascular disease outcomes among South Asian, Chinese and white patients.

Methods We identified patients with newly diagnosed hypertension aged ≥20 years. Patients were followed for 1–9 years for all-cause mortality and cardiovascular disease with myocardial infarction, heart failure and stroke. Cox proportional hazard models stratified by sex and adjusted for age, median income and co-morbid conditions, were constructed to determine the independent association between ethnicity and the development of the combined cardiovascular endpoint as well as death.

Results There were 39 175 South Asian (49.4% men, 34.4% age ≥65), 49 892 Chinese (48.1% men, 36.7% age ≥65) and 841 277 white (47.9% men, 38.8% age ≥65) patients with newly diagnosed hypertension. Age and sex adjusted incidence of hypertension was highest in South Asian patients and lowest in Chinese patients. Compared with white patients, South Asian and Chinese patients had a lower mortality (adjusted HR (aHR) 0.91 and 0.66) and risk of cardiovascular disease outcomes (aHR 0.94 and 0.49). Compared to men, women had significantly lower mortality (aHR: 0.83 for Chinese, 0.78 for South Asian and 0.77 for white) and cardiovascular disease outcomes (0.72 for Chinese, 0.63 for South Asian and 0.65 for white).

Conclusions South Asian patients had higher rates of hypertension compared to the other ethnic groups. South Asian and Chinese patients had a lower risk of death and developing cardiovascular outcomes compared to whites. Women with hypertension have a better prognosis than men regardless of ethnicity.

INTRODUCTION

Asian populations have had an increased incidence of cardiovascular disease including stroke,[1–4] acute myocardial infarction[5] and heart failure[6–8] over the past two decades that has now surpassed that of many Western populations. These diseases account for 30% of the global mortality, and over 80% of cardiovascular disease deaths are from developing countries.[9] The Sino-MONICA-Beijing stroke study[1] reported a higher incidence of stroke, particularly hemorrhagic stroke, in China compared to other countries. South Asian men and women living in India, the UK and North America also have substantially higher rates of deaths due to heart disease compared to white populations.[10 11]

A substantial component of this increase in cardiovascular disease is thought to be due to rapid modernisation and urbanisation of Asian populations leading to consumption of poor diets, and sedentary lifestyles.[12 13] These factors may predispose these populations to higher rates of hypertension, a leading risk factor for cardiovascular disease. In the INTERHEART study, 66% of stroke was attributable to hypertension while 17–22% of acute myocardial infarction in South Asian and Chinese populations was attributable to hypertension.[14 15]

Demographic characteristics in industrialised countries including Canada have been changing dramatically. The Asian population is a major source of immigration to Western countries and has shown the fastest growth. It has been reported that women of Chinese descent die from stroke more often than women of European descent, and that women of South Asian descent die from cardiovascular disease at a substantially higher rate.[10] Stroke was more common among Pakistani men than white Scottish and Chinese men.[16] Given the disproportionate mortality seen among women of varying ethnic origin, it is crucial to identify the key explanatory factors for these differences. Thus, we compared cardiovascular disease events (any of stroke, myocardial infarction or heart failure) and all-cause mortality within a follow-up period of up to 9 years by sex among Chinese, South Asian and white patients with newly diagnosed hypertension. Understanding the incidence and risk of development of cardiovascular disease is essential for public health programming and planning.

