

# Disparities in Mortality Patterns Among Canadian Immigrants and Refugees, 1980–1998: Results of a National Cohort Study

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This study examines mortality patterns among Canadian immigrants, including both refugees and non-refugees, 1980–1998. Records of a stratified random sample of Canadian immigrants landing between 1980–1990 (N = 369,936) were probabilistically linked to mortality data (1980–1998). Mortality rates among immigrants were compared to those of the general Canadian population, stratifying by age, sex, immigration category, region of birth and time in Canada. Multivariate analysis examined mortality risks for various immigrant subgroups. Although immigrants presented lower all-cause mortality than the general Canadian population (SMR between 0.34 and 0.58), some cause-specific mortality rates were elevated among immigrants, including mortality from stroke, diabetes, infectious diseases (AIDS and hepatitis among certain subgroups), and certain cancers (liver and nasopharynx). Mortality rates differed by region of birth, and were higher among refugees than other immigrants. These results support the need to consider the heterogeneity of immigrant populations and vulnerable subgroups when developing targeted interventions.

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**KEY WORDS:** mortality; immigration; refugees; longitudinal; record linkage.

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## INTRODUCTION

In the last few decades, the foreign born population in Canada has increased as the country received many new immigrants from all over the world, (1). In 2001, the population born outside of Canada

represented 18.4% of the population (1), an increase from 10.7% in 1981 (2). The ethno-cultural profile of the country has also changed, as new immigrants are more often from Asia, compared to previous cohorts (pre-1980) who tended to come from European countries (1, 3).

Comprehensive research on the health of this increasingly significant and diverse population in Canada is lacking, particularly on chronic or non-communicable diseases and longer-term health outcomes. Research to date has shown that immigrant populations may present elevated rates of certain communicable diseases such as HIV/AIDS and tuberculosis (3–5); moreover national immigration policies to date have predominantly addressed health concerns in the area of communicable diseases (6, 7). Research conducted on chronic diseases generally suggests that overall, immigrants, especially those who have landed recently, exhibit a “healthy migrant

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effect”, with somewhat lower disease rates than their Canadian-born counterparts (3, 4, 8–15). This finding may be due to the practice of positive health behaviors, genetic factors, the requirement of basic health to be physically capable of migrating or exclusion of the unhealthiest immigrants from entry through medical screening. (3, 8, 11, 16). However, considering that the health of national immigrant populations may be determined by an array of factors including personal characteristics, length of time in the country, cultural and country of origin factors, the migration experience itself, and dynamic factors such as international policy (3, 4, 6, 8–16), this general finding on immigrant health overall may be misleading. In fact, it has been suggested that important disparities exist between the diverse subgroups of immigrants with various social, cultural, demographic, ethnic, or economic characteristics possibly presenting disease vulnerabilities (3, 17–21).

Research on the health of immigrant subgroups is currently piecemeal. This is largely due to the fact that data sources often do not include the detailed information on immigrants required for such research; for example, variables to differentiate the foreign born from other Canadians, and socio-demographic subgroups such as those with and without official language skills (3, 4, 8–15). Administrative data sources may also lack information needed to control for continued national residency, which is important considering that studies may report spuriously low rates for health outcomes due to migration biases or losses to follow-up, i.e., by not counting events that occurred in other countries and including immigrants who left the country in the denominator population (22–27). While in recent years the inclusion of immigration-related variables in national population surveys has improved some of the barriers to immigrant health research, and has allowed migration and culture-sensitive research based on administrative and survey datasets, survey data sources still lack variables on immigrant subgroups such as refugees and sufficient sample size for detailed inter-subgroup comparisons. Moreover, immigrant populations may be underrepresented in survey-based data for reasons such as cultural barriers and lack of official language skills (3, 28).

In this context the need for research that optimizes the use of available national administrative databases on immigrants and health through record linkage was recognized in a recent report (3). The current study linked national administrative data sources to assess the health of immigrants in Canada

including the understudied immigrant subgroups in terms of mortality from chronic diseases, injuries and infectious diseases. The results from this study provide a comprehensive and informative picture of health risks in immigrant populations in Canada, particularly with respect to chronic diseases.

## METHODS

A historical cohort record linkage study design was used. The sample frame consisted of immigration records collected for administrative purposes on all those achieving landed immigrant status (i.e., “landing”) in Canada between January 1, 1980 and December 31, 1990. This sample frame does not include illegal immigrants, nor those denied landed immigrant status. The immigrant cohorts are stratified random samples from the sample frame. The refugee sample consists of every second record in this group ( $n = 128,962$ ) and the non-refugee sample consists of every fifth record of this group ( $n = 241,010$ ) (Table I). Refugees were over-sampled to increase the statistical power for this subgroup of immigrants. This random sample represented approximately 50 and 20% of all refugee and non-refugee immigrants who landed in Canada during the study period respectively. Variables in the dataset included landing date, birth date, sex, birthplace, immigration category, and longitudinal flags indicating tax-filing and emigration status. These flags, which are incorporated into the Longitudinal Immigration Database (IMDB) by Statistics Canada through a regular link to the taxation records, provided a means to verify immigrants’ continued presence in Canada (29). Specifically, the tax-filing flag indicated whether or not an individual filed taxes in a given year.

