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Article

All-cause mortality, age at arrival, and duration of residence among adult migrants in Sweden: A population-based longitudinal study

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ABSTRACT

Background: A mortality advantage has been observed among recently arrived immigrants in multiple national contexts, even though many immigrants experience more social disadvantage compared to natives. This is the first study to investigate the combined influence of duration of residence and age at arrival on the association between region of origin and all-cause mortality among the adult immigrant population in Sweden.

Methods: Using population-based registers, we conducted a follow-up study of 1,363,429 individuals aged 25–64 years from 1990 to 2008. Gompertz parametric survival models were fitted to derive hazard ratios (HR) for all-cause mortality.

Results: Compared to native Swedes, we observed a health advantage in all group of immigrants, with the exception of individuals from Finland. However, when information on age at arrival and duration of residence was combined, an excess mortality risk was found among immigrants who arrived before age 18, which largely disappeared after 15 years of residence in Sweden. Non-European immigrants over age 18 showed similar or lower mortality risks than natives in all categories of age at arrival, regardless of duration of residence.

Conclusions: The findings suggest that the mortality advantage commonly observed among immigrants is not universal. Combined information on age at arrival and duration of residence can be used to identify sensitive periods and to identify possible selection bias. The study also suggests that young immigrants are a vulnerable subpopulation. Given the increased number of unaccompanied minors arriving in Europe, targeted health or integration policies should be developed or reviewed.

Introduction

Health is a fundamental component of social and economic integration and a precondition for the successful development of many dimensions of life (Indicators of Immigrant Integration, 2015). In several national contexts, recent immigrants have been shown to be relatively healthy, despite often experiencing more social disadvantages, than natives ('healthy migrant paradox') (Markides & Coreil, 1986). This health advantage, which has been shown to be both origin- and outcome-specific (Urquia, O'Campo, & Heaman, 2012), has disappeared in some contexts with greater duration of residence, leading to similar health outcomes (*convergence hypothesis*) (Harding, 2003; McCredie, Williams, & Coates, 1999; Kliewer & Smith, 1995) or worse health outcomes (*unhealthy assimilation*) (Antecol & Bedard, 2006) compared to natives. Variation in the relationship between duration of residence and all-cause mortality, a general measure of overall health, is of particular societal interest because changes with duration of residence can be seen as an indicator of how well host country conditions enable immigrants to obtain good living standards or to buffer potentially adverse early-life circumstances (Juárez & Hjern, 2017).

The relationship between duration of residence and mortality has been assessed in different national contexts, with mixed results (Harding, 2003; Ott et al., 2010; Bos et al., 2007; Gray, Harding, & Reid, 2007). A recent U.S. study (Holmes, Driscoll, & Heron, 2015) suggested that mortality risk among Hispanics varies by age at arrival rather than by duration of residence. The authors postulated that young immigrants might be more likely to adopt risky health behaviors in the new social environment than older immigrants. However, U.S. born Hispanics who had immigrant parents were used as the reference category, rather than the larger U.S. native-origin population, which limits the evaluation of the convergence hypothesis with respect to the host population. Furthermore, age at arrival might be important to

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consider for health prevention efforts, revealing potential sensitive periods in immigrants' health. The lack of studies that assess duration of residence and age at arrival simultaneously in relation to mortality risk limits the generalization of such findings to other receiving contexts.

In this study we aim to assess the extent to which duration of residence and age at arrival modify associations between country or region of birth and the risk of mortality in the Swedish context. Sweden represents an interesting case study to discuss the universality of the healthy migrant and assimilation paradoxes from an international perspective. Unlike the U.S., where these phenomena have primarily been examined, Sweden has an inclusive healthcare system in which access is granted to all legal migrants on equal terms with the native-born population (Hjern, 2012). Furthermore, Sweden is well known for its humanitarian approach to migration (Huddleston et al., 2007), being the European country which hosts the most refugees *per capita* (Integration Migration Outlook, 2015). This characteristic permits assessment of the healthy migrant paradox in a large and heterogeneous group of refugees while testing the most common hypotheses proposed to explain the health advantage: unlike labor migrants, forced migrants are less likely to be positively selected in origin (healthy migrant effect) and to return (salmon bias). While previous studies have found a mortality advantage among forced migrants in Sweden (Honkaniemi et al., 2017), to the authors' knowledge, this is the first Swedish study that investigates the effect of duration of residence and age at arrival simultaneously. Additionally, unlike most previous studies using survey data, Sweden offers the possibility of studying these issues using highly reliable population-based register data that allows us to overcome problems of selection, non-response and attrition which might lead to bias.

Methods

Study population

The study uses the Swedish Work and Mortality Data (HSIA), which contains information on the total population of Sweden born before 1986 who were alive on December 31st, 1980 or 1990, as well as all foreign-born individuals who arrived in Sweden through 2002. The data contains information from different population registers linked via a pseudonymized personal identification number. This study was approved by the Regional Ethical Review Board of Stockholm (decision no. 2012/1260-31).

Fig. 1 shows the selection criteria that defined our study population. From the total population comprised in HSIA (n = 8,604,611 individuals), 7,030,327 observations were excluded according to the following criteria: 1) 'second generation' individuals, who were born in Sweden with at least one foreign-born parent (n = 509,162); 2) persons with multiple in- and out- migrations (n = 180, 192); 3) individuals with missing education and income information in all years of the follow-up period (n = 213,637); 4) foreign-born individuals with missing or unreliable information on date of arrival in Sweden (n = 59,612); and 5) native-born Swedes with recorded out migration and duration of residence (n = 3282). A random sample of 10% of the Swedish-born population was selected for comparison (n = 6,122,184 exclusions). An additional 152,386 observations were excluded by design (see the conditions for inclusion below). The total study population consisted of 1,363,429 individuals.

