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Abstract

Second-generation children of migrants represent one of the fastest growing and diverse young populations in many rich countries in the world today. In contrast with the lower mortality risk typically experienced by migrants, a growing body of work highlights a higher adult mortality risk in the second-generation. Previous studies have attempted to understand this reversal by studying its association with inequality in adult socioeconomic background (SEB). Here, we instead implement a life course perspective to examine its association with childhood SEB. We use Swedish register data to fit survival models on a dataset of 13,339 deaths among 2.4 million people aged between 16 and 41. We observe initial higher mortality among G2 with parent(s) born in Finland, Other Nordic countries, Fr. Yugoslavia, Rest of Europe, Sub-Saharan Africa, Northern Africa and Iran & Iraq. Their mortality risk is driven by high mortality from external causes. After adjusting for childhood SEB, higher all-cause mortality levels only persist in G2 with parent(s) born in Finland and Other Nordic countries. Additional analysis reveals that G2 with parent(s) born in Finland and Other Nordic countries show consistently higher mortality across all levels of parental disposable income. However, higher mortality in G2 with parents born in Fr. Yugoslavia, Sub-Saharan Africa and Northern Africa is instead limited to the upper end of the parental income distribution. Our findings reveal that childhood SEB *is* associated with higher adult mortality among the G2 in Sweden, although not always in a way we might expect.

Keywords: mortality, socioeconomic inequality, life course, second-generation, migrants

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Introduction

The second-generation (**G2** children of migrants**)** are most commonly defined as people born in a country to at least one foreign-born parent (1). This group is one of the fastest growing and diverse young populations in many rich countries across the world today, owing to the establishment and continuation of many decades of international migration (2). In the European Union (EU) in 2021, 7% of the resident population aged 15-74 were **G2**. These shares were even higher in early adulthood (15-29; 11%). In Sweden—the focus of this study—the shares were some of the highest in all of the EU, at 12% and 19% respectively. In stark contrast with the "healthy migrant effect" (HIE) typically experienced by their parents (i.e., lower mortality among first-generation [**G1**] migrants compared to individuals born in the host country to two parents born in the host country) (3), an emerging body of work highlights an *increased* adult mortality risk among the **G2** in Europe (including in Sweden) compared to the same reference group (4–10). This raises questions about how the HIE is not only lost—but reversed—within a generation (10).

So far, nearly all previous research has tried to understand this excess by focusing upon its association with inequalities in the *adult* socioeconomic background (SEB) of the **G2—**particularly their educational and labour market outcomes (4,6–9). Less work has focused upon its association with *childhood* SEB (11). From a life-course perspective, parental SEB informs their children's SEB and influences health outcomes (including mortality) in later life *independently* of their children's own adult SEB (12). This "long arm" that childhood SEB exerts upon health in later life has been shown to operate via multiple paths such as biological embedding, health behaviours, and social mechanisms (12). Intergenerational social mobility could also mean that parent's SEB might differ substantially from their children's adult SEB (12). Concerning the **G2**, childhood SEB may represent an important piece of the puzzle with respect to their higher mortality for two reasons. **First**, migrants typically undergo *downward* social mobility after arriving in a new country (13,14), so the **G2** may experience their childhood in relatively worse conditions than the **G1**. **Second**, there is evidence of *upward* intergenerational mobility among the **G2** in Europe, notably among those with low SEB origins (15,16). Focusing

upon adult SEB may fail to capture this early life disadvantage. Our **aim** is to understand the association of childhood SEB with the increased young adult mortality of the **G2** in Sweden.

Methods

We use the collection of Swedish register data *Ageing Well* at Stockholm University. The collection covers longitudinal, individual-level data from a range of administrative sources. Here, we use the total population register, migration register, multigenerational register, cause-of-death register, and the *Longitudinal Integrated Database for Health Insurance and Labour Market Studies* (LISA). Information is linked between the same individuals across the different registers using a unique individual identifier. The analysis was conducted under an existing ethical approval granted by the Stockholm regional ethics board. *Ageing Well* was generated and pseudo-anonymised for research purposes.

To be included in the study, subjects had to be born in Sweden, turn age 16 between 1st January 1992 and 31st December 2016, and have at least one living parent upon turning age 16.

The outcomes are **all-cause mortality** and death from **specific causes**. The age-at-death (derived from exact date-of-death in the *cause-of-death register*) was used to determine whether someone had died. Cause-of-death was derived from the underlying cause-of-death variable from the *cause-of-death register* and categorised into **natural** (ICD9 [001-798]; ICD-10 [A00-R98; U01-U85]) and **external** (ICD9 [800-999; ICD-10 [V00-Y99]). That mortality is a very rare event at young adult ages, combined with the smaller **G2** population sizes, restricts us from moving beyond these two broader cause-of-death groups.