Death records were obtained from the Canadian Mortality Database (CMDB) (1980–98). The records in these nationally managed databases are from provincial and territorial registries of vital statistics. The CMDB includes information recorded on the death registration. Causes of death were recorded as 9<sup>th</sup> Edition International Classification of Disease codes (ICD-9).

A Generalized Iterative Record Linkage System was used to probabilistically record link the immigrant cohort to the CMDB (30). The linkage was based on phonetically standardized immigrant names, sex, birth date and birthplace. Records were eliminated if they were incomplete or contained a deportation date. Please see Appendix II for further

**Table I.** Distribution of Immigrants in the sample Frame and Cohort and the General Canadian Population with Respect to Linkage Variables (Age, Sex and Immigrant Category) and Region of Birth

Characteristics	Refugees				Non-refugees				Canada 1986 <sup>c</sup>	
	Sample frame <sup>a</sup>		Cohort <sup>b</sup>		Sample frame <sup>a</sup>		Cohort <sup>b</sup>		Count	Percent
	Count	Percent	Count	Percent	Count	Percent	Count	Percent		
<b>Sex</b>										
Male	151,215	58.6	75,607	58.6	569,940	47.3	114,015	47.3	12,341,850	49.3
Female	106,710	41.4	53,355	41.4	635,113	52.7	126,995	52.7	12,679,850	50.7
<b>Age group</b>										
0–19	92,172	35.7	46,080	35.7	351,105	29.1	70,227	29.1	7,318,600	29.3
20–44	142,080	55.1	71,040	55.1	549,313	45.6	109,860	45.6	10,362,650	41.4
45–64	22,116	8.6	11,060	8.6	234,932	19.5	46,981	19.5	4,845,300	19.4
65+	1,557	0.6	782	0.6	69,703	5.8	13,942	5.8	2,495,150	10.0
<b>Region of birth<sup>d</sup></b>										
Europe total	80,002	31	40,000	31.0	296,855	24.6	59,373	24.6	2,443,650	9.8
Western Europe	57,493	22.3	28,747	22.3	265,650	22	53,129	22		
Eastern Europe & former Soviet Union	22,509	8.7	11,253	8.7	31,205	2.6	6,244	2.6		
Asia total	130,270	50.5	65,281	50.6	594,519	49.3	118,905	49.3	691,900	2.8
Middle East & West Asia	14,063	5.5	7,177	5.6	103,213	8.6	20,642	8.6		
North East Asia	12,444	4.8	6,223	4.8	200,203	16.6	40,043	16.6		
South Asia	2,895	1.1	1,447	1.1	128,201	10.6	25,639	10.6		
South East Asia	100,868	39.1	50,434	39.1	162,902	13.5	32,581	13.5		
Oceania & Pacific Islands	98	0	51	0	18,675	1.5	3,733	1.5		
Africa	14,737	5.7	7,223	5.6	38,678	3.2	7,735	3.2	114,500	0.5
USA	700	0.3	349	0.3	69,948	5.8	13,992	5.8	287,750	1.2
South & Central America total	31,898	12.3	15,949	12.3	184,776	15.4	36,956	15.4	346,850	1.4
Caribbean	833	0.3	417	0.3	92,348	7.7	18,470	7.7		
South & Central America	31,065	12	15,532	12	92,428	7.7	18,486	7.7		
Canada	—	—	—	—	—	—	—	—	21,074,650	84.2

<sup>a</sup>The sample frame (1,462,978 records) includes all non-refugee and refugee immigrants who landed in Canada between January 1st 1980 and December 31st 1990 except deportees and immigrants who had missing values of the linkage variables immigration category, sex and birth date (<0.5% of records).

<sup>b</sup>The immigrant cohorts are random samples of immigrants from the sample frame. The refugee sample consisted of every second record (128,962 records). The non-refugee sample consisted of every fifth record (241,010 records).

<sup>c</sup>Source: Statistics Canada, Census 1986.

<sup>d</sup>The percentages by Region of Birth may not add to 100% due to small numbers of unknown places of birth in both the immigrant cohort and the Canadian population, 0.1% and 0.25%, respectively.

details on the quality assurance of the record linkage process.

Person-years of follow-up for the immigrant cohort were calculated using Epicure and SAS programs. Landing date was used as the follow-up start date. Originally the study intended to use the tax filing flags to “censor” immigrants who no longer resided in Canada by excluding from the study the immigrants who never filed income taxes, and by determining a more appropriate end-date of follow-up for those who stopped filing taxes and are likely to have re-migrated elsewhere. It was deemed this approach would allow the adjustment of estimates for residency in Canada. Preliminary analysis of the data, however, indicated that this adjustment method excluded many deaths that occurred among immi-

grants who continued to reside in Canada, but were never flagged as having filed taxes during the study (2,950 deaths among non-refugees and 543 deaths among refugees). To avoid excluding these migrants, it was decided that those never flagged as having filed taxes during the study period would be followed until either their death date, emigration date or end of study date (December 31, 1998). For those migrants flagged as having filed taxes at least once during the study period, it was found that ending follow-up on the last date that the immigrant filed taxes in Canada was an adequate adjustment method. In particular, during the years following the last tax filing flag for cohort members who filed taxes at least once and then stopped filing (for reasons other than death), very few deaths occurred (although approximately

640 deaths were expected). This suggested that these immigrants probably no longer resided in Canada. Thus the study exit date used for these migrants was one of death date, emigration date, end of the study or last date that taxes were filed in Canada.

