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Immigration and all-cause mortality in Canada: An illustration using linked census and administrative data

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Outline

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Background

- Even though Canada is historically an immigrant country, immigration is increasingly playing an important role in the country's demographic profile.
- In the 2006 Census 19.6% of the population was foreign-born and increased to 20.6 in the 2011 NHS.
 - Projected to reach between 25% and 28% by 2031 (Malenfant et al. 2009).
 - Between 2001 and 2006, newcomers comprised 69.3% of the people added to the population; this had declined slightly to 62.4% between 2006 and 2011.
- There is also a shift in the source countries from Europe to mostly Asia.



Background continued

Table 1: Top five birthplace of recent immigrants, 1981 to 2011

Order	1981	1991	2001	2006	2011
1	UK	Hong Kong	China	China	Philippines
2	Vietnam	Poland	India	India	China
3	USA	China	Philippines	Philippines	India
4	India	India	Pakistan	Pakistan	USA
5	Philippines	Philippines	Hong Kong	USA	Pakistan

Note: 'Recent immigrants' refers to landed immigrants who arrived in Canada within five years prior to a given census.

Sources: Statistics Canada, censuses of population, 1981 to 2011

Brown – Asian Country

Green – Europe or United States

Background continued

- Given the changing demographic profile of Canada, it is critical to understand the health risks associated with immigration as well as healthcare utilisation.
- Overall, immigrants tend to have better health outcomes (mortality, morbidity, hospitalisation) compared to non-immigrants.
- Based on review of literature, there are several explanations for the immigrant mortality advantage:
 - Healthy immigrant effect,
 - Data artefact, and
 - Cultural effects.



Explaining immigrant mortality advantage

- Healthy immigrant effect-: Immigrants are selected for better health at the outset: Health enhancing characteristics and/or better physical and mental health (e.g., Hajat et al. 2010).
- Data artefact: data quality (e.g., Palloni & Arias 2004) and the 'salmon bias' (Pablos-Mendez 1994).
- Cultural effects: Health behaviours and interaction with the environment (Franzini et al. 2001; Abraído-Lanza et al. 2005; Viruell-Fuentes & Schulz 2009).

Limitations of previous mortality studies

- The testing of these hypotheses is hampered by lack of data:
 - Administrative data: Details about deaths, age and sex.
 - Census or survey data: Characteristics of individuals including immigrant status, but no information on deaths.
- Concurrent examination of country of birth, period of immigration and relevant predictors was not possible in previous studies.
- Linked data such as the 1991 Canadian Census Cohort Mortality & Cancer Follow-up Study address these limitations.

Research questions and goal

- Q1. Do immigrants have a mortality advantage compared to the Canadian-born?
- Q2. If immigrants have a mortality advantage, does it decline as their duration of residence in Canada increases? Is this dependent on age?
- Q3. What is the role of socioeconomic and sociodemographic factors on the observed immigrant mortality patterns?
- **Goal: Highlight the availability and utility of the 1991 Canadian Census Mortality and Cancer Follow-up Study.**

Why data linkage?

- Administrative data in Canada do not uniformly contain individual identifiers (socioeconomic status, ethnicity, Aboriginal) or other characteristics beyond basic demographic information (age, sex, residence).
- Few datasets are suitable for geographic linkage with environmental exposure data due to lack of detailed place of residence information.
- Difficult to provide health indicators for important population sub-groups.

What is record linkage?

- Combines two or more datasets using common identifiers
 - Deterministic
 - Probabilistic.
- Need to achieve a balance between the need to protect privacy of individuals and the public good a linkage may achieve.

Benefits of a census linkage

- Expanded knowledge base
 - Improved understanding of social determinants.
 - Allow for multi-variable & multi-level analysis.
 - Environmental exposure studies.
 - Identification of multiple dimensions of socioeconomic disadvantage
 - With respect to education, income, occupation, housing, etc...

- Large cohort size
 - Analysis of population sub-groups
 - Such as immigrants, marginally housed, ethnic origins, First Nations, Métis, and Inuit.
 - Ability to examine rare outcomes .
 - Allow for cross-classification
 - Urban – Aboriginal; Cardiovascular Disease – Recent immigrants .