Exposure is **second-generation status**. Individuals are classed as **G2** if they were born in Sweden to *at least* one parent who was born abroad. **G2** status was then generated by linking parents to their children (via the *multigenerational register* and the matching of parental and child IDs) and using information on individual and parental birth country (derived from the *total population register*). The reference population are those born in

Sweden to two parents who were also born in Sweden. We investigate variation in **G2** mortality by origin, among **G2** with at least one parent born in Finland, the other Nordic countries, other (non-Nordic), European Union (EU)/European Economic Area (EEA) countries, former Yugoslavia, the Rest of Europe, South America, Sub-Saharan Africa, North Africa, Iran & Iraq, other Middle East and North African (MENA) countries, and Asia.

Sex is derived from the *total population register* and categorised into male and female. **Birth cohort** is derived from date of birth in the same register for years 1975 to 2001. **Family situation** is derived from *LISA* and categorised into living at home with married parents (*ref*), living at home with cohabiting parents, living at home with a single parent, and living alone. **Highest level of parental education** (from *LISA*) is derived from the highest education level of the mother and father when the individual was aged 16. It is categorised using the International Standard Classification of Education (ISCED) into Primary, Secondary, and Post-Secondary (*ref*) education. **Parental disposable income** quintile (from *LISA*) is based upon an average of two parents' annual disposable income information in the 3-years before the child turned age 16. It is categorised into lowest, lower, medium, higher, and highest quintiles (*ref*). **Parental unemployment status** (LISA) is based upon an average of two parents' number of years of unemployment in the three years before the child turned age 16, where unemployment in a given year is defined as being unemployed for 90-days or more. It is categorised into 0-years (*ref*), 0-1 years, 1-2 years, and 2-3 years of unemployment. In the negligible number of cases where a parent has died before the child turns age 16 (69,225: 2.86%), we use the living parent's education level and their unaveraged values for the income and unemployment status.

We use **survival analysis**, fitting *Cox Proportional Hazards* (PH) models to analyse the period 1992-2016. Individuals become at risk upon turning aged 16. They then exit risk via death, emigration, or reaching 31st December 2018 alive and living in Sweden. The oldest age reached is therefore 41-years. Whether or not someone has emigrated is determined from both registered emigration events found in the *migration register and*

a residence indicator from the total population register that is updated at the end of each year.

We conducted a complete case analysis. From a potentially eligible starting population of **2,456,498** people, **2,433,872** (~99%) were retained for our final statistical analysis. 22,626 cases were removed due to missing data in their family situation (17,763; 0.7%), parental educational level (1,732; 0.1%), parental disposable income (3,959; 0.2%), and parental unemployment status[1] (3,995; 0.2%). Note that these absolute numbers do not sum to 17,763 due to overlap in missing data across the variables for specific individual cases.

We conducted a sensitivity analysis that stratifies the main results by sex. Other, more descriptive, supplementary materials are reported on directly alongside the main set of results.

Results

Table 1 presents descriptive information on the population sizes, time-at-risk (in years), deaths, and crude death rates. The average death rates in the sample are 4.5 people per 10,000 (all-cause), 1.4 people per 10,000 (natural), and 2.9 people per 10,000 (external). However, there is considerable variation around these averages and notable differences between the death rates of the **G2** and children born in Sweden to two parents born in Sweden. Many **G2** groups have higher all-cause and external death rates than people born in Sweden to two parents born in Sweden, particularly **G2** with parent(s) born in Finland, other Nordic countries, the Rest of Europe, Sub-Saharan Africa and Northern Africa.

[1] Note that the parents are alive and having missing information for the socioeconomic variables. This sets them apart from people who only have one living parent and so have values for these variables based solely upon that parent.

Table 1. Population sizes, deaths, and death rates according to parental origins

Parental origins		Population sizes	Time-at-risk (years)	All-cause		Natural		External	
				Deaths	Rate per 10,000	Deaths	Rate per 10,000	Deaths	Rate per 10,000
Two parents born in Sweden		1,998,706	24,862,195	10,783	4.3 (4.3-4.4)	3,423	1.3 (1.3-1.4)	7,019	2.8 (2.8-2.9)
At least one parent born in:	Finland	107,997	1,486,191	1,039	7.0 (6.6-7.4)	241	1.6 (1.4-1.8)	761	5.1 (4.8-5.5)
	Other Nordic	40,285	497,950	267	5.4 (4.8-6.0)	63	1.3 (1.0-1.6)	198	4.0 (3.5-4.6)
	Other EU/EEA	48,507	624,358	297	4.8 (4.3-5.3)	85	1.4 (1.1-1.7)	195	3.1 (2.7-3.6)
	Former Yugoslavia	39,666	379,133	180	4.8 (4.1-5.5)	55	1.5 (1.1-1.9)	116	3.1 (2.6-3.7)
	The Rest of Europe	34,957	412,981	216	5.2 (4.6-6.0)	52	1.3 (1.0-1.7)	149	3.6 (3.1-4.2)
	Southern America	22,369	215,834	94	4.4 (3.6-5.3)	20	0.9 (0.6-1.4)	70	3.2 (2.6-4.1)
	Sub-Saharan Africa	19,204	138,942	75	5.4 (4.3-6.8)	20	1.4 (0.9-2.2)	48	3.5 (2.6-4.6)
	Northern Africa	9,824	99,848	58	5.8 (4.5-7.5)	12	1.2 (0.7-2.1)	43	4.3 (3.2-5.8)
	Iran & Iraq	23,949	163,391	76	4.7 (3.7-5.8)	18	1.1 (0.7-1.7)	50	3.1 (2.3-4.0)
	Other MENA	46,264	433,474	159	3.7 (3.1-4.3)	51	1.2 (0.9-1.6)	99	2.3 (1.9-2.8)
	Asia	29,203	246,799	95	3.8 (3.1-4.7)	26	1.1 (0.7-1.5)	64	2.6 (2.0-3.3)
Total sample		2,420,931	29,561,096	13,339	4.5 (4-5-4.5)	4,066	1.4 (1.3-1.4)	8,812	2.9 (2.9-3.0)