Age-standardized mortality rates (ASMRs) were calculated by strata (immigrant type, sex, country and region of birth, time in Canada, etc.) using the direct method. The standard population is the 1991 Canadian general population. An indirect method was applied to calculate standardized mortality ratios (SMRs). The cohort of all Canadians who were resident in Canada from 1980–1998 was used to obtain corresponding age-adjusted rates for the general Canadian population (Census 1991). Mortality rates were compared between immigrants and the general population, and between subgroups of immigrants, using comparative mortality figures (CMFs). Rates and ratios were calculated for all-cause mortality, ICD-9 chapters and selected causes.

Poisson regression was used to examine the relationship between all-cause mortality and potential determinants including: region of birth, time in Canada, sex, education at landing, immigration period, destination province, language skills at landing, the occupation that the immigrant intended to pursue in Canada and marital status. The regression analyses were conducted for refugees and non-refugees in turn, and using different age groups (19 age groups vs. 4 age groups) to control for possible age effects.

## RESULTS

### Characteristics of the Immigrant Cohort

As described in Table I, the immigrant sample was representative of all immigrants to Canada for the study time period with respect to sex, age, and region of birth. While there were more men than women among refugees (58.6% vs. 41.4% respectively), there were more women than men (52.7% vs. 47.3%) among non-refugees. Immigrants were relatively young, with approximately 80% of the population aged less than 45 at landing. Over the time period, immigrants were most frequently of European or Asian origin. Table I additionally includes information on the characteristics of the general Canadian population in 1986.

### Mortality

Overall, ASMRs were low for all immigrant subgroups compared to the general Canadian population, irrespective of the time since immigration, as shown by the CMF values significantly less than 1. There was, however, evidence of a decreasing healthy immigrant effect with increasing exposure, except among refugee men (Table II). The difference in mortality between immigrants and Canadians was more pronounced among males than females, and

**Table II.** Direct Age Standardized Mortality Rates (ASMR), Comparative Mortality Figures (CMF) and 95% Confidence Intervals (CI) for All-Cause Mortality (1980–98) in Immigrants by Years in Canada

Category	Exposure	Person years	<i>N</i>	ASMR <sup>a</sup>	CMF <sup>b</sup>	CI
<i>Non-refugees (years)</i>						
Males	<5	454,410	745	306.16	0.33	0.30–0.35
	5–9	545,211	1,312	314.76	0.34	0.32–0.36
	10+	386,498	1,669	358.39	0.38	0.36–0.40
Females	<5	506,643	612	189	0.34	0.31–0.37
	5–9	610,146	1,262	226.81	0.41	0.38–0.43
	10+	439,887	1,669	250.33	0.45	0.43–0.47
<i>Refugees</i>						
Males	<5	301,987	199	415.93	0.55	0.48–0.61
	5–9	365,421	379	500.89	0.60	0.54–0.66
	10+	273,505	499	579.45	0.38	0.25–0.52
Females	<5	213,203	101	304.92	0.55	0.37–0.73
	5–9	258,415	188	274.55	0.49	0.40–0.59
	10+	199,865	355	410.21	0.74	0.65–0.82

<sup>a</sup>ASMR is the direct age standardized mortality rate. Rates are for the 1980–1998 period. The standard population is Canada 1991. The comparative ASMR for the general Canadian population (1980–1998) is 936.4 for males and 557.1 for females.

<sup>b</sup>CMF is the comparative mortality figure. The CMF compares the ASMR for the immigrant group to the ASMR for the respective Canadian general population.

**Table III.** Main Effect Relative Risk (RR) Estimates and 95% Confidence Intervals (CI) from Poisson Regression of Mortality Among the Immigrant Cohort, 1980–1998<sup>a</sup>

Variable	Non-refugees		Refugees	
	RR	CI	RR	CI
Sex				
Females	1.00		1.00	
Males	1.66	1.54–1.79	1.64	1.49–1.79
Age group				
65+ years	1.00		1.00	
45–64 years	0.29	0.26–0.32	0.22	0.16–0.30
20–44 years	0.07	0.06–0.09	0.06	0.04–0.09
0–19 years	0.08	0.06–0.10	0.02	0.01–0.03
Region of birth				
North East Asia	1.00		1.00	
West Europe	1.51	1.35–1.68	1.39	1.02–1.89
East Europe & Russia	1.40	1.24–1.59	1.81	1.22–2.67
South Asia	0.76	0.67–0.86	1.36	0.96–1.91
South East Asia	0.96	0.86–1.08	na <sup>b</sup>	na <sup>b</sup>
Middle East & Africa	na <sup>b</sup>	na <sup>b</sup>	1.22	0.86–1.73
Middle East & North Africa	0.81	0.67–0.98	na <sup>b</sup>	na <sup>b</sup>
Africa	1.09	0.87–1.38	na <sup>b</sup>	na <sup>b</sup>
Caribbean	0.90	0.77–1.05	1.79	1.22–2.63
North America	1.51	1.26–1.80	1.36	0.88–2.11
South & Central America	1.08	0.92–1.27	1.68	1.07–2.64
Oceania & Pacific	na <sup>b</sup>	na <sup>b</sup>	0.77	0.19–3.11
Time in Canada				
<5 years	1.00		1.00	
5–9 years	1.15	1.09–1.21	1.16	0.91–1.41
10+ years	1.36	1.30–1.42	1.10	0.84–1.34

<sup>a</sup>Model additionally adjusted for immigration period and certain socio-economic variables, including language, marital status, education and occupation.