Follow-up commenced on January 1, 1990 until death, censoring, or end of follow-up (Dec 31, 2008), whichever was earliest. Individuals included in the study were those aged between 25 and 64 years. We considered as left-truncated those immigrants who entered the country during the follow-up until 2002 and as right-censored those who emigrated during the follow-up period.

Outcome and covariates

Our main outcome variable was all-cause mortality. Migrants were identified according to their country of birth and classified by country/region of origin, as follows: Finland, Other Nordic countries, Eastern Europe, Other European countries, Former Yugoslavia, Middle East and Other Non-European (including Africa and Latin America). These categories were based on a classification scheme developed by the

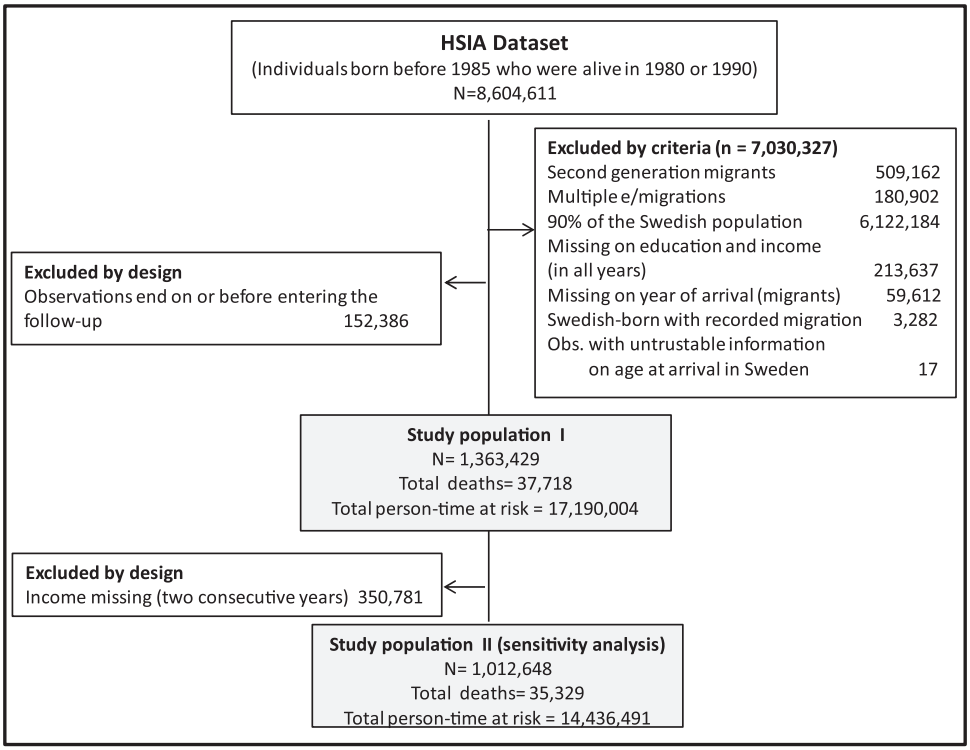

Fig. 1. .

Swedish statistical authorities to warrant sufficient statistical power, while also identifying the largest groups of immigrants in Sweden. Duration of residence was classified into two categories (< 15 and ≥ 15 years) to guarantee statistical power in combination with age at arrival. Age at arrival was categorized into < 18, 18 to 24, 25–34 and 35–64 years, which is a modified version of the categorization recommended by Rumbaut (2004). To examine the combined effect of both age at arrival and duration of residence and to avoid problems of multicollinearity, a combination variable was created.

Statistical analysis

We assessed mortality risk by duration of residence and age at arrival among adult migrants in Sweden (aged 25–64), using the Swedish-born population as the reference to assess convergence with natives. Parametric regression survival-time models (Gompertz) were estimated using age as the time-scale to derive hazard ratios (HR) and 95% confidence intervals (CI). Two model specifications were defined. Model 1 includes calendar period, since early life conditions and selection in origin might vary over time. Model 2 additionally includes annual time-varying covariates that could mediate the association between age at arrival or duration of residence and mortality, including education, disposable income, and civil status. All models were stratified by gender. Using the Wald test, we also assessed whether there was an interaction between 1) the variable of interest and participant's sex and 2) duration of residence and age at arrival on the risk of mortality. Post estimation linear hypothesis tests were used to assess for statistically significant differences ($P < 0.05$) in hazard ratio estimates in each age group by duration of residence. All analyses were performed using Stata, V.13, software (StataCorp, LP, College Station, Texas, USA).

Sensitivity analyses

Given that out-migration is well-known to be under-reported, and has been suggested to contribute to an artificial lower mortality rate among immigrants (Andersson & Drefahl, 2017), commonly referred to as 'salmon bias' (Pablos-Mendez, 1994) we also censored immigrants with no recorded income for two subsequent years (n = 350,781) as a proxy for unreported out-migration. In contrast to a previous study (Weitoft et al., 1999), we restricted the time frame to two years to prevent exclusion of individuals who might have temporarily resided in Sweden without any income. This could be the case, for example, among non-European immigrants without a permanent residence permit who become unemployed. Such persons are not eligible for unemployment benefits or any other source of income, but they could possibly stay in the country (undocumented) until they change their legal situation (e.g., find a new job). The study population for this sensitivity analysis consists of 1,012,648 individuals.