METHODS

Data sources

We used four routinely collected administrative datasets from the Canadian provinces of British Columbia (BC) and Alberta (AB). These provinces have a catchment population of 7.4 million and according to the Canadian census 2006, 43% of all Chinese (ie, 527 500) and 34% of all South Asians (ie, 366 175) in Canada reside in these two provinces.[17] The administrative data included hospital discharge abstracts, physician claims, population registry and vital statistics registries from 1994 to 2005. These databases were linked using a unique

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personal identifier (ie, personal health number) or personal information.[18]

Hospital discharge abstracts include all inpatient services for all provincial residents and contain primary and secondary discharge diagnosis codes of the International Classification of Diseases, 9th revision (ICD-9) and 10th revision (ICD-10), with up to 25 diagnosis fields per individual admission. Physicians submit claims for their services, which contain at least one ICD-9 diagnosis. Thus, physician claims files contain clinical information for nearly all patients who are covered by the provincial insurance programme regardless of services location (including emergency department, hospital and outpatient clinic) and physician specialty. In the universal health care programme, virtually all residents from provinces are registered with provincial insurance programmes. The provincial health care insurance registries contain information such as surname, age, sex and postal code for residents of the province. Population counts from provincial registries correspond to census population estimates but unlike census data, also provide actual counts in inter-censal years.[19] Vital statistics registries are updated regularly and include date of death.

Study population: newly diagnosed hypertensive patients

Hypertension cases were identified using a validated case definition for Canadian hospital discharge and physician claims administrative databases (sensitivity 75%, specificity 94%, positive predictive value 81%, negative predictive value 92%).[20] This definition had a similar validity across sex, age groups and rural/urban residential areas. We excluded patients who were non-AB or non-BC residents, were less than 20 years of age or had gestational hypertension (which was identified with ICD coding for an obstetrical event within 5 months of hypertension diagnosis).

To determine incident hypertension cases, we assigned the first date of physician visit or hospitalisation with hypertension diagnosis code as the index date for all hypertensive patients in the period 1993–2007, using a 3-year washout period to determine incident status to minimise misclassifying prevalent cases as incident. About 80% of ethnic populations saw physicians at least once a year in Canada.[21] Three year-washout through physician claims and inpatient data could exclude most of the patients with the condition. Thus, incident cases are determined for each year in the period 1997–2005. To avoid falsely attributing an incident case of hypertension diagnosis to newly-arrived immigrants, we only included those cases with a valid provincial healthcare insurance registration for at least 3 years prior to their hypertension diagnosis.

Outcomes

We defined outcomes in the period 1997–2006, with at least 1 year and up to 9 years' follow-up. Time to death after hypertension diagnosis was assessed from vital statistics data. Development of cardiovascular events was defined as occurrence of hospitalisation for myocardial infarction, heart failure or stroke, using hospital discharge abstracts and validated ICD coding algorithms.[22–24] For analysis of cardiovascular endpoints, we excluded patients with a diagnosis of these outcomes within at least 3 years prior to hypertension diagnosis, and any patients with co-morbidity claims for ischaemic heart disease, cerebrovascular disease, heart failure or previous myocardial infarction at least 3 years prior to hypertension diagnosis were excluded. Patients were censored if they moved out of province, reached the end of the observation period or died.

Ethnic group and potential confounding:

Self-reported ethnicity is not documented in administrative data in Canada. Therefore we used a validated unique surname analysis to categorise patients as South Asian (from Pakistan, India or Bangladesh) or Chinese (ancestry from China, Taiwan or Hong Kong). Patient surnames, recorded in provincial registries, were merged with Quan's Chinese name list[25] and the Nam Pehchan computer program to define Chinese and South Asian ethnicity. Compared to self- report, the sensitivity for Quan's surname algorithm was 78%, specificity was 99.7% and the

Table 1 Baseline characteristics by ethnicity among patients with newly diagnosed hypertension

