Age at immigration, generational status, and mortality among children of immigrant mothers: a longitudinal analysis of siblings

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Abstract

Previous studies document that age at immigration and generational status predict socioeconomic outcomes among children of immigrants. Whether these characteristics are related to mortality is unknown. Leveraging variation within sib-ships, we evaluated the association of age at immigration and generational status (first or second) with mortality among children of immigrant mothers to Sweden. Data included 133,819 sib-ships aged 15+ from the total Swedish population followed during 1990-2009. Population-average and sibling fixed-effect regressions were estimated; the latter controlling for unobserved factors shared by siblings. Models indicated that the foreign born experienced 17% higher mortality compared to their Swedish-born siblings. This excess risk was evident for external and non-external causes of death. This study provides robust evidence that among children of immigrants being foreign born was associated with a long-term mortality penalty compared to being born in the host country.

Introduction

Immigrants and their immediate descendants are a growing percentage of populations in high-income countries.[1] An estimated 13% of the U.S. population and 11% of the European population was born outside of their resident country in 2015.[2,3] Studies often focus on the health of immigrants, but far less is known about the health of their descendants. Understanding patterns of health and mortality among children of immigrants is critical to evaluating long-term and intergenerational effects of immigration on national health profiles.

Children of immigrants are a heterogeneous group. They may be immigrants themselves having immigrated with their parents at various stages of childhood or adolescence. This group, although technically "first generation" immigrants, are sometimes referred to as the 1.5 generation because early formative experiences (e.g., schooling, peer group formation) occur in the host country and are shared with the native born.[4,5] Children of immigrants may, alternatively, have been born in the host country and have only experiences in the host country (the second generation). These differences in age at immigration and generational status are important determinants of long-term social and economic success in this population.[6–10] How these characteristics relate to death risks, however, remains unknown. We evaluated the roles of generational status (first/second generation) and age at immigration in predicting death risks among children of immigrant mothers using Swedish population registry data.

Studies have long documented that early life experiences leave a lasting imprint on health and socioeconomic attainment.[11–14] First generation children of immigrants are a particularly important group in the context of early life impacts because they are oftentimes exposed to two vastly different socioeconomic and healthcare contexts during childhood—one in their birth country, which is often resource poor, and one in their host country, which is often

wealthy. The age at which a child immigrates demarcates the exposure the child has to each context and has been used in previous studies to identify the long-term effect of childhood social experiences in this population.[6,9,10,15] Emerging from this literature is a consistent finding that an older age of immigration is associated with poorer educational and economic outcomes. Hypothesized pathways include extended exposures to poor nutritional and disease environments and challenges integrating into the social and educational norms of the host country among older-aged childhood immigrants.[6,10,15]

Studies have also compared the first generation with the second generation. A particularly insightful comparison is that of first generation children who immigrated before the age of five years with the second generation as both groups would attend all of their schooling in the host country.[10,15] Comparing Swedish siblings—an analytic strategy that accounts for all observed and unobserved confounders shared by siblings—Van den Berg et al.[15] found that first generation children who arrived before age five years were shorter at age 18 years and achieved lower educational attainment than their second generation siblings.

We evaluated the association of generational status and age at immigration with mortality at ages 15+ years among children of mothers who immigrated to Sweden; a country that has experienced a steady growth in the percentage of its foreign-born population since 1960.[16] We hypothesized that being born in Sweden, the host country, confers a mortality advantage over being foreign born even if immigration of the foreign born child occurred at a very young age. Given the disadvantages associated with migrating during older childhood noted above, we additionally hypothesized that an older age of immigration among the foreign born is associated with higher mortality.

We make several contributions. First, to gain a more accurate understanding of the causal effects of generational status and age at migration we estimated both population averaged models controlling for observed characteristics as well as sibling fixed effects models. Sibling fixed effects models allowed us to control for all unobserved characteristics shared by siblings; such as shared early social environments. Second, we focused on birth timing in relation to mother's immigration—born 0–4 or 5+ years before mother's immigration or 0-4 and 5+ years after—in order to identify potential critical exposure periods. Third, we analyzed register-based data covering the total Swedish population, which allow sibling identification and a consistent measurement of mortality without attrition.