<sup>b</sup>The region of birth groupings differed between non-refugees and refugees.

refugees presented a mortality disadvantage over non-refugees, as indicated by the ASMRs and CMFs (Table II). Additionally, the effect of time since immigration among non-refugees was not confounded by cohort effects of the immigration period. The relative risk of mortality among non-refugees appears to increase significantly with time since arrival (Table III).

As indicated in Tables IV and V, all-cause mortality among non-refugees and refugees was relatively low compared to that of the general Canadian population (SMR = 0.34, 0.40, 0.48 and 0.58 for non-refugee men, non-refugee women, refugee men and refugee women respectively). This pattern of low all-cause mortality is also apparent by age group with the exception of female non-refugees 0–19 years of age who present elevated mortality (SMR = 1.80,

95% CI: 1.49, 2.11) compared to the Canadian reference (Table IV). Similarly, low SMRs were found for most causes of death examined, with the exception of infectious and parasitic diseases (SMR = 1.97, 95% CI: 1.20, 2.74 for refugee females), in particular HIV/AIDS (SMR = 3.66, 95% CI: 2.10, 5.32 for non-refugee females, and hepatitis (SMR = 1.78, 95% CI: 1.05, 2.51 and 3.81, 95% CI: 1.87, 5.67 for non-refugees and refugees respectively)(not shown in table). However, examination of SMRs by cause and region of birth revealed other patterns (Tables VI and VII). In particular, statistically significantly increased SMRs were found for AIDS in Caribbean non-refugees (SMR = 4.23, 27.38 for males and females); stroke in refugee males 65+ (SMR = 1.45, 95% CI: 1.03, 1.87) and South East Asian refugee females (SMR = 1.53, 95% CI: 1.10, 1.97); diabetes in non-refugee males from the Caribbean (SMR = 1.67, 95% CI: 1.03, 2.32). Elevated risks of death were also observed for liver cancer (SMR = 2.18, 95% CI: 1.69, 2.68; SMR = 1.77, 95% CI: 1.18, 2.37, and SMR = 4.89, 95% CI: 3.29, 6.49 for non-refugee males, females and refugee males respectively) (Tables IV and V), particularly for immigrants who were from North East Asia (SMR = 5.83, 95% CI: 4.04, 7.61 for male non-refugees) (not shown in table). For nasopharyngeal cancers, SMR was 2.88 (95% CI: 1.51, 4.24) for male non-refugees (Table IV).

## DISCUSSION

This study of immigrant mortality highlights key health patterns among this population, and offers a number of methodological advantages over other studies conducted to date. National in scope, it was based on linked administrative data rather than self-reported data, and included a representative sample cohort of non-refugees and refugees. It also provided immigration-relevant information such as immigrant category (refugees and non-refugee immigrants) and birth region, as well as a sufficient sample size to highlight mortality among specific immigrant subgroups.

The findings of this study indicate that both non-refugees and refugees are overall at lower risk of death as compared to the general Canadian population, a result not explained by potential losses to follow-up. This overall result is supported by previously documented evidence of a healthy immigrant effect, discussed above. Specifically, in light of evidence that the odds of exhibiting

**Table IV.** Indirect Standardized Mortality Ratios (SMR) and 95% Confidence Intervals (CI) for Non-Refugee Compared to the Canadian General Population, 1980–1998

Cause (ICD-9)	Males			Females		
	N	SMR	CI	N	SMR	CI
Age 0–19 year	107	0.67	0.54–0.80	132	1.80*	1.49–2.11
20–44 year	364	0.43	0.39–0.47	187	0.46	0.39–0.53
45–64 year	770	0.35	0.33–0.37	551	0.36	0.33–0.39
65+ year	2482	0.32	0.31–0.33	2670	0.39	0.38–0.40
All causes (001–999)	3,723	0.34	0.33–0.35	3,540	0.40	0.39–0.41
Infectious & parasitic diseases (001–139)	123	0.80	0.66–0.94	65	0.91	0.69–1.13
AIDS (042–044)	69	1.00	0.77–1.24	21	3.66*	2.10–5.23
All site cancer (140–239)	1128	0.38	0.36–0.41	1010	0.40	0.38–0.43
Nasopharyngeal cancer	17	2.88*	1.51–4.24	n.a. <sup>a</sup>		
Liver cancer	74	2.18*	1.69–2.68	34	1.77*	1.18–2.37
Endocrine/ Nutritional/ Metabolic disorders (240–279)	118	0.43	0.36–0.51	170	0.57	0.49–0.66
Diabetes (250)	98	0.47	0.38–0.56	136	0.60	0.50–0.70
Mental disorders (290–319)	33	0.22	0.14–0.29	65	0.40	0.30–0.50
Nervous system or sensory disorders (320–389)	67	0.30	0.22–0.37	92	0.39	0.31–0.47
Circulatory disease (390–459)	1,340	0.31	0.29–0.33	1,457	0.40	0.38–0.42
Ischemic heart disease (410–414, 429)	773	0.28	0.26–0.30	725	0.37	0.34–0.39
Stroke (430–438)	317	0.47	0.42–0.52	415	0.51	0.46–0.56
Respiratory disease (460–519)	282	0.29	0.26–0.32	224	0.34	0.30–0.39
Chronic obstructive pulmonary disease & asthma (490–493, 496)	103	0.21	0.17–0.24	63	0.27	0.20–0.34
Digestive disease (520–579)	115	0.29	0.24–0.34	119	0.35	0.28–0.41
Genitourinary disease (580–629)	54	0.34	0.25–0.43	65	0.46	0.35–0.57
Accidents/ Poisoning/ Violence (800–999)	339	0.31	0.27–0.34	189	0.39	0.34–0.45
Motor vehicle traffic accidents (810–819)	94	0.31	0.24–0.37	62	0.46	0.35–0.57
Suicide (950–959)	102	0.30	0.24–0.36	35	0.33	0.22–0.44
Ill-defined causes (780–799)	80	0.53	0.41–0.64	46	0.38	0.27–0.50