	Chinese		South Asian		White		
Variables	N	%	N	%	N	%	p Value
Total	49892	100	39175	100	841277	100.0	
Men	23978	48.1	19342	49.4	403256	47.9	<0.01
Age							
20–49	14065	28.2	11381	29.1	219811	26.1	<0.01
50–64	17482	35.1	14318	36.5	295583	35.1	
65–74	11742	23.5	7930	20.2	178157	21.2	
≥75	6603	13.2	5546	14.2	147726	17.6	
Income quintile							
1 (lowest)	12068	24.2	7002	17.9	173805	20.7	<0.01
2	11338	22.7	7022	17.9	163784	19.5	
3	8534	17.1	7778	19.9	161117	19.2	
4	7841	15.7	8156	20.8	154202	18.3	
5 (highest)	8901	17.8	6762	17.3	139315	16.6	
Missing	1210	2.4	2455	6.3	49054	5.8	
Region of residence							
Rural	863	1.7	4409	11.3	147626	17.5	<0.01
Urban	48647	97.5	34509	88.1	685396	81.5	
Missing	382	0.8	257	0.6	8255	1.0	
Charlson co-morbidities							
Renal disease	880	1.8	668	1.7	15506	1.8	>0.05
Peripheral vascular disease	936	1.9	1016	2.6	29400	3.5	<0.01
Diabetes	2188	4.4	2158	5.5	47622	5.7	<0.01
Cancer	1958	3.9	2229	5.7	58083	6.9	<0.01
Chronic pulmonary disease	5637	11.3	5631	14.4	136606	16.2	<0.01
Liver disease	804	1.6	360	0.9	8376	1.0	<0.01
HIV	18	0.04	34	0.09	635	0.08	<0.01
Rheumatic disease	364	0.7	406	1.0	10712	1.3	<0.01
Dementia	335	0.7	456	1.2	14147	1.7	<0.01
Peptic ulcer disease	1694	3.4	1396	3.6	22274	2.5	<0.01
Myocardial infarction	884	1.8	1942	5.0	46954	5.6	<0.01
Cerebrovascular disease	1708	3.4	1826	4.7	47675	5.7	<0.01
Congestive heart failure	1370	2.7	2009	5.1	52488	6.2	<0.01
Paraplegia and hemiplegia	463	0.9	305	0.8	7878	0.9	>0.05
Number of Charlson co-morbidities							
0	36215	72.6	25828	65.9	530360	63.0	<0.01
1	12436	24.9	11656	29.8	264877	31.5	
≥2	1241	2.5	1691	4.3	46040	5.5	

positive predictive value was 81%. Validation studies for the Nam Pehchan surname algorithm report a sensitivity of 90–94%, specificity of 99.4% and positive predictive value of 63–96%.[26 27] All remaining patients are referred to as white patients given that less than 7% of this group includes other non-South Asian, non-Chinese minority persons according to the 2001 census information.[17]

To control for severity of illness at time of diagnosis of hypertension, we measured clinical variables from Charlson co-morbidities[28 29] (ie, peripheral arterial disease, cancer, dementia, chronic pulmonary disease, diabetes, connective tissue disease–rheumatic disease, peptic ulcer disease, mild liver disease, paraplegia and hemiplegia, moderate or severe liver disease, metastatic carcinoma and AIDS/HIV). Socioeconomic status was assessed using area level median income derived from the Canadian census 2001 socioeconomic file after patients' postal codes are converted into census enumeration area using the Statistics Canada postal code conversion file (2001). Median income data was missing in 2.4% of Chinese, 6.3% of South Asian and 5.8% of white patients. A missing value was assigned to these cases and retained in all models.

Statistical analysis

Incidence rates of diagnosed hypertension per 1000 population in Alberta were calculated using new cases for a given year divided by the aggregated population counts based on registry data for the corresponding ethnic group. Incidence rates were directly standardised to the 2001 Canadian census age and sex data. Cox proportional hazards models adjusted for age, rural versus urban, area level income quintile and Charlson co-morbid conditions were constructed to determine the association between the endpoints and ethnicity. Then ethnicity and sex interaction was analysed in the Cox models; proportionality assumptions for Cox models were met. All analyses were conducted using SAS V.9.2. This study was approved by the local ethics boards.