Results

During the 17,190,004-person-years of follow-up, 37,718 individuals died. Table 1 shows the number of individuals and death rates per 1,000 person-years by different levels of the explanatory variables included in the study. All immigrant groups demonstrated lower mortality rates than individuals born in Sweden (< 2.6/1,000 person-years), except for those coming from Finland (3.16/1,000 person-years). However, mortality rates increased with longer time spent in Sweden and older age at arrival. When duration of residence and age at arrival were combined, a clear gradient by age emerged; persons who were older at migration and with 15+ years of residence in Sweden showed the highest mortality rates (6.41/1,000 person-years among those who arrived when they were 35 years or older). As expected, death rates were slightly higher among males than females (3/1,000 vs. 2/1,000 person-years) and decreased as education increased. Single and widowed persons were the categories of civil status with the highest death rates (3.33 and 4.47/1,000 person-years, respectively).

Table 1
Person-time, number of deaths, and mortality incidence rates with 95% confidence intervals per 1000 person-years.

	Person-time	No. of deaths	Mortality rate	95% CI
Total	17,19,0004	37,718	2.19	2.17, 2.22
Regions and countries of birth				
Sweden	6,754,621	17,677	2.62	2.58, 2.66
Finland	2,375,185	7500	3.16	3.09, 3.23
Other Nordic countries	761,779	1766	2.32	2.21, 2.43
Other European countries	970,850	2109	2.17	2.08, 2.27
Eastern Europe	1,292,355	2418	1.87	1.80, 1.95
Former Yugoslavia	1,384,368	2204	1.59	1.53, 1.66
Middle East	1,467,719	1411	0.96	0.91, 1.01
Africa	581,696	835	1.44	1.34, 1.54
Latin America	599,653	688	1.15	1.06, 1.24
Other Non-European countries	1,001,778	1110	1.11	1.04, 1.18
Sex				
Male	8,522,757	23,509	2.76	2.72, 2.79
Female	8,667,246	14,209	1.64	1.61, 1.67
Duration of residence (years)				
≤ 5	1,337,975	834	0.62	0.58, 0.67
6 to 9	1,614,696	1647	1.02	0.97, 1.07
10 to 14	1,522,969	2018	1.33	1.27, 1.38
≥ 15	5,959,744	15,542	2.61	2.57, 2.65
Age at arrival (years)				
≤ 18	2,452,392	3944	1.61	1.56, 1.66
18–24	3,132,077	5550	1.77	1.73, 1.82
25–34	3,393,677	6081	1.79	1.75, 1.84
≥ 35	1,457,237	4466	3.06	2.98, 3.16
Duration of residence and age at arrival				
≤ 15 years in Sweden				
< 18	189,192	108	0.57	0.47, 0.69
18–24	1,118,512	495	0.44	0.41, 0.48
25–34	1,999,884	1284	0.64	0.61, 0.68
35–64	1,168,052	2612	2.24	2.15, 2.32
> 15 years in Sweden				
< 18	2,263,200	3836	1.69	1.64, 1.75
18–24	2,013,566	5055	2.51	2.44, 2.58
25–34	1,393,793	4797	3.44	3.35, 3.54
35–64	289,185	1854	6.41	6.13, 6.71
Period				
1990 to 1995	5,087,952	8367	1.64	1.61, 1.68
1996 to 1999	3,676,040	8309	2.26	2.21, 2.31
2000 to 2003	3,810,200	9354	2.45	2.41, 2.51
2004 to 2009	4,615,812	11,688	2.53	2.49, 2.58
Income quintiles				
1 (Lowest)	2,690,694	6609	2.46	2.40, 2.52
2	2,743,276	10,016	3.65	3.58, 3.72
3	3,825,750	8818	2.30	2.26, 2.35
4	4,148,772	6867	1.66	1.62, 1.69
5 (Highest)	3,779,844	5408	1.43	1.39, 1.47
Missing	1,667			
Education				
Primary	4,448,298	15,659	3.52	3.47, 3.58
Secondary	7,584,426	15,759	2.08	2.05, 2.11
Tertiary	4,864,144	6300	1.30	1.26, 1.33
Missing	293,136			
Civil status				
Single	3,142,547	10,454	3.33	3.26, 3.39
Partner	9,103,772	16,384	1.80	1.77, 1.83
Divorced	4,617,185	9427	2.04	2.00, 2.08
Widowed	324,833	1453	4.47	4.25, 4.71
Missing	1667			

Table 2 (for men) and 3 (for women) show the association between specific countries/regions of birth and all-cause mortality in relation to duration of residence and age at migration with different model specifications. With the exception of Finnish men, all foreign-origin groups showed systematically lower mortality risks compared to Swedes. However, some differences emerged, most notably among European immigrants, when age at arrival and duration of residence were considered.

Table 2
Association between origin, duration of residence, age at arrival and all-cause mortality among men[a].