<sup>a</sup>n.a. indicates that the observed deaths (*N*) is  $\leq 15$ .

health behaviors predictive of poorer health, such as smoking, overweight and heavy drinking, are lower among immigrants to Canada, particularly those most recently arrived, the validity of this overall result is further corroborated (11).

This study also highlights health risks specific to immigrant subgroups. For example, all-cause mortality was elevated among non-refugee females aged 0–19, a finding not previously reported in Canada, and needing further examined. Among non-refugees the analyses showed that the risk of death increased with time in Canada, and therefore, that the health status of immigrants appears to diminish in the years following immigration.

Refugees had an increased risk of death as compared to non-refugees, a finding likely explained, at least in part, by the process of self-selection for immigration, which is clearly different among refugees and non-refugee immigrants. Moreover, some exemptions regarding medical testing may occur among refugees, especially in more recent years. In contrast with non-refugees, however, refugees showed no pronounced change in mortality after years in Canada. This study is one of the very few examin-

ing the health of refugees specifically. Such studies focusing on refugees who have already immigrated to a host country are likely to underestimate the health vulnerabilities of refugees generally, as many do not successfully migrate. More research on the health status of refugees is therefore needed.

Analysis of mortality by specific causes revealed elevated rates among immigrants for some chronic diseases (stroke and diabetes), cancers (liver and nasopharynx) and infectious and parasitic diseases (in particular AIDS and hepatitis). Although overall cardiovascular disease mortality was low, a fact consistent with previous Canadian research and systematic reviews on immigrants (3, 19), mortality from stroke was elevated for male refugees aged 65+ and South East Asian-born female refugees. This is an important finding as cardiovascular diseases have been increasing in many countries of the world (32). Moreover, studies have reported variations in cardiovascular disease and stroke rates among immigrants from different geographical regions (3, 4, 13, 32–35). The finding of high mortality from diabetes among Caribbean immigrants is consistent with the epidemiological data indicating that

**Table V.** Indirect Standardized Mortality Ratios (SMR) and 95% Confidence Intervals (CI) for Refugee Compared to the Canadian General Population, 1980–1998

Cause (ICD-9)	Males			Females		
	<i>N</i> <sup>a</sup>	SMR	CI	<i>N</i> <sup>a</sup>	SMR	CI
Age 0–19 year	48	0.41	0.29–0.53	32	0.64	0.42–0.86
20–44 year	395	0.54	0.49–0.59	109	0.55	0.45–0.65
45–64 year	362	0.41	0.37–0.45	201	0.55	0.47–0.63
65+ year	271	0.54	0.48–0.60	301	0.62	0.55–0.69
All causes (001–999)	1076	0.48	0.45–0.51	643	0.58	0.54–0.63
Infectious & parasitic diseases (001–139)	58	0.72	0.54–0.91	25	1.97*	1.20–2.74
AIDS (042–044)	33	0.62	0.41–0.84	n.a.		
All site Cancer (140–239)	299	0.59	0.53–0.66	234	0.62	0.54–0.70
Liver cancer (155)	36	4.89*	3.29–6.49	n.a.		
Endocrine/ Nutritional/ Metabolic disorders (240–279)	17	0.36	0.19–0.53	n.a.		
Circulatory disease (390–459)	231	0.40	0.35–0.45	172	0.53	0.45–0.61
Ischemic heart disease (410–414, 429)	112	0.28	0.23–0.34	71	0.42	0.32–0.52
Stroke (430–438)	76	1.02 <sup>b</sup>	0.79–1.24	72	0.96	0.74–1.18
Respiratory disease (460–519)	45	0.48	0.34–0.62	34	0.55	0.37–0.74
Chronic obstructive pulmonary disease & asthma (490–493, 496)	16	0.39	0.20–0.58	n.a.		
Digestive disease (520–579)	30	0.37	0.24–0.50	22	0.52	0.30–0.74
Accidents/ Poisoning/ Violence (800–999)	295	0.43	0.39–0.48	82	0.55	0.43–0.67
Motor vehicle traffic accidents (810–819)	90	0.43	0.34–0.52	24	0.45	0.27–0.62
Suicide (950–959)	97	0.43	0.34–0.51	24	0.58	0.35–0.81
Ill-defined causes (780–799)	56	1.13	0.84–1.43	n.a.		

<sup>a</sup>n.a. indicates that the observed deaths (*N*) is ≤ 15.