RESULTS

This study included 49 892 (5.4%) Chinese, 39 175 (4.2%) South Asian and 841 277 (90.4%) white patients with newly diagnosed hypertension (table 1). At time of diagnosis, Chinese and South Asian patients were younger than white patients and had fewer co-morbid conditions compared to white patients. For example, the lower diabetes prevalence of 4.4% for Chinese

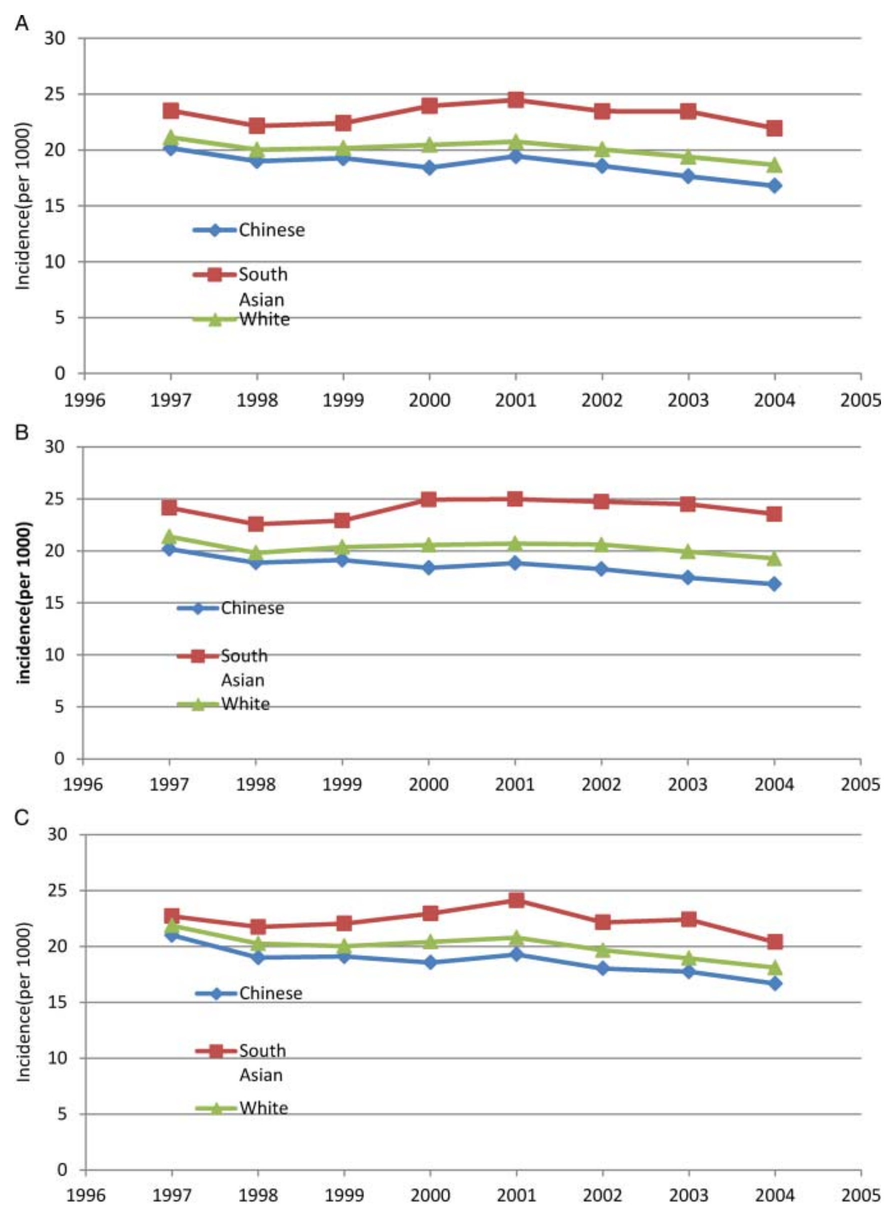

Figure 1 Hypertension incidence among population 20 years and older. (A) For total: age and sex adjusted incidence (1/1000). (B) For men: age adjusted incidence (1/1000). (C) For women: age adjusted incidence (1/1000). This figure is only reproduced in colour in the online version.

and 5.5% for South Asians than the 5.7% for whites was related to the difference in age composition. More Chinese than South Asian and white patients resided in low-income neighbourhoods, and a minority (less than 12%) of Chinese and South Asian patients resided in rural areas. The age–sex adjusted incidence of hypertension ranged from 16/1000 to 25/1000 in the study years (figure 1) and was the highest for South Asian and the lowest for Chinese patients.