Methods

Data and Sample

Data were from the Swedish Work and Mortality Data (HSIA). The data contains linkages of the Swedish Register of the Total Population with the Cause of Death Register. It includes information on the total population of Sweden who were alive in 1990 and who were born before 1986. The Register of the Total Population includes a rich set of sociodemographic information including familial relationships. Data include pertinent information on birth country and immigration year. Death records were available from January 1st 1990 through to December 31st, 2009. There is a risk that immigrants leave Sweden and their emigration is not recorded. Previous analyses of Swedish immigrants, however, have concluded that the issue does not pose a large threat to mortality estimation using register data.[17,18]

Our main analytical sample (N=288,414) included all individuals aged 15+ years who resided in Sweden in 1990 and whose mother's immigrated to Sweden during the 1945-1985

period at ages 18-49 years. These individuals comprised 133,819 sib-ships defined by having the same mother. There were 6,743 deaths recorded during the 1990-2009 follow-up period at ages 15-74 years with a mean age at death of 39 years.

Family-level Characteristics

Family-level characteristics were derived from maternal information. Age of maternal immigration was calculated by subtracting the mother's birth year from her immigration year. The time of immigration in the data records the time that permanent residency is granted, which may differ to some extent from the time of arrival in Sweden. Mother's birth region was classified as Nordic Countries (Finland, Norway, Iceland, Denmark), Other Europe, Africa, and Rest of World. Mother's highest educational attainment was categorized as primary or less, secondary, and tertiary. Primary education was compulsory schooling, which comprises of primary and lower secondary schooling that is normally completed at age 16 years. Secondary education is high school ("gymnasieutbildning") or vocational training ("yrkesgymnasiun"), which is normally completed at ages 18-19 years. Tertiary is a higher education degree of at least two years in length.

Generational Status and Age at Migration

Generational status was defined by place of birth—foreign (first generation) or Sweden (second generation). We additionally examined a more detailed four category variable incorporating generational status and the time difference between the individual's birth and her or his mother's immigration. For the first generation, this variable simply represented age at migration and was calculated by subtracting the individual's birth year from the immigration year of her or his

mother. For the second generation, it reflected the number of years between the mother's

immigration and the individual's birth. The categories were: foreign born (born ≥5.0 years prior

to mother's immigration), foreign born (born <5.0 years prior to mother's immigration), Swedish

born (born <5.0 years after mother's migration), and Swedish born (born ≥5.0 years after

mother's immigration). We referred to this variable as "Migration Status".

Analysis

Death risks were modelled with generalized linear models estimated on a person-year file using a

log-link and Poisson distribution. Sex-stratified models did not result in differing conclusions so

both sexes were combined. We began by exploiting variation in death risks across all individuals

in the sample. Model 1 took the form:

$$\ln \mu_{it} = \gamma_0 + \gamma_1 * Age_{it} + \gamma_2 * Foreign_i + \gamma_3 * Female_i + \gamma_4 * Year_{it} \qquad \text{eq. [1];}$$

where *i* indexes an individual and *t* a calendar year, μ is the rate of death, *Age* is single years of

age, *Foreign* is the binary indicator of generational status (1=foreign, 0=Swedish), *Female* is an

indicator for female gender, and *Year* is calendar year in single years.

Two additional models were estimated to provide stronger causal inference. Model 2

added to Model 1 a set of observed maternal characteristics that may confound the association

between generational status and mortality. These included: mother's region of birth, mother's

educational attainment, and mother's age at immigration. Model 2 additionally controlled for

whether the family had siblings discordant by place of birth—that is whether there was at least

one foreign and one Swedish born child in the family. Model 3 relied on the sibling fixed effect

strategy. This strategy produced average estimates of mortality differences within sib-ships and

by design accounts for all observed and unobserved family characteristics shared by siblings.

Effectively comparing the migration experience of siblings, such designs allow for robust causal inference. Models 4-6 followed the same approach as Models 1-3, but used the more detailed four category migration status variable instead of the binary generational status.

A non-fixed effect and a sibling fixed effect model were estimated on a sample restricted to "mixed" families as an additional robustness check (Models 7 and 8). We additionally performed a cause-of-death analysis separating external from non-external causes using data from all families. External deaths included deaths from accidents, suicides, homicides, and other external causes (ICD9 [1990-1998]: 800-899, 900-999; ICD10 [1999-2009]: V00-V99, W00-W99, X00-X99, Y00-Y99). Non-external causes were deaths from all other causes.