<sup>b</sup>Stroke mortality is elevated among refugee males in age group 65+, *N* = 46 SMR = 1.45 (1.03, 1.87).

diabetes varies by ethnicity, and is high among black Caribbean populations (36). Strategies to prevent stroke and diabetes in immigrant subgroups should be considered; also surveillance of these diseases in immigrant subgroups is important for monitoring variations between populations and over time.

The higher rates of liver and nasopharyngeal cancer among Asian immigrants have been documented elsewhere (17, 18). One of the risk factors for nasopharyngeal cancer is the consumption of salt-preserved foods. Other possible risk factors include extensive exposure to dust or smoke, Epstein-Barr virus and genetic susceptibility (18, 38). Strategies should be considered for the early detection of nasopharyngeal cancer in high-risk immigrant patients, especially those with ear, nose or throat symptoms (38). Elevated liver cancer mortality is consistent with the reportedly higher rate of hepatitis in Asian populations (17, 18, 39, 40). Hepatitis infection is an established risk factor for hepatocellular carcinoma, and is responsible for approximately 50% of cases worldwide (41). Other risk factors for liver cancer include moulds on food and parasitic infections (17, 41). A number of strategies should be considered

for the prevention and control of liver cancer among Canadian immigrants, in particular, vaccination and screening for hepatitis B, as well as early detection strategies for liver cancer among high-risk groups.

The overall elevated infectious disease mortality among immigrants has been reported elsewhere (3). With respect to AIDS, the higher mortality found among immigrant women but not among immigrant men is an important finding, in light of the fact that the HIV infection male: female ratio is very different in different parts of the world. Most countries in Africa, unlike countries such as Canada, have higher infection rates for women, compared to men (42, 43). The higher risk of death from AIDS in immigrants as compared to the rates for Canada as a whole is likely to diminish in the future, with the recent introduction of new HIV testing policies in Canada. Under the current immigration policies, principal immigrant (non-refugee) applicants who test positive for HIV may not be able to immigrate to Canada. However, other strategies should also be considered, such as early diagnosis and improved access to proper care among HIV-positive immigrants currently living in Canada as well as HIV-positive refugees and

**Table VI.** Standardized Mortality Ratios (SMR) by Cause and Region of Birth for Non-Refugees Compared to the General Canadian Population 1980–98

Cause	Region	Male			Female		
		<i>N</i> <sup>a</sup>	SMR	CI	<i>N</i> <sup>a</sup>	SMR	CI
All causes	Africa	86	0.38	0.30–0.46	61	0.42	0.31–0.52
	America	165	0.41	0.35–0.47	200	0.43	0.37–0.49
	Caribbean	368	0.41	0.37–0.45	348	0.41	0.36–0.45
	Eastern Europe & Russia	267	0.44	0.38–0.49	322	0.49	0.43–0.54
	Middle East & Africa	189	0.27	0.23–0.31	123	0.31	0.26–0.37
	North East Asia	665	0.30	0.27–0.32	496	0.30	0.28–0.33
	Oceania & Pacific Islands	31	0.37	0.24–0.50	37	0.63	0.43–0.84
	South Asia	485	0.27	0.24–0.29	331	0.33	0.29–0.36
	South East Asia	363	0.29	0.26–0.32	308	0.31	0.28–0.35
	Western Europe	904	0.40	0.37–0.43	1104	0.51	0.48–0.54
Infectious & parasitic disease	Caribbean	31	2.17*	1.41–2.94	21	2.93*	1.67–4.18
AIDS	Caribbean	30	4.23*	2.72–5.74	18	27.38*	14.73–40.04
Endocrine/ Nutritional/ Metabolic disorders	Caribbean	30	1.39	0.89–1.89	21	0.73	0.42–1.04
	North East Asia	18	0.32	0.17–0.47	24	0.43	0.26–0.61
Diabetes	South Asia	21	0.46	0.26–0.65	20	0.58	0.32–0.83
	Western Europe	n.a.			46	0.63	0.45–0.81
	Caribbean	26	1.67*	1.03–2.32	18	0.87	0.47–1.27
	North East Asia	16	0.39	0.20–0.58	20	0.49	0.28–0.71
	South Asia	16	0.47	0.24–0.70	17	0.67	0.35–0.98
Circulatory disease	Africa	36	0.45	0.30–0.59	21	0.41	0.24–0.59
	America	64	0.41	0.31–0.50	86	0.42	0.33–0.51
	Caribbean	123	0.37	0.30–0.43	143	0.42	0.35–0.49
	Eastern Europe & Russia	102	0.41	0.33–0.49	135	0.46	0.39–0.54
	Middle East & Africa	68	0.26	0.20–0.33	35	0.24	0.16–0.32
	North East Asia	171	0.20	0.17–0.23	151	0.23	0.19–0.26
	Oceania & Pacific Islands	19	0.64	0.35–0.93	19	0.93	0.51–1.35
	South Asia	223	0.30	0.26–0.34	148	0.37	0.31–0.43
	South East Asia	139	0.27	0.23–0.32	135	0.35	0.29–0.41
	Western Europe	324	0.36	0.32–0.40	500	0.51	0.47–0.56
Stroke	America	16	0.68	0.35–1.02	19	0.44	0.24–0.64
	Caribbean	30	0.62	0.40–0.84	51	0.73	0.53–0.92
	Eastern Europe & Russia	23	0.60	0.35–0.84	36	0.58	0.39–0.77
	North East Asia	63	0.50	0.37–0.62	61	0.44	0.33–0.56
	South Asia	33	0.30	0.20–0.40	40	0.50	0.35–0.66
	South East Asia	43	0.57	0.40–0.74	48	0.61	0.44–0.79
	Western Europe	71	0.52	0.40–0.64	123	0.58	0.47–0.66
	North East Asia	53	0.27	0.20–0.34	33	0.28	0.18–0.37
Respiratory disease	South Asia	31	0.18	0.12–0.24	18	0.25	0.14–0.37
	South East Asia	33	0.28	0.18–0.37	n.a.		
	Western Europe	88	0.42	0.33–0.51	93	0.53	0.42–0.63
	Caribbean	40	0.34	0.23–0.44	n.a.		
Accidents/ Poisoning/ Violence	Eastern Europe & Russia	27	0.50	0.31–0.69	18	0.59	0.32–0.86
	North East Asia	38	0.20	0.13–0.26	26	0.31	0.19–0.43
	South Asia	62	0.45	0.34–0.56	22	0.43	0.25–0.61
	South East Asia	16	0.14	0.07–0.21	18	0.33	0.18–0.48
	Western Europe	93	0.39	0.31–0.46	55	0.51	0.37–0.64