	Finland			Other Nordic countries			Other EU			Eastern Europé	
	N= 74,036 (17%)			N=34,833 (8%)			N=64,268 (15%)			N=30,004 (7%)	
	D	HR	95%CI	D	HR	95%CI	D	HR	95%CI	D	HR
Model 1[b]											
Sweden (ref)	*10,.834*	1		*10,834*	1		*10,834*	1		*10,834*	1
Migrants	*4,740*	1.28***	[1.23,1.32]	*997*	0.82***	[0.76,0.87]	*1,521*	0.63***	[0.60,0.67]	*1,147*	0.91**
Migrants with less or 15 years in Sweden											
< 18	*4*	**3.17***	**[1.19,8.47]**	*NED*	NED	NED	*9*	**2.47****	**[1.28,4.77]**	*10*	**2.79****
18–24	*50*	**2.38*****	**[1.80,3.16]**	*19*	**1.30**	**[0.83,2.05]**	*37*	**0.81**	**[0.58,1.12]**	*15*	1.03
25–34	*55*	1.38*	[1.06,1.80]	*45*	0.95	[0.71,1.27]	*84*	0.69***	[0.56,0.86]	*59*	0.84
35–64	*126*	**1.61*****	**[1.35,1.92]**	*135*	0.97	[0.82,1.15]	*103*	**0.57*****	**[0.47,0.69]**	*133*	0.87
Migrants with more than 15 years in Sweden											
< 18	*1,395*	**1.20*****	**[1.13,1.27]**	*200*	0.82**	[0.71,0.94]	*279*	**0.80*****	**[0.71,0.90]**	*186*	**0.93**
18–24	*1,536*	**1.15*****	**[1.09,1.21]**	*172*	**0.49*****	**[0.42,0.57]**	*474*	**0.57*****	**[0.52,0.63]**	*219*	0.77***
25–34	*1,196*	1.31***	[1.24,1.40]	*276*	0.78***	[0.69,0.88]	*411*	0.57***	[0.52,0.63]	*376*	0.99
35–49	*378*	**2.21*****	**[1.99,2.45]**	*150*	**1.51*****	**[1.28,1.77]**	*124*	**0.82***	**[0.69,0.98]**	*149*	0.95
Model 2[c]											
Sweden (ref)	*10,834*	1		*10,834*	1		*10,834*	1		*10,834*	1
Migrants	*4,740*	1.07***	[1.03,1.11]	*997*	0.77***	[0.72,0.82]	*1,521*	0.59***	[0.56,0.62]	*1,147*	0.86***
Migrants with less or 15 years in Sweden											
< 18	*4*	2.14	[0.80,5.72]	*NED*	NED	NED	*9*	**1.78**	**[0.92,3.43]**	*10*	**1.94***
18–24	*50*	**1.89*****	**[1.43,2.51]**	*19*	**1.14**	**[0.73,1.80]**	*37*	0.67*	[0.48,0.93]	*15*	0.85
25–34	*55*	1.15	[0.88,1.50]	*45*	0.95	[0.71,1.27]	*84*	0.65***	[0.52,0.81]	*59*	0.82
35–64	*126*	**1.16**	**[0.97,1.38]**	*135*	**0.86**	**[0.72,1.02]**	*103*	0.54***	[0.44,0.65]	*133*	0.82*
Migrants with more than 15 years in Sweden											
< 18	*1,395*	1.05	[0.99,1.11]	*200*	0.76***	[0.66,0.88]	*279*	**0.76*****	**[0.68,0.86]**	*186*	**0.91**
18–24	*1,536*	**0.99**	**[0.94,1.05]**	*172*	**0.48*****	**[0.41,0.55]**	*474*	0.56***	[0.51,0.61]	*219*	0.73***
25–34	*1,196*	1.04	[0.97,1.10]	*276*	0.76***	[0.67,0.85]	*411*	0.52***	[0.47,0.57]	*376*	0.91
35–49	*378*	**1.42*****	**[1.27,1.57]**	*150*	**1.20***	**[1.02,1.41]**	*124*	0.66***	[0.55,0.79]	*149*	0.85*

	F.Yugoslavia				Middle East			Rest non-EU		
	N=54,312 (13%)				N=68,413 (16%)			N=91,064 (22%)		
	95%CI	D	HR	95%CI	D	HR	95%CI	D	HR	95%CI
Model 1[b]										
Sweden (ref)		*10,834*	1		*10,834*	1		*10,834*	1	
Migrants	[0.86,0.97]	*1,625*	0.88***	[0.83,0.92]	*1,050*	0.63***	[0.59,0.67]	*1,595*	0.76***	[0.72,0.80]
Migrants with less or 15 years in Sweden										
< 18	**[1.50,5.21]**	*14*	1.96*	[1.16,3.33]	*19*	1.99**	[1.27,3.14]	*22*	1.65*	[1.08,2.52]
18–24	[0.62,1.72]	*31*	0.77	[0.54,1.10]	*87*	**1.02**	**[0.83,1.27]**	*81*	**1.00**	**[0.80,1.25]**
25–34	[0.65,1.09]	*152*	**0.90**	**[0.76,1.06]**	*178*	0.61***	[0.52,0.71]	*239*	0.79***	[0.70,0.91]
35–64	[0.73,1.03]	*530*	0.96	[0.88,1.05]	*324*	**0.61*****	**[0.54,0.68]**	*273*	**0.69*****	**[0.61,0.77]**

(*continued on next page*)

Table 2 (*continued*)