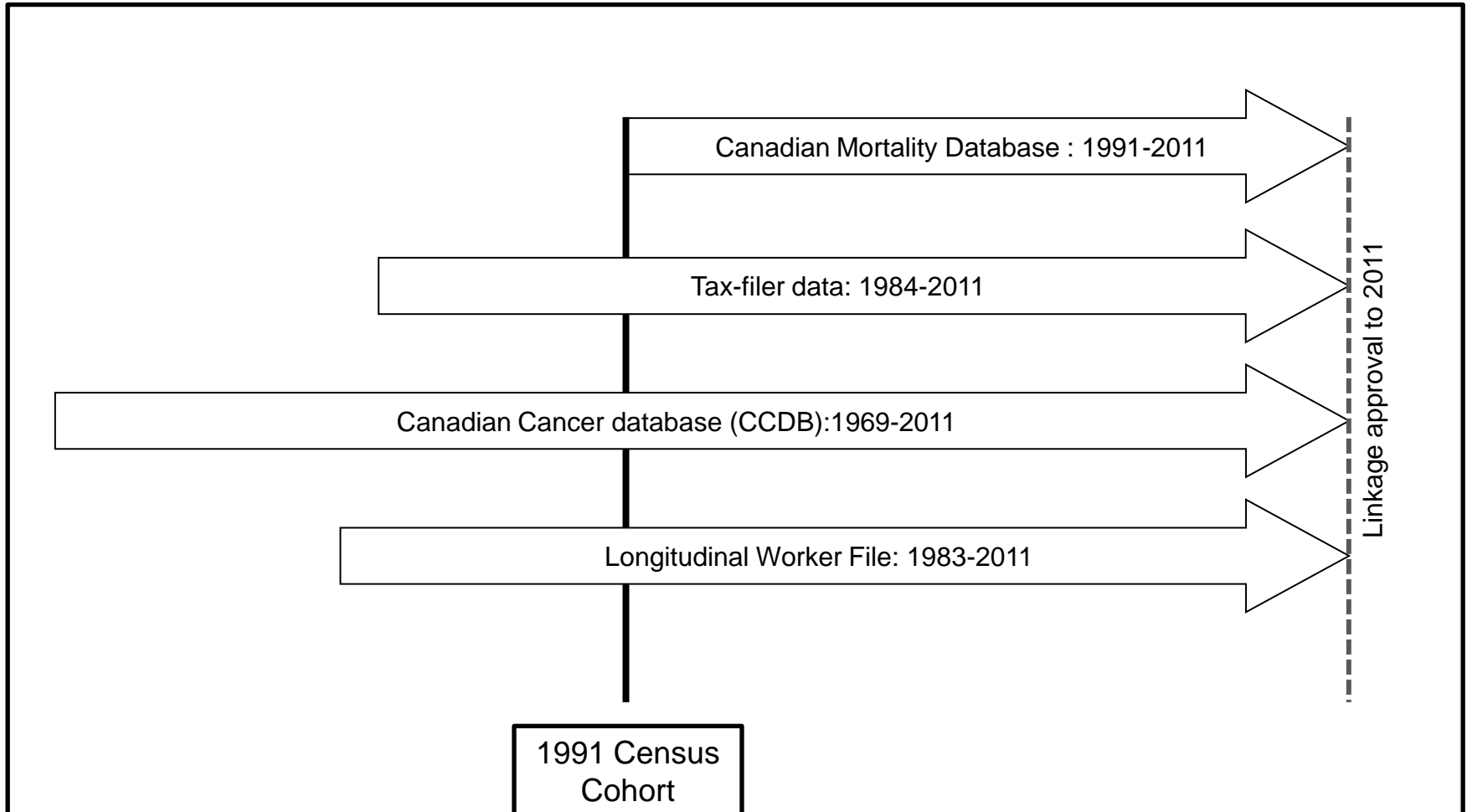
1991 census cohort

- **Purpose of the linkage:** Develop a set of baseline indicators of mortality to monitor health inequalities.
- **Eligibility:**
 - Enumerated on 1991 census long form (1 in 5 (20%) households *).
 - Aged 25 or older as of June 4, 1991.
 - Not a usual resident of an institution .
 - Linkage approval for 15% of persons aged 25+.
- Note that 3.4% of the Canadian population of all ages were not enumerated by the 1991 census.

* Note that all residents of Indian Reserves and remote northern communities receive long form questionnaire



Structure of the 1991 Canadian Census Cohort



Source: Peters et al. 2013

Content

- 1991 Census
 - Demography, labour market, income, education, language, disabilities, housing, immigration, ethno-cultural, Aboriginal ancestry, Registered Indian.
- Tax-filer Summary File (T1 Family File (T1FF))
 - Annual place of residence (postal code on tax return), marital status- tracking of mobility.
- Canadian Cancer database (CCDB):
 - Diagnosis site of primary malignant neoplasm, morphology, topology, date and province of diagnosis, date of death.
- Canadian Mortality Database (CMDB)
 - Underlying cause of death, date of death, age at death.
- Longitudinal Worker File (LWF).
 - Employment income, history, and reason of job separation.

1991 census cohort

- Cohort creation
 - Eligible census respondents linked to tax filer data (non-financial) in order to get names.
 - Matching variables: sex, date of birth, postal code, spousal date of birth.
 - Results: 80% linkage rate, 99% correct links.

- Deterministic linkage of LWF to tax summary file for annual place of residence.
 - Postal codes (1984-2008), approval to 2011.
 - Employment history (1983-2010), approval to 2011.

- Probabilistic linkage to mortality and cancer.
 - Matching variables: sex, date of birth, names, postal code.
 - Mortality (1991-2006), approval to 2011.
 - Cancer (1969 to 2003), approval to 2011.