<sup>a</sup>n.a. indicates that the observed deaths (*N*) is  $\leq 15$ .

HIV-positive spouses, common-law partners, and children of a Canadian citizen or permanent resident who are still allowed to come to Canada (7).

Record linkage studies can have some limitations, such as the possibility of false non-links due

to immigrant name misspellings in the databases. Moreover using the general Canadian population as a comparison group, which includes immigrants, diluted measures of associations under study. However, due to the rigor of the record linkage approach



**Table VII.** Standardized Mortality Ratios (SMR) by Cause and Region of Birth for Refugees Compared to the General Canadian Population 1980–98

Cause	Region	Male			Female		
		N <sup>a</sup>	SMR	CI	N <sup>a</sup>	SMR	CI
All causes	Africa	40	0.47	0.32–0.61	n.a.		
	Americas	72	0.35	0.27–0.44	42	0.40	0.28–0.52
	Eastern Europe & Russia	334	0.46	0.41–0.51	174	0.58	0.50–0.67
	Middle East & Africa	41	0.38	0.26–0.49	n.a.		
	North East Asia	96	0.59	0.47–0.70	79	0.58	0.45–0.71
	South East Asia	470	0.52	0.47–0.57	317	0.64	0.57–0.71
Circulatory disease	Eastern Europe & Russia	66	0.35	0.27–0.44	32	0.44	0.29–0.60
	North East Asia	40	0.57	0.40–0.75	42	0.67	0.47–0.88
	South East Asia	90	0.40	0.32–0.49	89	0.60	0.48–0.73
Stroke	North East Asia	17	1.70	0.89–2.51	n.a.		
	South East Asia	39	1.46	1.00–1.91	48	1.53*	1.10–1.97
Respiratory disease	South East Asia	24	0.64	0.39–0.90	17	0.61	0.32–0.89
Accidents/ Poisoning/	Eastern Europe & Russia	118	0.54	0.45–0.64	24	0.51	0.31–0.71
Violence	South East Asia	123	0.41	0.34–0.48	43	0.64	0.45–0.83

<sup>a</sup>n.a. indicates that the observed deaths (N) is ≤ 15.

used, including the use of multiple names and name change information from the IMDB database, and because of the consistency of the findings as compared to other studies, the results of this study are believed to be valid. Moreover, the use of tax filing flags as well as emigration information, which have been unavailable to other immigrant health studies in Canada, were valuable in identifying potential losses to follow-up, particularly with respect to immigrants who filed tax returns and then stopped (as they were likely to have re-emigrated elsewhere). It must be kept in mind, however, that since this methodology required record linkage, illegal immigrants, for whom there is no record, are automatically excluded from the study.

Due to the number of variables being investigated in this study (i.e., age, sex, place of birth, immigration category and cause of death), another limitation of the study could be multiple statistical testing, resulting in some statistically significant results due to chance (i.e., false positives). This should be kept in mind in the interpretation of the results.

The results from this research indicate specific health risks, and offer areas for consideration when establishing whether policies and clinical health care services meet health needs of recent and long-term immigrants, or rather gaps exist for some vulnerable subgroups within the immigrant population. Moreover the results emphasize the presence of health disparities in mortality (including cancer mortality) among socio-demographic subgroups, specifically persons from different geographical regions, by

sex and immigrant categories. Future research needs to examine co-morbidities, variance of disease risks by other socio-demographic determinants of health,

**Appendix I.** Group of Countries

Western Europe	ANDORRA
	AUSTRIA
	AZORES
	BELGIUM
	CANARY ISLANDS
	CHANNEL ISLANDS
	CYPRUS
	DENMARK
	ENGLAND
	FINLAND
	FRANCE
	GERMAN DEMOCRATIC REPUBLIC
	GERMANY FEDERAL REPUBLIC OF
	GIBRALTAR
	GREECE
	HOLY SEE (Vatican City)
	ICELAND
	IRELAND, REPUBLIC OF
	ITALY
	LIECHTENSTEIN
	LUXEMBOURG
	MADEIRA
	MALTA
	MONACO
	NETHERLANDS, THE
	NORTHERN IRELAND
	NORWAY
	POLAND
	PORTUGAL
	SAN MARINO (Italy)
	SCOTLAND