	F.Yugoslavia				Middle East			Rest non-EU		
	N = 54,312 (13%)				N = 68,413 (16%)			N = 91,064 (22%)		
	95%CI	D	HR	95%CI	D	HR	95%CI	D	HR	95%CI
Migrants with more than 15 years in Sweden										
< 18	**[0.81,1.08]**	*128*	1.24*	[1.04,1.48]	*44*	1.43*	[1.06,1.93]	*170*	1.11	[0.95,1.29]
18–24	[0.67,0.88]	*364*	0.91	[0.82,1.01]	*85*	**0.62*****	**[0.50,0.77]**	*197*	**0.76*****	**[0.66,0.87]**
25–34	[0.90,1.10]	*317*	**0.73*****	**[0.65,0.82]**	*178*	0.66***	[0.57,0.76]	*424*	0.78***	[0.70,0.85]
35–49	[0.81,1.11]	*89*	1.18	[0.95,1.45]	*135*	**0.84***	**[0.70,0.99]**	*189*	**0.85***	**[0.74,0.98]**
Model 2[c]										
Sweden (ref)		*10,834*	1		*10,834*	1		*10,834*	1	
Migrants	[0.81,0.92]	*1,625*	0.78***	[0.74,0.83]	*1,050*	0.54***	[0.51,0.58]	*1,595*	0.65***	[0.62,0.69]
Migrants with less or 15 years in Sweden										
< 18	**[1.04,3.62]**	*14*	1.50	[0.88,2.54]	*19*	1.30	[0.82,2.04]	*22*	1.06	[0.70,1.62]
18–24	[0.51,1.41]	*31*	0.65*	[0.46,0.93]	*87*	**0.74****	**[0.60,0.92]**	*81*	0.75*	[0.60,0.94]
25–34	[0.63,1.06]	*152*	**0.88**	**[0.75,1.04]**	*178*	0.52***	[0.44,0.60]	*239*	0.70***	[0.61,0.80]
35–64	[0.69,0.97]	*530*	0.93	[0.85,1.02]	*324*	0.57***	[0.51,0.64]	*273*	0.63***	[0.56,0.71]
Migrants with more than 15 years in Sweden										
< 18	**[0.79,1.05]**	*128*	1.06	[0.89,1.26]	*44*	1.10	[0.82,1.49]	*170*	0.93	[0.79,1.08]
18–24	[0.64,0.83]	*364*	0.79***	[0.71,0.87]	*85*	**0.54*****	**[0.44,0.67]**	*197*	0.65***	[0.56,0.75]
25–34	[0.82,1.01]	*317*	**0.59*****	**[0.53,0.66]**	*178*	0.56***	[0.48,0.65]	*424*	0.66***	[0.59,0.72]
35–49	[0.72,1.00]	*89*	0.89	[0.72,1.10]	*135*	0.67***	[0.56,0.80]	*189*	0.69***	[0.60,0.80]

Abbreviations: D, number of deaths; CI, confidence interval; HR, hazard ratio; ND, Not Enough Data to estimate hazard ratios.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$

[a] Results in bold represent statistically significant differences ($P < 0.05$) between categories with the same age at arrival but different duration of residence for each origin group. This serves to test whether there are statistical differences by duration of residence.

[b] Model adjusted for period

[c] Model adjusted for period, education, disposable income, and civil status

After adjusting for social and demographic characteristics, there was an indication of effect modification among immigrants who arrived before age 18, depending on whether their duration of residence was less (showing higher HRs) or more (lower or equal HRs) than 15 years in Sweden. This dampened risk with greater duration of residence among those who migrated before age 18 was seen in all immigrant groups; however, post-estimation tests revealed that differences in these risk estimates by duration of residence were only statistically significant among men from Other European countries and Eastern Europe. The lack of statistically significant differences in other groups by duration of residence could be explained by the small size of the migration under 18 age group. A similar pattern of decreased risk was also found among men from Finland and Other Nordic countries with longer duration of residence who migrated between ages 18–24.

In contrast to the above-mentioned pattern, elevated HRs were found among Finnish men who arrived in Sweden aged 35–64 and immigrants from Other Nordic countries (both sexes, but statistically significant differences in risk estimates by residence duration only in men) who spent at least 15 years in Sweden.

The higher HRs observed among Finnish immigrants is notable compared to non-European immigrants. However, these HRs attenuated when social characteristics were considered in Model 2. Finnish women showed an indication of elevated risk only among those who arrived before age 18 and spent less than 15 years in Sweden (Table 3).

Sensitivity analyses

The above-mentioned results are generally consistent with those from sensitivity analyses in which immigrants without income during two consecutive years were censored as a proxy for underreported out migration (see Tables S1–2 in the supplementary file).

Discussion

Main findings

Except for Finnish men, all immigrant groups had overall lower mortality risks compared to native Swedes. However, this pattern was modified when duration of residence and age at arrival were considered, showing three main findings. First, all immigrant groups showed evidence of a higher mortality risk among younger individuals (those aged < 18), but these risk indications were less evident in those with 15 years or more of residence in Sweden. Although results were not statistically significant in all immigrant groups, the increased risk estimates among children and teenagers who arrived more recently compared to those who had lived in Sweden for a longer time deserves attention. Second, evidence of a moderate health deterioration was found among older immigrants (≥ 35 years) from Other Nordic countries (men and women) and Finland (only among men) after 15 years of residence. Third, non-Nordic immigrants showed similar or lower mortality risks than Swedes regardless of duration of residence in all categories of age at arrival above age 18.

Links with previous research

Although comparison with other studies is difficult, given that not all of them use the host population as the reference category or include the same controls, overall, our results are consistent with previous international findings. In line with the 'healthy migrant paradox' in Sweden (Honkaniemi et al., 2017; Saraiva Leão et al., 2009; Rostila & Fritzell, 2014) and elsewhere (Markides & Coreil, 1986; Honkaniemi et al., 2017; Darmon & Khlat, 2001; Deboosere & Gadeyne), we showed that non-European immigrants have lower mortality rates than natives. However, our results also suggest that this is not the case for immigrants who arrived before age 18, who demonstrated higher risks of mortality than Swedes. This result is consistent with a prior study conducted on the U.S. Hispanic population, which compared Hispanic immigrants with U.S. born Hispanics (Holmes et al., 2015). Although we cannot fully disregard the importance of duration of residence, since we found an indication of lower risk after 15 years in Sweden, this finding might well reflect a selection produced by the premature deaths of those with shorter duration of residence in Sweden.