Table 2: In-scope* and cohort breakdown

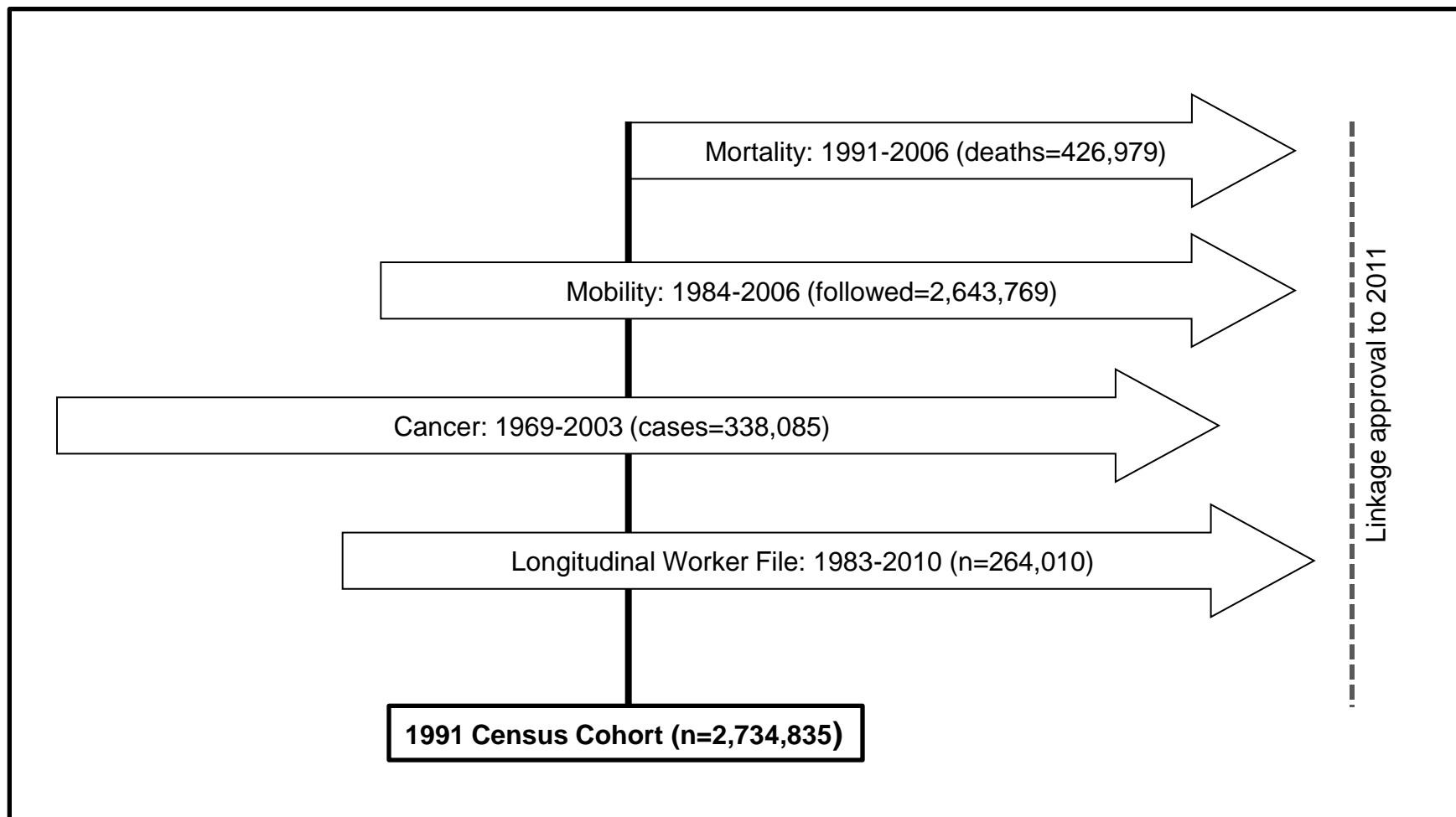
Characteristic	In-scope	Cohort
Total (count)	3,576,485	2,734,835
Sex (%)		
Male	48.6	49.7
Female	51.4	50.3
Age (%)		
25 to 44	52.6	54.5
45 to 64	30.5	30.0
65 +	16.9	15.4
Educational attainment (%)		
Less than secondary graduation	37.8	34.9
Secondary graduation or higher	62.2	65.1
Income adequacy quintile (%)		
Quintile 1-poorest	20.0	17.2
Quintile 5-richest	20.0	21.5

* In-scope refers to all individuals who were enumerated by the long-form, were aged 25+, and were not a resident of an institution