Results

Table 1 provides descriptive characteristics based on data from all families. The sample was well distributed according to migration status. Roughly one-third of the sample was foreign born and among the foreign born, about 56% immigrated at ages ≥5 years. Among the Swedish born, about two-thirds were born within five years of their mother's immigration and one-third were born five or more years after migration. The Swedish born, on average, were born in 1970 compared to an average birth year of 1964 among the foreign born. Approximately 55% of mother's were born in other Nordic countries, 31% in other European countries, 1% in Africa, and 12% in other world regions. The majority of mothers (72%) had not completed tertiary education. The mean year of immigration was 1968. Supplementary Table 1 provides descriptive characteristics of the "mixed" families.

Table 2 shows hazard ratios from Models 1-6, which were based on the total sample. Model 1, the minimally adjusted non-fixed effect specification, indicated that the foreign born

have an 18% (p<.001) higher death risk than the Swedish born. Estimates from Model 2 (non-fixed effect) and Model 3 (sibling fixed effect) suggest that the effect size shown in Model 1 is robust to both observed and unobserved confounders. In Model 3, for example, the foreign born displayed a 13% (p<.001) higher death risk compared to the Swedish born. The excess risk for the foreign born was observed for external and non-external death causes (Figure 1).

Models 4-6 indicate that the foreign born, regardless of their arrival age, had higher death rates than the Swedish born groups. Those born in Sweden ≥5 years after their mother's migration were the reference group. In Model 5 (non-fixed effect fully adjusted) the foreign-born arriving at ages ≥5 years had an 18% higher death risk (p<.001) compared to the reference group. As noted, of particular importance is the comparison of the foreign-born immigrating before age five with the Swedish born. Model 5 indicated this group experienced an 11% higher death rate (p=.040) compared to the reference group and a 9% higher death rate (HR=1.11/1.02) compared to those born in Sweden <5 years after their mother's migration. Results from Model 6 (sibling fixed effect) indicated that the magnitude of these associations were robust to observed and unobserved fixed confounders.

With respect to comparisons within the place of birth groups, Models 4-6 indicated that birth timing was weakly related to mortality. For instance, among the Swedish born, those born within five years of mother's migration experienced a 1-5% higher mortality that those born ≥5 years after mother's migration (Models 4-6). Among the foreign-born, we did not observe consistent differences in death rates between those arriving at ages ≥5 years compared to those arriving at ages <5 years.

Table 3 shows hazard ratios of death from models restricted to "mixed" families. Model 7 (non-fixed effect) indicated that the foreign born have an 11% higher mortality (p=.039)

compared to the Swedish born, which is comparable to the 13% excess mortality estimated for the same difference using the total sample shown in Model 1 of Table 2. Model 8 (sibling fixed effect) suggested that the magnitude of this association is robust to all observed and unobserved fixed characteristics.

Discussion

Sweden, typical of many European countries, has experienced a rapidly growing foreign born population over the past half century. In 2016, approximately 18% of the Swedish population was born outside of Sweden, up from 11% in 2000.[16] A recent study of Swedish immigrants found that immigrants born in other European countries experienced similar or higher mortality compared to native-born Swedes, but that groups from the middle-east experienced relatively lower mortality.[18] A study of Swedish-born offspring of foreign-born parents covering 1990-2008 and at ages 18-65 years found that male offspring had higher mortality than male offspring of Swedish-born parents, but there were less differences among females.[19] No study, to our knowledge, has examined the role of age at migration or generational status to long-term mortality among children of immigrants to Sweden or any other high-income country.

A strength of our study design was the ability to leverage within-sibling variation. We showed that foreign born children experienced approximately 15% higher death risks through to age 75 years compared to Swedish born second generation children. The excess mortality of the foreign born was observed even among those immigrating at very young ages, such as those <5 years of age. We did not, however, find conclusive evidence that age at immigration among the foreign born was associated with death risks. Cause-specific analyses revealed that the excess mortality risk of the foreign born was evident for both external and non-external death causes.