The combined cardiovascular endpoint was most common in white patients. Chinese patients had fewer hospitalisations for myocardial infarction, heart failure and stroke (table 2) than both South Asians and white patients.

After adjustment for age, sex and other potential confounding (table 3), Chinese and South Asian patients had a significantly lower risk of death, combined cardiovascular complications and hospitalisation for myocardial infarction, heart failure and stroke. Chinese and South Asian men and women were less likely to die or be hospitalised for the combined cardiovascular endpoints compared to their white counterparts. However, South Asian men were as likely as white men to have myocardial infarction (adjusted HR (aHR): 0.95, 95% CI 0.89 to 1.01). Heart failure incidence was similar between South Asian and white women (aHR: 1.02, 95% CI 0.91 to 1.15). Women had significantly fewer cardiovascular events and lower mortality than men across the three ethnic populations.

Table 2 All-cause mortality and incidence for hospitalised cardiovascular disease* (per 1000 person-years, 95% CI) by ethnicity among patients with newly diagnosed hypertension

	Men			Women			Total		
Outcome	Chinese	South Asian	White	Chinese	South Asian	White	Chinese	South Asian	White
All-cause mortality	12.8 (12.2 to 13.4)	20.0 (19.1 to 20.9)	26.5 (26.2 to 26.7)	12.2 (11.7 to 12.8)	18.0 (17.2 to 18.8)	21.8 (21.6 to 22.0)	12.5 (12.1 to 12.9)	18.9 (18.4 to 19.5)	24.0 (23.8 to 24.1)
Cardiovascular disease	10.5 (9.9 to 11.1)	21.0 (20.1 to 22)	24.7 (24.5 to 25)	8.7 (8.2 to 9.2)	15.9 (15.1 to 16.7)	18.5 (18.4 to 18.7)	9.6 (9.2 to 10.0)	18.3 (17.7 to 19)	21.4 (21.3 to 21.6)
Myocardial infarction	4.3 (3.9 to 4.7)	9.7 (9.1 to 10.4)	11.3 (11.2 to 11.5)	2.3 (2 to 2.5)	5.6 (5.1 to 6)	6.4 (6.3 to 6.5)	3.2 (3 to 3.5)	7.6 (7.2 to 8)	8.7 (8.6 to 8.8)
Heart failure	4.0 (3.6 to 4.4)	8.2 (7.7 to 8.8)	10.4 (10.3 to 10.6)	3.8 (3.5 to 4.1)	7.9 (7.3 to 8.5)	9 (8.9 to 9.1)	3.9 (3.6 to 4.1)	8.1 (7.7 to 8.5)	9.7 (9.6 to 9.8)
Stroke	4.6 (4.2 to 5)	6.7 (6.2 to 7.3)	8.3 (8.1 to 8.4)	4.4 (4.1 to 4.8)	6 (5.5 to 6.5)	7.2 (7.1 to 7.3)	4.5 (4.2 to 4.8)	6.4 (6 to 6.7)	7.7 (7.6 to 7.8)

*Cardiovascular disease includes myocardial infarction, heart failure and stroke. Analysis is based on up to 9 years' follow-up of patients with hypertension.

DISCUSSION

Using a large population cohort we found that the incidence of diagnosed hypertension was highest among South Asian, compared with Chinese and white patients. Chinese and South Asian hypertensive patients, however, had significantly lower mortality and cardiovascular disease rates compared to white hypertensive patients. Women with hypertension had a better prognosis than men regardless of ethnicity.