Source: Peters et al. 2013



Linkage results

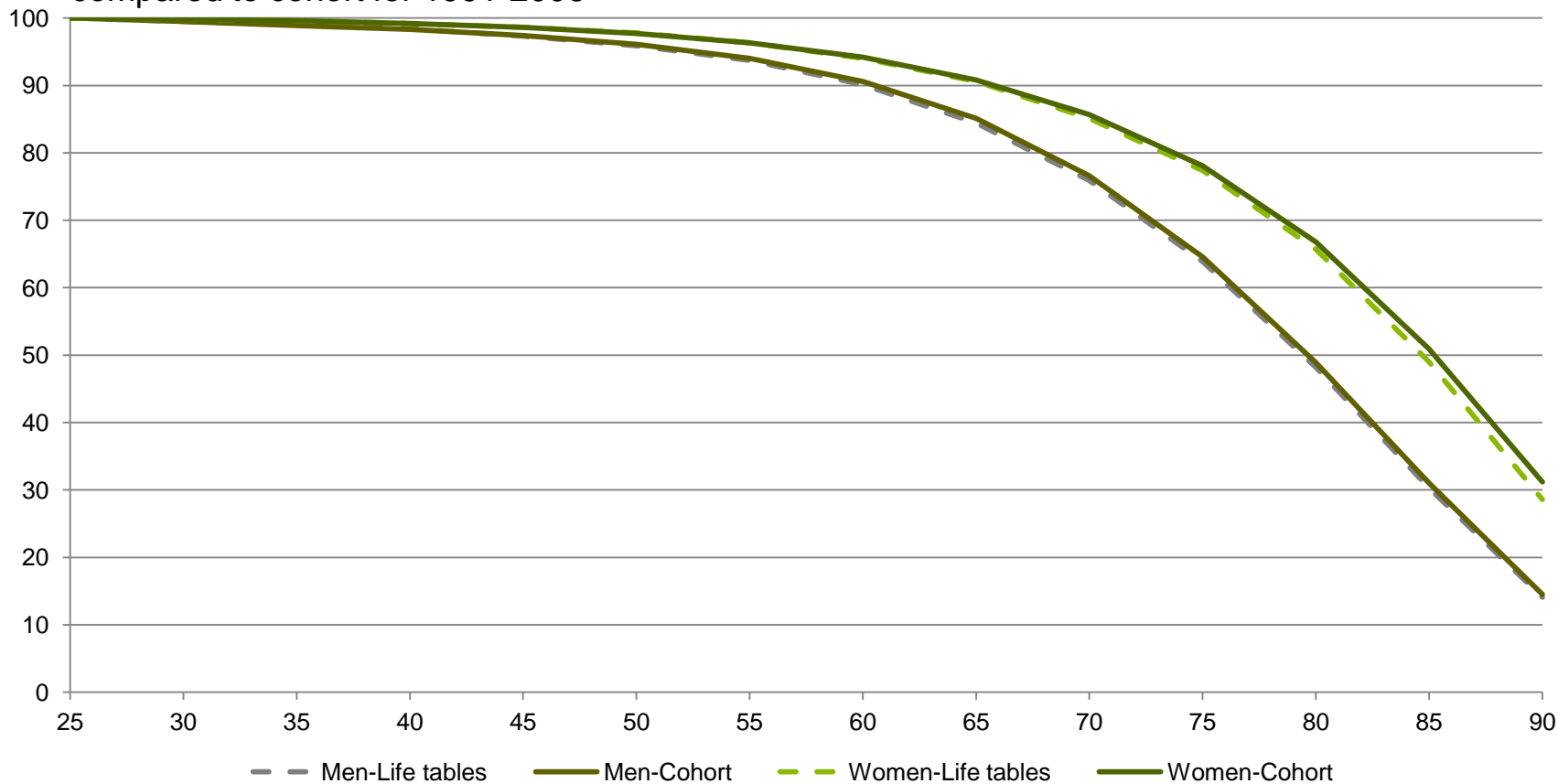


Source: Peters et al. 2013



Results - survival

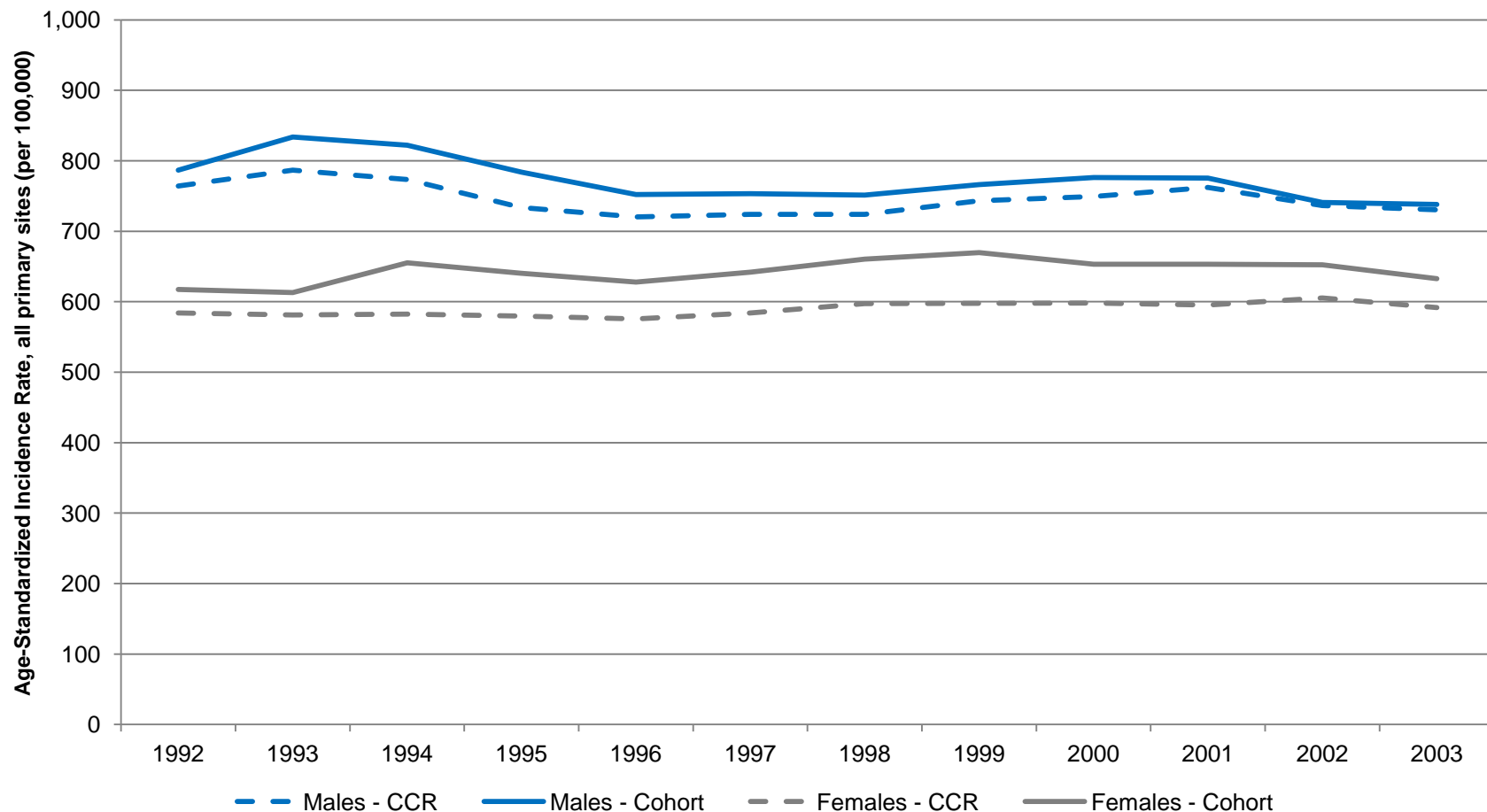
Figure 1: Percentage surviving to various ages in Canada for 1995-1997 and 2002 (average) compared to cohort for 1991-2006



Source: Peters et al., 2013

Results - Cancer incidence

Figure 2: Age-standardized incidence rates of cancer, the cohort compared to Canadian Cancer Registry



Source: Peters et al., 2013

Potential research areas

- Sub-population analysis
 - First Nations, Métis, immigrants (year of immigration), place of birth, ethnic origin etc.
- Analysis by socioeconomic status
 - Income (source, household, individual), education (years, qualifications), occupation, industry, type of housing, marital status .
- Multi-dimensional analysis
- Exposure analysis
 - Assign exposure via postal code representative points.
- Labour outcomes
 - Economic outcomes associated with cancer survival.

Study sample

- The 1991 CCMCFS:
 - The first follow-up: 1991-2001 (No cancer data)
 - Follow-up period for the study: 1991-2006 (Cancer and employment data)
 - Latest follow-up: 1991-2009.
- Sample description:
 - Cohort sample: N=2,734,835.
 - Analysis sample: n=2,719,500.
 - Exclusions: non-permanent residents (n=14,300) and people born in Canada classified as immigrants (n=1,000).

Variables

- Outcome variable: Risk of death measured by duration of survival in the follow-up period.
 - Deaths included in the analysis: 425,785.

- Independent variables: Immigrant status and duration in Canada.

- Control variables: age, marital status, knowledge of official languages, education, income quintiles, and employment.

Analytical methods

- Cox proportional hazard model used:
 - Conditional on survival to time t , the model estimates a non-parametric baseline risk of death at time t for individual i .
 - The focus is mainly on the predictors and less on shape of the baseline hazard.

- Models were estimated separately for males and females and selected countries (UK, India, China/Hong Kong, Philippines, and the Caribbean)