The fact that the excess risk was observed for both external and internal causes suggests that multiple vulnerabilities are at play. A distal explanation is that excess risks are a function of broad socioeconomic disadvantages and challenges with integration and assimilation among the foreign born. Recent work by Hermansen[10] analyzing children of immigrants to Norway and also using a sibling fixed effects design found that relative to their native born counterparts the foreign born children completed fewer years of schooling and achieved lower adult earnings. Hermansen[10] observed this pattern among both those who immigrated during early childhood ($\geq$6 years of age) and at older ages (7-16 years of age). A finding consistent to this pattern was reported by Åslund et al.[6] among children of immigrant parents to Sweden in that the foreign born completed fewer years of schooling, were more likely to be unemployed, and experienced higher levels of social segregation compared to their Swedish born counterparts.

Our findings support the hypothesis that critical periods in very early life (<5 years of age) and in utero negatively affect long-term health. By comparing the foreign born who arrived prior to age five years with the Swedish born, we were able to control for differences in exposure to the Swedish schooling environment thereby helping isolate the effect of differences in conditions occurring in utero, around the time birth, and during very early life. We found that the young-arriving foreign born (<5 years of age) displayed higher death risks than the Swedish born. As noted, Van den Berg et al.[20] found that early-arriving foreign born were shorter than their Swedish born counterparts. Shorter attained height and higher mortality among the foreign born could be reflective of poor nutritional environments and high disease exposure of the mother or child during critical early periods.[15,21] Our study could not disentangle deprivation effects occurring around the time of birth from negative effects associated with the migration process itself, which can be accompanied by social and material hardships.[22]

Prior studies have reported that foreign born children who immigrated at older ages have poorer socioeconomic outcomes compared to younger-aged arrivals. A U.S. study showed that educational attainment and English language proficiency were higher among children who arrived at younger (at ages 0-12 years) as compared to older (at ages 13-17 years) ages.[5] Hermansen[10] found that arrival at progressively older ages was associated with lower levels of educational attainment, worse employment outcomes, and higher levels of social welfare assistance among childhood immigrants to Norway. A similar pattern was observed for children of Swedish immigrants.[6] We, however, did not find strong evidence that age at immigration was positively associated with death risks despite implementing various model specifications to detect the relationship. This finding may be due to statistical power or that the most salient predictor of long-term death risks is in fact generational status, rather than the immigration age.

Two strengths of our study—use of high quality total population register data and the use of a within sibling design—allowed us to produce robust estimates. Our study, however, had some noteworthy limitations. We were unable to control for birth order because it was highly correlated with place of birth within sib-ships with the foreign born being of lower birth order than the Swedish born. Prior studies of birth order and mortality, including those conducted in Sweden, report that birth order is positively associated with death risks.[23,24] Our estimates of excess risks associated with foreign birth would be conservative if the processes generating such an association is operating among immigrant populations. The sample included only a small number of immigrants born outside of Europe due to the period analyzed. This segment of the Swedish immigrant population is growing. Finally, our approach could not account for unobserved time-varying attributes of families that differentially affect siblings. If immigrant

families, for example, experience rising income, the younger Swedish born sibling could benefit more than the older foreign born sibling.

In sum, we found robust evidence that among children of immigrants being foreign born was associated with a long-term mortality penalty compared to being born in the host country. Our findings contribute new evidence on the long-lasting mortality effects of early life conditions and underscores that childhood migrants may be distinctly disadvantaged and an important target of immigrant integration policies. We also raise pertinent research questions on the socioeconomic and physiologic pathways through which this vulnerability arises.

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Table 1. Descriptive characteristics of children of immigrant mothers based on data from all families.

Characteristic	N	All Families Proportion or Mean	Range
Individual-level (N=288,414)			
Migration Status			
Foreign born, 5+ years prior to mother's arrival	57,826	20.0%	-
Foreign born, 0-5 years prior to mother's arrival	45,870	15.9%	-
Swedish born, 0-5 years after mother's arrival	112,526	39.0%	-
Swedish born, 5+ years after mother's arrival	72,192	25.0%	-
Mean Year of Birth, Foreign Born	103,696	1964	1932-1985
Mean Year of Birth, Swedish Born	184,718	1970	1945-1985
Female	140,662	48.8%	-
Deaths	6,743	-	-
Family- and Mother-level (N=133,819)[1]			
Mother's Region of Birth			
Africa	1,729	1.3%	-
Nordic Countries	73,971	55.3%	-
Other Europe	42,273	31.6%	-
Rest of World	15,846	11.8%	-
Mother's Educational Attainment			
Primary	51,441	38.4%	-
Secondary	45,263	33.8%	-
Tertiary	21,335	15.9%	-
Unknown	15,780	11.8%	-
Mother's Year of Migration	133,819	1968	1945-1985
Mother's Age at Migration	133,819	26.0	18.0-45.0
Mother's Age at Birth	133,819	26.9	12.5-50.7
Family Type			
Foreign Born Children Only	65,086	22.6%	
Swedish Born Children Only	148,591	51.5%	
Mixed[2]	74,737	25.9%	

Note: Mortality follow-up was 1990-2009 (7,000,91 person-years). Deaths were recorded at ages 15-74 years.