	Appendix I. Continued.	Appendix I. Continued.
	SPAIN	REPUBLIC OF
	SWEDEN	LEBANON
	SWITZERLAND	OMAN
	UNITED KINGDOM AND COLONIES	KUWAIT
	WALES	IRAN
Eastern Europe	ALBANIA	IRAQ
	BOSNIA-HERCEGOVINA	BAHRAIN
	BULGARIA	ANGUILLA
	CROATIA	BARBADOS
	CZECH REPUBLIC	BERMUDA
	CZECHOSLOVAKIA	DOMINICAN REPUBLIC
	ESTONIA	GRENADA
	FYR MACEDONIA	GUADELOUPE
	HUNGARY	HAITI
	LATVIA	JAMAICA
	LITHUANIA	MARTINIQUE
	ROMANIA	MONTSERRAT
	SLOVAK REPUBLIC	NETHERLANDS ANTILLES, THE
	SLOVENIA	NEVIS
	TURKEY	PUERTO RICO
	YUGOSLAVIA	ST. KITTS-NEVIS
South Asia	BANGLADESH	ST. LUCIA
	PAKISTAN	ST. VINCENT AND THE GRENADINES
	SIKKIM	TRINIDAD AND
	SRI LANKA	TOBAGO, REPUBLIC OF
	MALDIVES, REPUBLIC OF	TURKS AND CAICOS ISLANDS
	INDIA	VIRGIN ISLANDS, BRITISH
	NEPAL	VIRGIN ISLANDS, U.S.
	BHUTAN	ANTIGUA AND BARBUDA
South East Asia	CAMBODIA	ARUBA
	INDONESIA, REPUBLIC OF	BAHAMA ISLANDS, THE
	MALAYSIA	CAYMAN ISLANDS
	MACAO	CUBA
	HONG KONG	DOMINICA
	HONG KONG SAR	
	SINGAPORE	
	BRUNEI	
	LAOS	
	NORTH VIETNAM	
	PAPAU NEW GUINEA	
	THAILAND	
	TIBET	
	VIETNAM, SOCIALIST REPUBLIC OF	
	MYANMAR (BURMA)	
	PAPAU	
North East Asia	JAPAN	
	TAIWAN	
	CHINA, PEOPLE'S REPUBLIC OF	
	PHILLIPINES	
	KOREA, PEOPLE'S DEMOCRATIC	
	REPUBLIC OF	
	KOREA, REPUBLIC OF	
Middle East	ISRAEL	
	JORDAN	
	PALESTINIAN AUTHORITY (GAZA/ WEST BANK)	
	QATAR	
	SAUDI ARABIA	
	SYRIA	
	UNITED ARAB EMIRATES	
	YEMEN, PEOPLE'S DEMOCRATIC	

as well as whether or not disease risks persist in second-generation immigrants.

## APPENDIX II: QUALITY ASSURANCE OF THE RECORD LINKAGE PROCESS

Potential links in the GRLS linkage software were classified as acceptable, possible and unacceptable and the user generally attempted to manually establish two thresholds: an upper and a lower one. The links with a total weight above the upper threshold were designated acceptable; links with a total weight between the upper and lower threshold were designated for possible manual review. Links with a total weight below the lower threshold were considered unacceptable and no longer included in the process.

The linkage for this project was done in two stages: the first stage used a strict set of code to compare two records; the second stage used code that was

more forgiving. The former was intended to capture the better quality links without excessive manual resolution. The second stage examined the remaining immigrant records not linked in the first stage and allowed records with a greater level of dissimilarity to be compared. This prevented miscoded variables from impeding the comparison of two records, but also avoided a large manual resolution operation as most of the deaths were found in the first linkage. The quality of the two linkages was benchmarked against tax death information obtained from previous linkage work already done by the Immigration Database staff that linked Citizenship and Immigration Canada data to Canada Customs and Revenue data.

In the end, 9855 death linkages were established. The first linkage to the Canadian Mortality Data Base (CMDB) yielded 9019 matches. The second, using tax sources, garnered another 411 linkages. The source breakdown was the following: 6837 were found only in the CMDB, 2636 were found both in the CMDB and tax sources, and 382 were only identified in the tax source.

Manual searching of the CMDB for those deaths found only in the tax sources uncovered only 43 additional linkages in the former. This result corroborated a low false negative rate in the CMDB linkage, and added assurance to the quality of this linkage. Two further quality checks were performed on the death linkages: firstly, if the death date was earlier than the immigrant landing date, the linkage was dropped; secondly, if an income tax filing flag was found for an individual more than two years after the death year, the death linkage was dropped.

## ACKNOWLEDGMENTS

The Canadian Population Health Initiative, of the Canadian Institute for Health Information, Citizenship and Immigration Canada, Statistics Canada and the Public Health Agency of Canada (PHAC) sponsored this study. Data were provided to PHAC by Citizenship and Immigration Canada and Statistics Canada. The authors also wish to acknowledge Mrs. Martha Fair, formerly of Statistics Canada, for her invaluable contribution to the data linkage process for this study, and Dr. Chris Archibald (PHAC), for his useful advice on the HIV/AIDS-related components of this article.

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