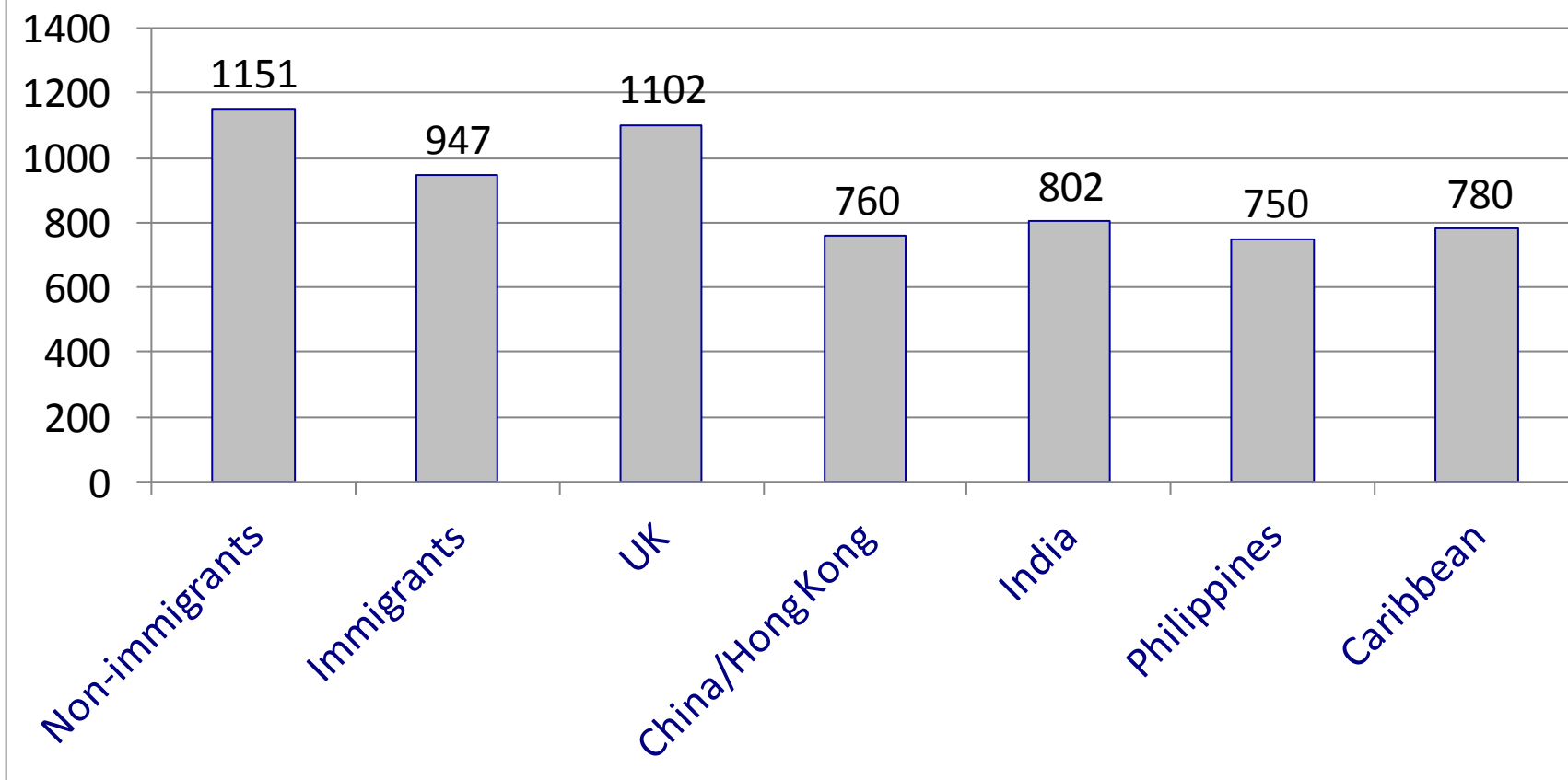
- We examined separately, differences by immigration status and duration of residence.

Table 3: Description of the sample

	Non-immigrants	Immigrants					
		Total immigrants	UK	China/HK	India	Philippines	Caribbean
Both sexes							
Number (%)	2,167,200 (79.9)	552,300 (20.3)	100,700 (50.7)	37,000 (18.6)	21,100 (10.6)	14,800 (7.4)	25,100 (12.6)
All cause deaths (%)	335,000 (78.7)	90,800 (21.3)	25,200 (75.9)	3,500 (10.7)	1,600 (4.7)	1000 (2.9)	1,900 (5.7)
Age group							
25-44	57.0	44.1	32.0	58.1	59.1	63.8	56.8
45-64	28.3	37.1	38.2	30.0	33.5	28.4	36.6
≥65	14.7	18.8	29.8	11.9	7.4	7.7	6.6
Duration in Canada, %							
<10 years	...	18.6	5.7	43.9	30.5	41.5	20.7
10-19 years	...	23.3	16.9	33.0	45.1	44.4	43.9
20-34 years	...	33.4	39.8	17.6	22.7	13.9	32.5
≥35 years	...	24.7	37.6	5.5	1.7	0.2	2.9