Support for a health deterioration by duration of residence (i.e. 'unhealthy assimilation') (Antecol & Bedard, 2006; Bos et al., 2007; Escarce, Morales, & Rumbaut, 2014; O'Brien et al., 2014), was found only among older immigrants (≥ 35 years) from Finland (only men) and Other Nordic countries (both sexes). Previous studies suggest this health deterioration might be explained by the adoption of risky health behaviors (Antecol & Bedard, 2006; Bos et al., 2007; Escarce et al., 2014; O'Brien et al., 2014) as a general process of acculturation (Berry, 2005). Although risk behaviors could operate as the main mechanisms at play, acculturation does not seem to be the main driving factor here, as these Nordic countries are the most culturally proximate to Sweden.

The observed mortality advantages among non-Nordic immigrants (who arrived after age 18) regardless of duration of residence do not support the common interpretation of the 'healthy migrant paradox' as a phenomenon exclusive to newly arrived immigrants (Urquia & Gagnon, 2011). Furthermore, the observed advantage among non-European immigrants in general shows that the 'paradox' is not limited to labor migrants but may also apply to refugees. This finding challenges the validity and/or universality of the health selection hypothesis (or 'healthy migrant effect'), which explains the 'healthy migrant paradox' as a natural consequence of migrants being healthier compared to their peers in origin. This explanation is questionable since refugees are exposed to a number of adverse health consequences before, during, and after migrating, including high levels of trauma (Hjern, 2012). Having said this, the context of reception may also be relevant since refugees in Sweden are entitled to a number of social benefits that might to some degree compensate for their negative experiences. Similarly, the mortality advantage among refugees also questions return migration ('salmon bias') as an alternative explanation since, unlike labor migrants, return might not occur in this group due to political and social conditions in the country of origin.

Our results suggest that migration might have harmful effects at younger ages (who arrived before age 18). Adolescence is a crucial period in life for the development of self-identity and sense of belonging (Alegria et al., 2007). Studies suggest that these processes may be intensified among young immigrants, insofar as they might be more likely to suffer from, for example, lack of acceptance by peers as well as greater intergenerational tension between the norms and values of sending and receiving countries (Alegria et al., 2007). In line with this, studies have shown an increased risk of psychiatric disorders among young Latinos in the U.S. (Alegria et al., 2007; Vega et al., 1998). Further studies should investigate if and how these common mechanisms proliferate among refugee unaccompanied migrants.

Strength and limitations

To the best of our knowledge, this is the first study looking at effect modification by duration of residence and age at arrival in the association between origin and all-cause mortality using the native-born population as a reference group. Controlling for time-varying socioeconomic variables is of great importance, especially among refugee immigrants who are initially economically dependent on benefits, i.e. income is non-informative among recent immigrants until they are established in the Swedish labor market. Compared to other studies that use survey or census data (Harding, 2003; Bos et al., 2007; Gray et al., 2007; Holmes et al., 2015; Borrell & Crawford, 2009) the use of population registers is a clear strength, since this information is not subject to bias arising from self-reported information, non-response, and interviewer effects. In addition, population–based research helps to avoid problems of selection due to loss of follow-up or coverage among

Table 3
Association between origin, duration of residence, age at arrival and all-cause mortality among women[a].

	Finland			Other Nordic countries			Other EU			Eastern Europé
	N = 97,995 (23%)			N = 36,677 (8%)			N = 51,299 (12%)			N = 44,030 (10%)
	D	HR	95%CI	D	HR	95%CI	D	HR	95%CI	D
Model 1[b]										
Sweden (ref)	*6,843*	1		6,843	1		6,843	1		*6,843*
Migrants	*2,760*	0.83***	[0.79,0.87]	760	0.87***	[0.80,0.93]	683	0.57***	[0.52,0.61]	*962*
Migrants with less or 15 years in Sweden										
< 18	*3*	2.45	[0.79,7.62]	1	1.51	[0.21,10.75]	4	1.66	[0.62,4.43]	*4*
18–24	*21*	0.99	[0.64,1.53]	13	**1.13**	**[0.65,1.96]**	15	0.65	[0.39,1.08]	*14*
25–34	*28*	0.98	[0.68,1.43]	16	0.55*	[0.33,0.89]	29	0.61**	[0.42,0.87]	*80*
35–64	*53*	0.92	[0.70,1.21]	81	**1.11**	**[0.89,1.39]**	44	0.48***	[0.36,0.65]	*157*
Migrants with more than 15 years in Sweden										
< 18	*807*	0.87***	[0.81,0.93]	168	0.9	[0.77,1.05]	176	0.76***	[0.65,0.88]	*78*
18–24	*1,118*	0.74***	[0.70,0.79]	218	**0.61****	**[0.53,0.69]**	198	0.44***	[0.38,0.51]	*187*
25–34	*575*	0.85***	[0.78,0.93]	182	0.96	[0.83,1.11]	160	0.55***	[0.47,0.64]	*299*
35–49	*155*	1.23*	[1.04,1.44]	90	**1.69****	**[1.37,2.08]**	57	0.70**	[0.54,0.91]	*143*
Model 2 [c]										
Sweden (ref)	*6.,843*	1		6,843	1		6,843	1		*6,843*
Migrants	*2,760*	0.77***	[0.74,0.81]	760	0.81***	[0.75,0.88]	683	0.54***	[0.50,0.58]	*962*
Migrants with less or 15 years in Sweden										
< 18	*3*	1.87	[0.60,5.82]	1	1.05	[0.15,7.50]	4	1.30	[0.49,3.48]	*4*
18–24	*21*	0.92	[0.60,1.42]	13	1.01	[0.58,1.75]	15	0.59*	[0.35,0.98]	*14*
25–34	*28*	1.00	[0.69,1.45]	16	0.57*	[0.35,0.93]	29	0.62**	[0.43,0.89]	*80*
35–64	*53*	0.82	[0.63,1.08]	81	1.02	[0.82,1.27]	44	0.44***	[0.33,0.60]	*157*
Migrants with more than 15 years in Sweden										
< 18	*807*	0.81***	[0.75,0.87]	168	0.83*	[0.71,0.97]	176	0.74***	[0.63,0.85]	*78*
18–24	*1,118*	0.70***	[0.66,0.75]	218	0.57***	[0.50,0.65]	198	0.43***	[0.38,0.50]	*187*
25–34	*575*	0.76***	[0.70,0.83]	182	0.93	[0.80,1.07]	160	0.53***	[0.45,0.62]	*299*
35–49	*155*	0.98	[0.84,1.15]	90	1.50***	[1.21,1.84]	57	0.59***	[0.45,0.76]	*143*