The incidence of diagnosed hypertension was higher in South Asians, and lower in Chinese although ethnic populations see physicians as frequently as whites in Canada. The Canadian Community Health Survey shows that the age and sex adjusted hypertension prevalence rate of 19.2% for Chinese and 18.7% for South Asian is slightly higher than 17.1% for white patients.[21] The reasons for the higher rates of hypertension in South Asians and conversely, lower rates in Chinese are unclear. Risk factors from prenatal through early and later life, and migration, health literacy and other socio-cultural factors may provide significant insight into ethnic disparities in the development of hypertension. Physical inactivity, increased body mass index and insulin resistance are likely to cause higher sympathetic activity and hypertension.[30] Low birth weight, which occurs in up to 20% of live births in India,[31] is associated with a higher frequency of hypertension,[32] and South Asian patients have a higher prevalence rates of renal disease,[33] which may be associated with increases in blood pressure. It is unknown whether South Asian or Chinese populations have greater salt sensitivity compared to other ethnic groups, although this is an underlying cause in black hypertensive patients.[34] Other factors implicated as secondary causes of hypertension, including increased alcohol intake, are lower in South Asian and Chinese persons as shown by national surveys.[35 36]

One of the first reports of the immigration–hypertension link[37] showed that Punjabis living in the UK had higher blood pressures and obesity rates than their siblings in India. Increasing hypertension (and/or its risk factors) have been reported for recent versus more acculturated South Asian and Chinese immigrants from health surveys in Canada[6] and the USA,[38] and in a

Table 3 Risk adjusted HR (95% CI) for all-cause mortality and cardiovascular disease events among patients with newly diagnosed hypertension