Source: 1991-2006 Canadian Census Mortality and Cancer Follow-up Study

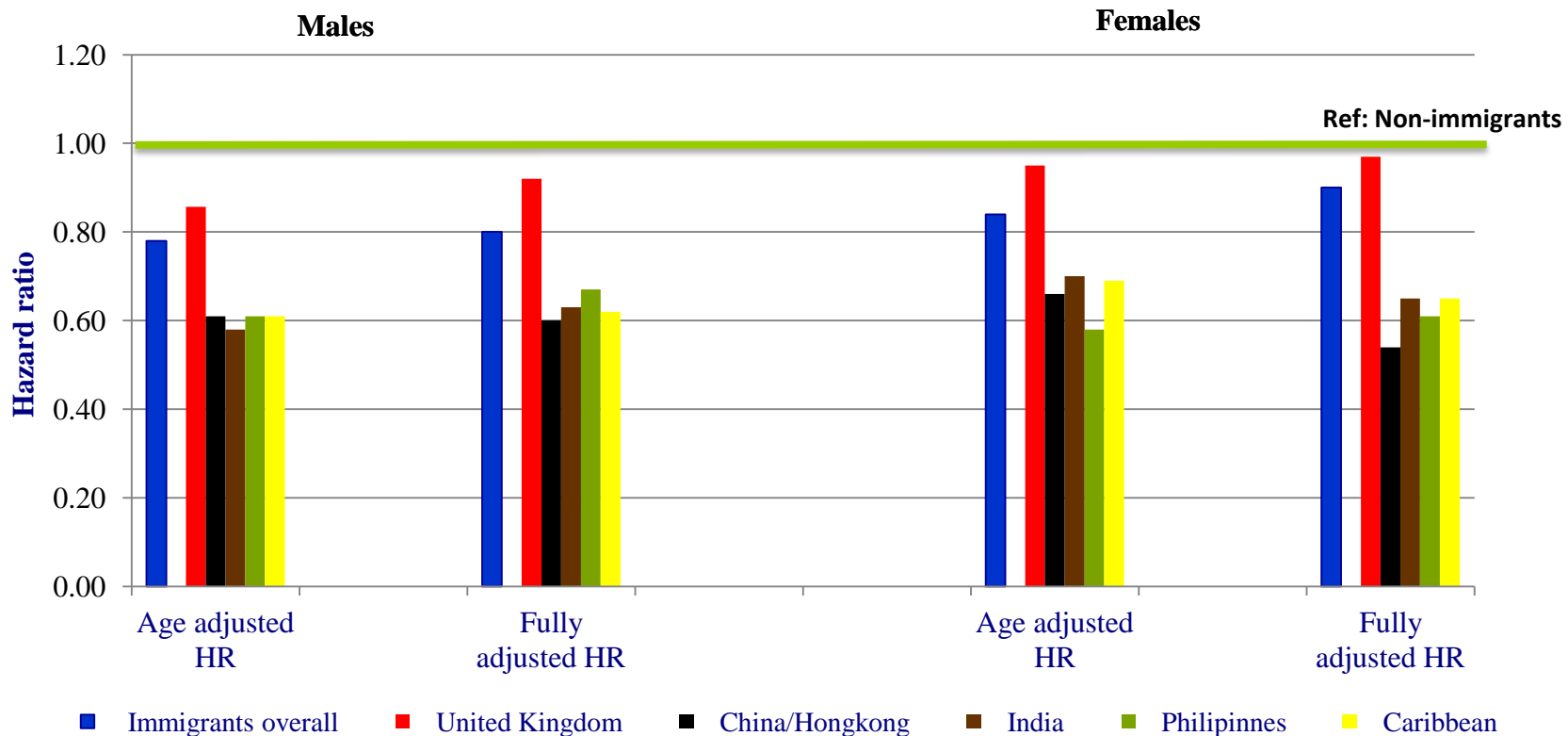
Figure 3: Age Standardised Mortality Rate (per 100,000 person years lived)



Source: The 1991 Canadian Census Cohort Mortality & Cancer Follow-up Study

Do immigrants have a mortality advantage?

Figure 4: Hazard ratios of mortality by sex, overall cohort, and selected countries



Note: All the ratios are statistically significant

Source: The 1991 Canadian Census Cohort Mortality and Cancer Follow-up Study



Table 4: Hazard ratios for all-cause mortality by immigrants duration in Canada compared to non-immigrants, 1991-2006 follow-up

	<u>Male</u>			<u>Female</u>		
	<u>Hazard ratio</u>	<u>95% CI</u>		<u>Hazard ratio</u>	<u>95% CI</u>	
<u>Overall</u>						
<10 years	0.60	0.58	0.62	0.67	0.64	0.69
10-19 years	0.67	0.65	0.69	0.75	0.72	0.77
20-34 years	0.75	0.74	0.77	0.78	0.76	0.79
>=35years	0.85	0.84	0.86	0.91	0.90	0.92
<u>UK</u>						
<20 years	0.72	0.68	0.77	0.85	0.80	0.91
>=20 years	0.87	0.86	0.89	0.96	0.95	0.98
<u>China/Hong Kong</u>						
<20 years	0.59	0.56	0.62	0.64	0.61	0.69
>=20 years	0.66	0.61	0.71	0.69	0.64	0.75