	Eastern Europé		F.Yugoslavia			Middle East			Rest non-EU		
	N = 44,030 (10%)		N = 50,414 (12%)			N = 52,355 (12%)			N = 101,660 (23%)		
	HR	95%CI	D	HR	95%CI	D	HR	95%CI	D	HR	95%CI
Model 1[b]											
Sweden (ref)	1		*6,843*	1		*6,843*	1		*6,843*	1	
Migrants	0.84***	[0.79,0.90]	*793*	0.75***	[0.70,0.81]	*361*	0.51***	[0.46,0.57]	*1,083*	0.77***	[0.72,0.82]
Migrants with less or 15 years in Sweden											
< 18	**2.00**	**[0.75,5.35]**	*4*	0.89	[0.33,2.38]	*NED*	NED	NED	*14*	**2.02****	**[1.19,3.43]**
18–24	0.59*	[0.35,1.00]	*23*	0.92	[0.61,1.40]	*26*	0.61*	[0.41,0.90]	*63*	0.92	[0.71,1.19]
25–34	0.96	[0.76,1.20]	*71*	0.68**	[0.54,0.87]	*71*	0.56***	[0.44,0.71]	*177*	0.84*	[0.72,0.98]
35–64	0.79**	[0.67,0.92]	*302*	0.94	[0.84,1.06]	*135*	0.52***	[0.44,0.62]	*216*	0.69***	[0.60,0.79]

(*continued on next page*)

Table 3 (*continued*)

	Eastern Europé		F.Yugoslavia			Middle East			Rest non-EU		
	N = 44,030 (10%)		N = 50,414 (12%)			N = 52,355 (12%)			N = 101,660 (23%)		
	HR	95%CI	D	HR	95%CI	D	HR	95%CI	D	HR	95%CI
Migrants with more than 15 years in Sweden											
< 18	**0.67*****	**[0.54,0.84]**	*66*	0.83	[0.65,1.05]	*16*	0.88	[0.54,1.44]	*123*	**1.12**	**[0.94,1.35]**
18–24	0.89	[0.77,1.03]	*147*	0.70***	[0.59,0.82]	*17*	0.42***	[0.26,0.68]	*123*	0.88	[0.73,1.05]
25–34	0.93	[0.83,1.04]	*138*	0.70***	[0.59,0.82]	*55*	0.65**	[0.50,0.85]	*210*	0.75***	[0.66,0.86]
35–49	0.91	[0.77,1.07]	*42*	0.78	[0.58,1.06]	*41*	0.55***	[0.40,0.75]	*112*	0.82*	[0.68,0.99]
Model 2 [c]											
Sweden (ref)	1		*6,843*	1		*6,843*	1		*6,843*	1	
Migrants	0.84***	[0.78,0.90]	*793*	0.66***	[0.61,0.71]	*361*	0.45***	[0.41,0.50]	*1,083*	0.70***	[0.65,0.75]
Migrants with less or 15 years in Sweden											
< 18	1.42	[0.53,3.80]	*4*	0.68	[0.26,1.83]	*NED*	NED	NED	*14*	1.41	[0.83,2.39]
18–24	0.57*	[0.34,0.97]	*23*	0.85	[0.56,1.29]	*26*	0.55**	[0.37,0.82]	*63*	0.8	[0.62,1.04]
25–34	1.03	[0.82,1.28]	*71*	0.69**	[0.55,0.88]	*71*	0.57***	[0.45,0.72]	*177*	0.82*	[0.70,0.96]
35–64	0.74***	[0.63,0.87]	*302*	**0.85****	**[0.75,0.95]**	*135*	0.46***	[0.39,0.55]	*216*	0.63***	[0.55,0.72]
Migrants with more than 15 years in Sweden											
< 18	0.67***	[0.54,0.84]	*66*	0.76*	[0.59,0.97]	*16*	0.75	[0.46,1.23]	*123*	0.98	[0.81,1.17]
18–24	0.93	[0.80,1.07]	*147*	0.63***	[0.53,0.74]	*17*	0.41***	[0.25,0.66]	*123*	0.85	[0.71,1.02]
25–34	0.95	[0.84,1.06]	*138*	0.58***	[0.49,0.69]	*55*	0.60***	[0.46,0.79]	*210*	0.71***	[0.62,0.82]
35–49	0.85	[0.72,1.01]	*42*	**0.59*****	**[0.44,0.80]**	*41*	0.44***	[0.32,0.60]	*112*	0.69***	[0.57,0.83]

Abbreviations: D, number of deaths; CI, confidence interval; HR, hazard ratio; ND, Not Enough Data to estimate hazard ratios.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$

[a] Results in bold represent statistically significant differences ($P < 0.05$) between categories with the same age at arrival but different duration of residence for each origin group. This serves to test whether there are statistical differences by duration of residence.