Variable	All-cause mortality	Cardiovascular disease*	Myocardial infarction	Heart failure	Stroke
Adjusted for age and sex					
Chinese versus white	0.57 (0.56 to 0.59)	0.46 (0.44 to 0.48)	0.37 (0.34 to 0.4)	0.42 (0.39 to 0.45)	0.61 (0.57 to 0.65)
South Asian versus white	0.88 (0.85 to 0.91)	0.93 (0.89 to 0.96)	0.92 (0.88 to 0.97)	0.92 (0.87 to 0.96)	0.9 (0.85 to 0.95)
Among men					
Chinese versus white	0.52 (0.5 to 0.55)	0.43 (0.41 to 0.46)	0.37 (0.34 to 0.41)	0.39 (0.36 to 0.43)	0.57 (0.52 to 0.62)
South Asian versus white	0.86 (0.82 to 0.9)	0.93 (0.88 to 0.97)	0.93 (0.87 to 0.99)	0.89 (0.82 to 0.95)	0.9 (0.83 to 0.98)
Among women					
Chinese versus white	0.63 (0.6 to 0.66)	0.5 (0.47 to 0.53)	0.37 (0.33 to 0.41)	0.45 (0.41 to 0.49)	0.65 (0.6 to 0.71)
South Asian versus white	0.9 (0.87 to 0.95)	0.93 (0.88 to 0.98)	0.91 (0.84 to 0.99)	0.95 (0.88 to 1.02)	0.89 (0.82 to 0.97)
Among Chinese					
Women versus men	0.77 (0.73 to 0.83)	0.7 (0.64 to 0.76)	0.45 (0.39 to 0.52)	0.78 (0.69 to 0.88)	0.82 (0.73 to 0.92)
Among South Asian					
Women versus men	0.69 (0.64 to 0.73)	0.61 (0.57 to 0.66)	0.46 (0.42 to 0.52)	0.73 (0.66 to 0.81)	0.71 (0.64 to 0.8)
Among white					
Women versus men	0.67 (0.66 to 0.67)	0.63 (0.62 to 0.64)	0.48 (0.47 to 0.49)	0.7 (0.69 to 0.72)	0.73 (0.71 to 0.74)
Adjusted for age, number of co-morbidities†, income quintile, and rural and urban residence					
Chinese versus white	0.66 (0.64 to 0.68)	0.49 (0.47 to 0.51)	0.39 (0.36 to 0.42)	0.47 (0.44 to 0.5)	0.66 (0.62 to 0.70)
South Asian versus white	0.91 (0.88 to 0.94)	0.94 (0.91 to 0.98)	0.94 (0.90 to 0.99)	0.95 (0.90 to 1.00)	0.92 (0.87 to 0.97)
Among men					
Chinese versus white	0.62 (0.59 to 0.65)	0.46 (0.43 to 0.49)	0.39 (0.36 to 0.43)	0.44 (0.41 to 0.49)	0.62 (0.57 to 0.68)
South Asian versus white	0.89 (0.85 to 0.93)	0.94 (0.9 to 0.99)	0.95 (0.89 to 1.01)	0.92 (0.85 to 0.99)	0.92 (0.85 to 1.00)
Among women					
Chinese versus white	0.70 (0.67 to 0.74)	0.70 (0.64 to 0.76)	0.71 (0.56 to 0.91)	0.65 (0.56 to 0.74)	0.74 (0.67 to 0.81)
South Asian versus white	0.93 (0.89 to 0.97)	0.91 (0.84 to 0.98)	0.69 (0.53 to 0.89)	1.02 (0.91 to 1.15)	0.92 (0.84 to 1.00)
Among Chinese					
Women versus men	0.83 (0.78 to 0.89)	0.72 (0.66 to 0.78)	0.46 (0.4 to 0.53)	0.83 (0.73 to 0.94)	0.85 (0.75 to 0.95)
Among South Asian					
Women versus men	0.78 (0.73 to 0.83)	0.63 (0.59 to 0.68)	0.48 (0.43 to 0.53)	0.80 (0.72 to 0.88)	0.75 (0.67 to 0.84)
Among white					
Women versus men	0.77 (0.76 to 0.78)	0.65 (0.64 to 0.66)	0.50 (0.49 to 0.51)	0.78 (0.76 to 0.79)	0.77 (0.76 to 0.79)

*Cardiovascular disease includes myocardial infarction, heart failure and stroke. Analysis is based on up to 9 years' follow-up of patients with hypertension.
†The co-morbidites include: myocardial infarction, heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease–rheumatic disease, peptic ulcer disease, diabetes with and without complications, paraplegia and hemiplegia, renal disease, liver disease (mild, moderate or severe), cancer and metastatic carcinoma, AIDS/HIV. Myocardial infarction, heart failure and cerebrovascular disease were excluded when estimating the HR for outcomes of myocardial infarction, heart failure or stroke.

record-linkage study in the UK.[39] In Canada, as duration of residency increases, both South Asians and Chinese immigrants report increasing rates of hypertension, smoking, psychological stress (in South Asian women especially), obesity, salt consumption, and inadequate fruit and vegetable intake, and low levels of physical activity (especially among South Asians).[6]