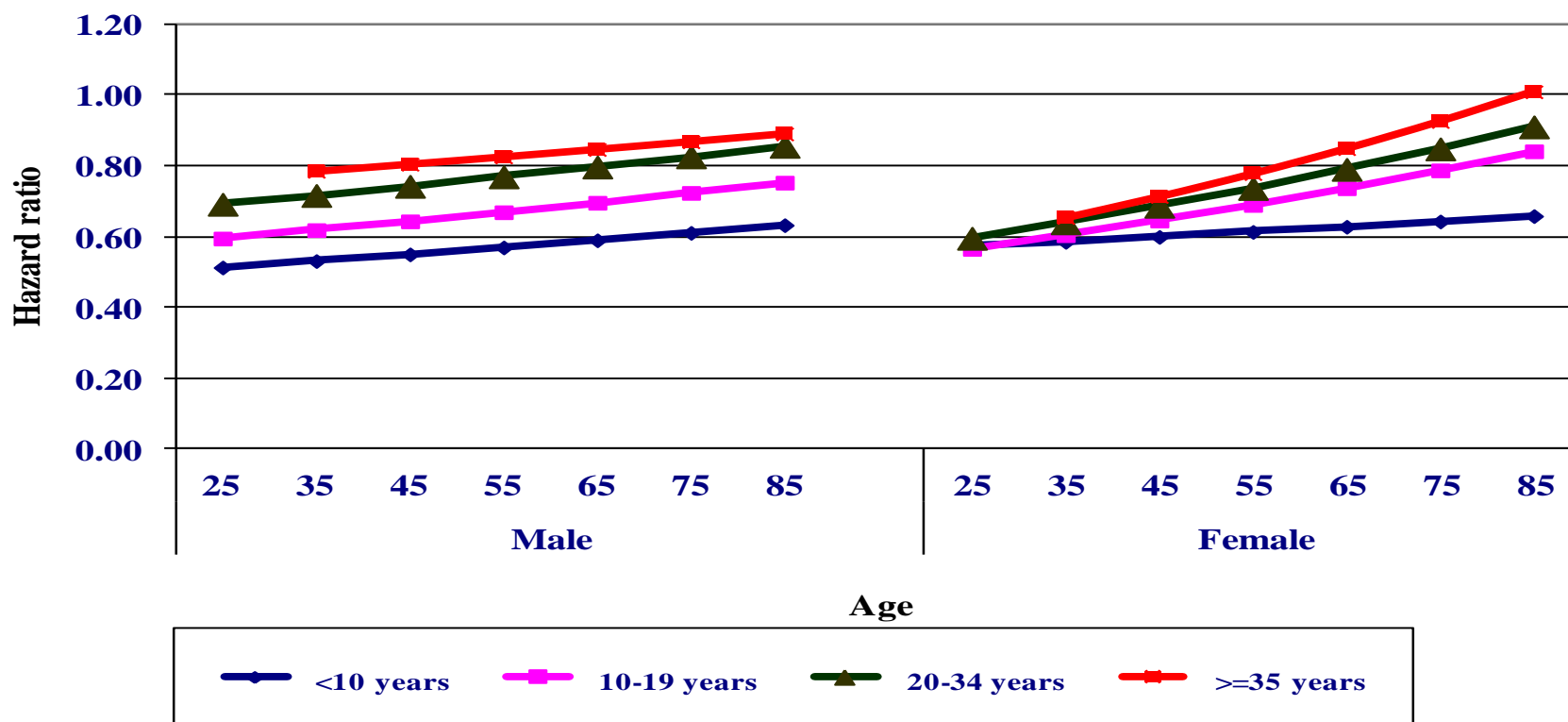
Table 4 continued

	<u>Male</u>			<u>Female</u>		
	<u>Hazard ratio</u>	<u>95% CI</u>		<u>Hazard ratio</u>	<u>95% CI</u>	
India						
<20 years	0.57	0.52	0.61	0.68	0.62	0.76
>=20 years	0.60	0.54	0.66	0.72	0.63	0.83
Philippines						
<20 years	0.62	0.56	0.68	0.56	0.51	0.62
>=20 years	0.60	0.47	0.77	0.66	0.54	0.81
Caribbean						
<20 years	0.56	0.51	0.62	0.69	0.63	0.75
>=20 years	0.66	0.60	0.72	0.70	0.64	0.77

Source: Same as Table 3

Is the duration effect dependent on age?

Figure 5: Hazard ratios of mortality by age and duration in Canada, all cohort



Source: Same as Table 3

Limitations

- Census characteristics measured at baseline.
- No lifestyle and proximate factors in the data such as smoking, alcohol drinking, engagement in physical activities, and sexual behaviour.
- Immigrants were not identified by immigrant class, e.g., refugees.
- Some population exclusions:
 - Non tax filers, under the age of 25, institutional residents at cohort inception, those not enumerated by 1991 long form census.
- Ongoing data linkage development at Statistics Canada attempt to address these limitations.

Strengths

- Large size and representative of most population groups (immigrants, Aboriginals).
 - In the current study, has permitted more realistic assessment of mortality differentials by immigrant status.
- Population based.
- Simultaneous analysis of several variables.
 - Multilevel analysis.
- Long latency period required for cancer outcomes.
- Captures residential mobility over a 27 year period.
 - Environmental exposure via the use of postal code representative points.

Conclusions

- Question 1: Results point to selection effects:
 - Cultural effects- Differences by source countries.
 - Canada's immigration system:
 - 'Points-based system selects immigrants on characteristics positively associated with health.
 - People selected mostly healthier because of medical screening.
 - Unobservable characteristics.

- Question 2: Healthy immigrant effect: Immigrants healthier at arrival, but decline occurs over time:
 - Early years- difficulties of integration.
 - Later years- acculturation.



Conclusions

- Data artefact and ‘Salmon bias’? – Implausible.
- Our knowledge of immigrant health (and other outcomes) will be further deepened from the ongoing data linkage work.



Data access

- Research Data Centres
 - www.statcan.gc.ca/rdc-cdr

- Centre for Data Development and Economic Research
 - For analysis using Longitudinal Worker File
 - www.statcan.gc.ca/cder-cdre



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