[1] N=133,819 indicates the number of mothers.

[2] At least one Swedish born child and one foreign born child present in family.

Table 2. Hazard ratios of death based on data from all families *(N=288,414)*

Characteristic	Model 1: Non-Fixed Effects Minimally Adjusted	Model 2: Non-Fixed Effects Fully Adjusted	Model 3: Sibling Fixed Effects	Model 4: Non-Fixed Effects Minimally Adjusted	Model 5: Non-Fixed Effects Fully Adjusted	Model 6: Sibling Fixed Effect
Generational Status						
Swedish Born (Second Generation)	Reference	Reference	Reference			
Foreign Born (First Generation)	1.18 (1.12, 1.24)	1.13 (1.07, 1.19)	1.16 (1.03, 1.32)			
Migration Status						
Swedish Born, ≥5 years after migration				Reference	Reference	Reference
Swedish Born, <5 years after migration				1.05 (0.98, 1.13)	1.02 (0.94, 1.10)	1.01 (0.89, 1.15)
Foreign Born, age <5 years				1.22 (1.12, 1.33)	1.11 (1.00, 1.22)	1.18 (0.97, 1.43)
Foreign Born, age ≥5 years				1.22 (1.13, 1.32)	1.18 (1.07, 1.29)	1.17 (0.90, 1.53)
Age	1.07 (1.07, 1.08)	1.07 (1.06, 1.07)	1.08 (1.06, 1.09)	1.07 (1.07, 1.08)	1.07 (1.06, 1.07)	1.08 (1.06, 1.09)
Female	0.49 (0.47, 0.52)	0.49 (0.47, 0.52)	0.48 (0.45, 0.51)	0.49 (0.47, 0.52)	0.49 (0.47, 0.52)	0.48 (0.45, 0.51)
Calendar Year	0.96 (0.96, 0.97)	0.97 (0.97, 0.97)	0.93 (0.93, 0.94)	0.96 (0.96, 0.97)	0.97 (0.97, 0.97)	0.93 (0.93, 0.94)
Family Type						
Non-Mixed		Reference			Reference	
Mixed[1]		1.08 (1.02, 1.14)			1.08 (1.02, 1.14)	
Mother's Region of Birth						
Africa		Reference			Reference	
Nordic Countries		0.94 (0.7, 1.27)			0.94 (0.7, 1.27)	

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Other Europe	0.75	0.75
	(0.55, 1.02)	(0.55, 1.02)
Rest of World	0.61	0.61
	(0.45, 0.84)	(0.45, 0.84)
Mother's Educational Attainment		
Primary	Reference	Reference
Secondary	0.89	0.89
	(0.84, 0.94)	(0.84, 0.94)
Tertiary	0.77	0.77
	(0.7, 0.85)	(0.7, 0.85)
Unknown	1.11	1.11
	(1.02, 1.21)	(1.02, 1.21)
Mother's Age at Birth	0.99	0.99
	(0.98, 0.99)	(0.98, 0.99)

Note: Mortality follow-up was 1990-2009 (7,000,91 person-years). 6,743 deaths were recorded at ages 15-74. 95% confidence intervals shown in parenthesis.

[1] At least one Swedish born child and one foreign born child present in family.