Our long-term follow-up of hypertension patients illustrated that Chinese and South Asian patients have better prognosis compared to their white hypertension counterparts even after adjusting for co-morbid conditions, with the exception that South Asian men had a similar risk of myocardial infarction and South Asian women had a similar risk of heart failure relative to white patients. The underlying reason for lower mortality and cardiovascular disease in Chinese and South Asian patients relative to white patients with hypertension may be related to differences in cardiovascular risk factors and disease management. A systematic review reported lower or similar blood pressure in South Asian hypertensive patients relative to white hypertensive patients.[40] Chinese patients have fewer cardiovascular disease risk factors in general. Liu *et al*[35] analysed the Canadian Community Health Survey and found the prevalence of smoking was much lower among the Chinese and South Asians compared to whites. Although the Chinese are less physically active overall, they become much more physically active once they develop cardiovascular disease events. King *et al*[41] found that Chinese patients with heart disease actively seek information and opinions on their disease management from multiple sources, attempt to maintain good relationships with healthcare providers, and are able to rely strongly on their family (ie, spouse and children) for transportation and language translation. These findings of better long-term prognosis in Chinese and South Asian populations is consistent with other studies examining myocardial infarction, diabetes and end-stage renal failure.[5 42 43] Although South Asians and Chinese are more likely to get prescriptions for evidence-based therapies following acute myocardial infarction compared with whites, they are less likely to adhere to ACE inhibitors, β-blockers and statins.[44] Blood pressure may be an important factor but this has not been well studied. Wood *et al*[45] are collecting data to show ethnic differences in frequency of blood pressure monitoring, threshold of diagnosis and treatment targets in the UK. Our study of analysing linked administrative data is limited by lacking behavioural and cardiovascular risk factors (such as immigration status, length of stay in Canada, smoking status, physical exercise, obesity, blood pressure level and medication adherence). Thus we could not specify major contributors to ethnic variation in hypertension incidence and outcome.

Women had a much better outcome than men and the magnitude of the sex difference was also similar across the three ethnic populations with hypertension, even after adjustment for potential confounding. This finding is not unique to patients with hypertension alone. The sex difference in outcome has been repeatedly reported in cardiovascular diseases.[46–48] Nair *et al*[49] reported that Canadian cardiovascular diseases were consistently higher for men than for women regardless of immigration status and ethnicity. Schmaltz *et al*[50] reported that mortality risk was highest for men living alone and lowest for women living with others among patients with acute myocardial infarction. King *et al*[51] reported that sex disparity in mortality after cardiac catheterisation is dependent on time and is treatment-specific. The lower blood pressure in women than in men may contribute to the sex difference. The mechanism for the sex gap has not been revealed.

This study represents a large population-based cohort with long-term follow-up of almost 900 000 patients. However, its limitations must be noted. We used surname analysis to determine ethnicity instead of the gold standard, self report. Although the specificities are moderate, this may have underestimated differences between groups. We were unable to measure hypertension control and this may have affected prognosis between the ethnic groups. However, a previous survey in Ontario indicated that blood pressure control in South Asian and East Asian patients was similar to that in whites.[52] Socioeconomic status was defined using medium income. The geo-code based method may not measure individual household income, particularly for ethnic populations who are more likely to reside in affluent areas compared with the general population. Outcome related factors including immigration status, length of stay in Canada, cardiovascular risk factors (such as smoking status, blood pressure and physical exercise) and medication adherence were not considered.

CONCLUSION

Although the hypertension incidence was high among South Asians, they had a lower mortality compared to whites. Chinese patients had both a lower incidence of hypertension and a lower risk of developing cardiovascular endpoints or mortality compared to whites and South Asians. Sex differences in hypertension outcome are independent of ethnicity. Future hypertension efforts should focus on prevention of hypertension in South Asian populations. More research is needed on the underlying causes for ethnic differences in prognosis in hypertension.

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Contributors HQ and NK contributed substantially to conception, design, analysis and interpretation of data; they drafted the article, and gave final approval of the version to be published. GC contributed substantially to design, analysis and interpretation of data, and gave final approval of the version to be published. RW contributed to acquisition of data, revised the article critically for important intellectual content, and gave final approval of the version to be published. AW, SD, KT, NC, BH, MH, HJ and FM all substantially contributed to conception and design, and interpretation of data, revised the article critically for important intellectual content, and gave final approval of the version to be published. HQ is responsible for the overall content as guarantor.

Competing interests None.

Ethics approval Conjoint Health Research Ethics Board, University of Calgary, Alberta Canada.

Provenance and peer review Not commissioned; externally peer reviewed.

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