[b] Model adjusted for period

[c] Model adjusted for period, education, disposable income, and civil status.

those who are in care institutions. The record linkage between different registers has been performed by the Swedish authorities using an individual personal number so that, unlike other studies (Holmes et al., 2015), we do not deal with problems of inaccurate record linkage.

In this study, we used the lack of disposable individual income during two subsequent years as a proxy for under-reported out migration (also referred to as over-coverage), assuming that registered individuals are not residing in Sweden without receiving any source of income (e.g., parental leave, salary, social allowance or disability pension). Accounting for the potential bias associated with over-coverage is another strength of our study, and future research should continue examining the extent to which our findings reflect true health differences or a source of artifact due to bias (e.g., underreported out-migration) or selection (non-random out-migration), especially among the group of non-refugees who are more likely to return to their homeland than refugees. A study conducted in Denmark in a cohort of refugee and family reunification immigrants showed that healthy individuals were more likely to return to the country of origin (Norredam et al., 2015). If this pattern applies to the Swedish context, then return migration might not explain the health advantage observed in the group of non-Europeans with more than 15 years of residence in Sweden.

Despite the above-mentioned strengths, register data is not free from limitations (Thygesen & Ersbøll, 2014). For example, information on date of migration was not available before year 1960, hence we may underestimate risk among those immigrants (predominantly from Finland) who have spent more than 15 years in Sweden. Another limitation associated to our setting is that we do not have information on the most recent waves of immigrants (those arriving in Sweden after 2002), including the last wave of immigration from Syria and the group of unaccompanied refugee minors, which has greatly increased since 2006. Despite this, the current study examines adult refugees who arrived in Sweden during the 1980s and 1990s, who represent an important part of the migration flows to Sweden. Unfortunately, in this study we were not able to account for undocumented immigrants, who may have a higher risk of mortality (Wahlberg et al., 2014). In Sweden, the number of undocumented migrants is estimated to be between 30,000 and 50,000 at present (Fackligt Center för Papperslösa, 2018). This figure means no more than the 0.05% of the total population, a magnitude considerably lower than the corresponding estimates for the U.S, which is approximately 3% (Key findings about U.S. immigrants., 2018).

Duration of residence may also to some extent be underestimated for some persons who entered Sweden as asylum seekers, given that the time of arrival is recorded from the date the residence permit is issued, and not the actual date of arrival in the country. However, we believe that the categorical use of this variable overcomes this potential limitation. Although refugees have been reported to have higher mortality rates than non-refugees (Hollander et al., 2016), in our study those who migrated predominantly as refugees (such as those from former Yugoslavia) did not show higher mortality risk than nationals, with other studies also showing similar findings (Rostila & Fritzell, 2014).

In our data, we do not have information on actual reason for migration so we cannot assume that non-European migrants are refugee migrants. However, beyond their recorded administrative migration status, most people in this group come from countries at war or in conflict and may share similar adverse experiences in origin.

Finally, there are some limitations related to sample size. For example, we could not further disaggregate the lowest category of age at arrival (< 18 years) given the small number of deaths in this group, and some of our main findings may not be statistically significant due to the lack of statistical power. Yet, drawing conclusions from statistically non-significant estimates could still be plausible in this instance, since we use information on the total population of migrants (not just a sample). Furthermore, with the exception of Yugoslavia, the observed effects are very consistent across countries and their corresponding effect sizes (magnitude) are rather large. This suggests to us that a conclusion based on statistical significance testing for each specific country of origin is limited due to small case numbers but that the overall effect seems substantive and important enough to be reported.

Migrants with multiple in and out migrations were excluded from this study since emigration dates for these individuals might be subject to bias (some have entered the country more than once in the same year). While it can be argued that this decision may lead to sample selection, to include these individuals in our study can also introduce 'noise' when studying the effect of duration of residence, since they have been exposed to protective and risk factors from more than one country context.

Generalization of the results and public health implications

The fact that our study does not include more recent (post 2002) immigrants entails that the generalization of our findings to more recent immigrants should be made with caution. However, we examine individuals coming from Iran, Iraq, Lebanon, Syria, Turkey, Eritrea, Somalia, Kosovo and former Eastern Bloc countries who arrived during the so-called 'asylum seekers' decade' in the 1980s (Migrationsverket, 2014), as well as refugees from the former Yugoslavia, who arrived in the 1990s. These refugee migrants may have been exposed to adverse situations similar to refugees from more recent migration waves, leading to common problems, including trauma. Our results suggest that migration might have harmful effects at younger ages. We expect this finding to be more pronounced in more recent migrants, considering the increasing number of unaccompanied minors as a consequence of the recent refugee crisis.

Although the migrant mortality advantage is assumed to be universal, our findings on the refugee population are not generalizable to other contexts. Sweden has a quite generous humanitarian approach that might to some extent explain our findings. In addition to having access to health care on equal terms with Swedes and having integration support (e.g., free language training), the Swedish welfare state provides refugees with compensation for accommodation (housing for asylum seekers who are waiting for a decision) and financial support for daily expenses sufficient to cover basic needs (food, clothing, medicines and dental care) as well as leisure activities(Migrationsverket, 2018). Moreover, they are entitled to apply for social allowances to cover special needs (Migrationsverket, 2018).

Our study provides evidence suggesting that both age at arrival and duration of residence are relevant to understand immigrant's health. This information can be used to identify sensitive periods for immigrants' health and, hence, relevant contexts of intervention. Based on our findings, we advocate for the design and implementation of reception policies oriented toward promoting children's health and wellbeing during the transition to the host country.

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Declarations of interest

None.

Ethical approval

This study was approved by the Regional Ethical Review Board of Stockholm (decision no. 2012/1260-31).

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ssmph.2018.07.007.

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