Table 3. Hazard ratios of death from models restricted to families with at least one foreign born and one Swedish born child (i.e., "mixed" families)

Characteristic	Non-Fixed Effects	Sibling Fixed Effects
Generational Status		
Swedish Born	Reference	Reference
Foreign Born	1.11	1.12
	(1.01, 1.22)	(0.94, 1.32)
Age	1.08	1.08
	(1.07, 1.09)	(1.05, 1.10)
Female	0.48	0.49
	(0.44, 0.53)	(0.44, 0.55)
Calendar Year	0.96	0.93
	(0.96, 0.97)	(0.91, 0.95)

Note: Mortality follow-up was 1990-2009 (1,867,830 person-years). 2,002 deaths were recorded at ages 15-74. 95% confidence intervals shown in parenthesis.
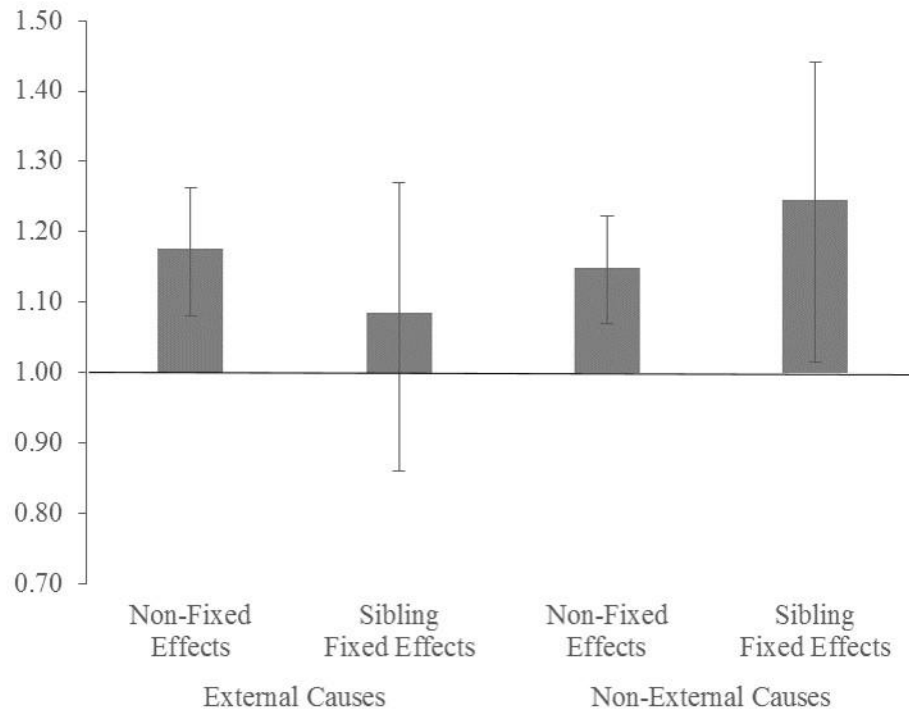
Figure 1

Figure 1 Legend. Hazard ratios of death by cause based on data from all families. Mortality follow-up was 1990-2009 (7,000,91 person-years). 6,743 deaths were recorded at ages 15-74. External causes of death were deaths from accidents, suicides, and homicides. All other causes of death were classified as non-external. Bars indicate 95% confidence intervals.

Supplementary Material

Supplementary Table 1. Descriptive characteristics of children of immigrant mothers based on data from families with at least one foreign born and one Swedish born child (i.e., "mixed" families).

Characteristic	N	Mixed Families Proportion or Mean	Range
Individual-level (N=74,737)			
Migration Status			
Foreign born, 5+ years prior to mother's arrival	13,910	18.6%	
Foreign born, 0-5 years prior to mother's arrival	24,700	33.0%	
Swedish born, 0-5 years after mother's arrival	25,998	34.8%	
Swedish born, 5+ years after mother's arrival	10,129	13.6%	
Mean Year of Birth, Foreign Born	38,610	1963	1932-1984
Mean Year of Birth, Swedish Born	36,127	1971	1945-1985
Female	36,731	49.1%	
Deaths	2,002		
Family- and Mother-level (N=24,336)[1]			
Mother's Region of Birth			
Africa	326	1.3%	
Nordic Countries	14,437	59.3%	
Other Europe	6,110	25.1%	
Rest of World	3,463	14.2%	
Mother's Educational Attainment			
Primary	11,521	47.3%	
Secondary	7,494	30.8%	
Tertiary	2,456	10.1%	
Unknown	2,865	11.8%	
Mother's Year of Migration	24,336	1968	1945-1985
Mother's Age at Migration	24,336	26.5	18.0-45.0
Mother's Age at Birth	24,336	26.1	12.7-49.9

Note: Mortality follow-up was 1990-2009 (1,867,830 person-years of follow-up). Deaths were recorded at ages 15-74 years.

[1] N=24,336 indicates the number of mothers.