Notes: the difference in the total number of deaths (and crude death rate) minus natural plus external cause deaths (and crude death rates) is mortality from ill-defined causes.
Source: authors' calculations based upon Swedish register data collection Ageing Well.

It is beyond the limits of the data to study more detailed causes-of-death. Nevertheless, supplementary **Table S1** provides some more detailed descriptive information. Suicide is the leading cause-of-death in nine of twelve groups, ranging from 23% of all deaths in **G2** with parent(s) born in other EU/EEA countries to 33% of all deaths in **G2** with parent(s) born in Asia. Exceptions are **G2** with parent(s) born in former Yugoslavia and Northern Africa (drug use is the leading cause at 26%) and other MENA (accidents & injuries is the leading cause at 21%). Deaths from other external causes (predominantly homicides and deaths of undetermined intent) stand out among **G2** with parent(s) born in Sub-Saharan Africa (17%), Northern Africa (12%), Iran & Iraq (14%), and other MENA (16%) compared to those born in Sweden to two parents born in Sweden (which is only 4%). Natural causes only ever account for a fifth to a third of all deaths at these ages.

Table 2. Risk-time (column %) of childhood SEB at age 16 by parental country of birth.

Predictors	Two parents born in Sweden	At least one parent born in:										
		Finland	Other Nordic	Other EU/EEA	Former Yugoslavia	Rest of Europe	Southern America	Sub-Saharan Africa	Northern Africa	Iran & Iraq	Other MENA	Asia
Family & living situation												
Measured when child aged 16												
Living with married parents	61	52	55	57	62	54	41	40	51	58	71	59
Living with cohabiting parents	12	13	11	8	10	7	12	10	7	7	5	9
With single parent	26	34	34	34	28	38	46	50	42	34	23	31
Not living with parents	0	1	1	1	0	1	1	1	1	1	0	1
Highest parental education level in household												
Measured when child aged 16												
Primary	1	3	2	2	6	2	1	4	4	3	13	6
Secondary	52	62	57	45	64	42	52	53	56	40	64	54
Post-secondary	47	35	41	52	31	56	47	43	40	58	23	41
Average parental disposable income quintile												
Measured over 3-years when child aged 14-16												
Lowest	18	28	27	27	28	34	39	43	43	41	37	34
Low	20	21	22	21	25	22	25	26	26	26	31	26
Medium	21	19	18	17	23	16	16	15	15	16	17	19
High	21	18	17	17	16	13	12	10	10	10	10	13
Highest	21	15	16	18	8	15	8	6	6	7	5	9
Average years of parental unemployment												
Measured over 3-years when child aged 14-16												
No unemployment	84	76	79	80	73	75	70	66	69	67	62	73
0-1 years unemployment	13	18	17	16	21	19	23	25	23	25	29	21
1-2 years unemployment	3	5	4	4	5	5	6	8	7	7	9	6
2-3 years unemployment	0	1	1	1	1	1	1	1	1	1	1	1

Source: authors' calculations based upon Swedish register data collection Ageing Well

Table 2 provides the distribution of childhood SEB by parental birth country. It shows a generalised pattern of disadvantage for the **G2** compared to children born in Sweden to two parents born in Sweden. Greater shares of **G2**: (a) live with a single parent, (b) have parents that have a primary education only, (c) have parents that occupy lower and lowest-disposable income quintiles, and (d) have parents that have experienced *at least some* unemployment. The patterns of disadvantage are most visible among **G2** with parent(s) born in non-Western countries (inclusive of South America to Asia in **Table 2**). **G2** with parent(s) born other EU/EEA countries have the most comparable SEB to

those born in Sweden to two parents born in Sweden. Exceptions include higher shares of post-secondary education among **G2** with parent(s) born in Rest of Europe and Iran & Iraq.

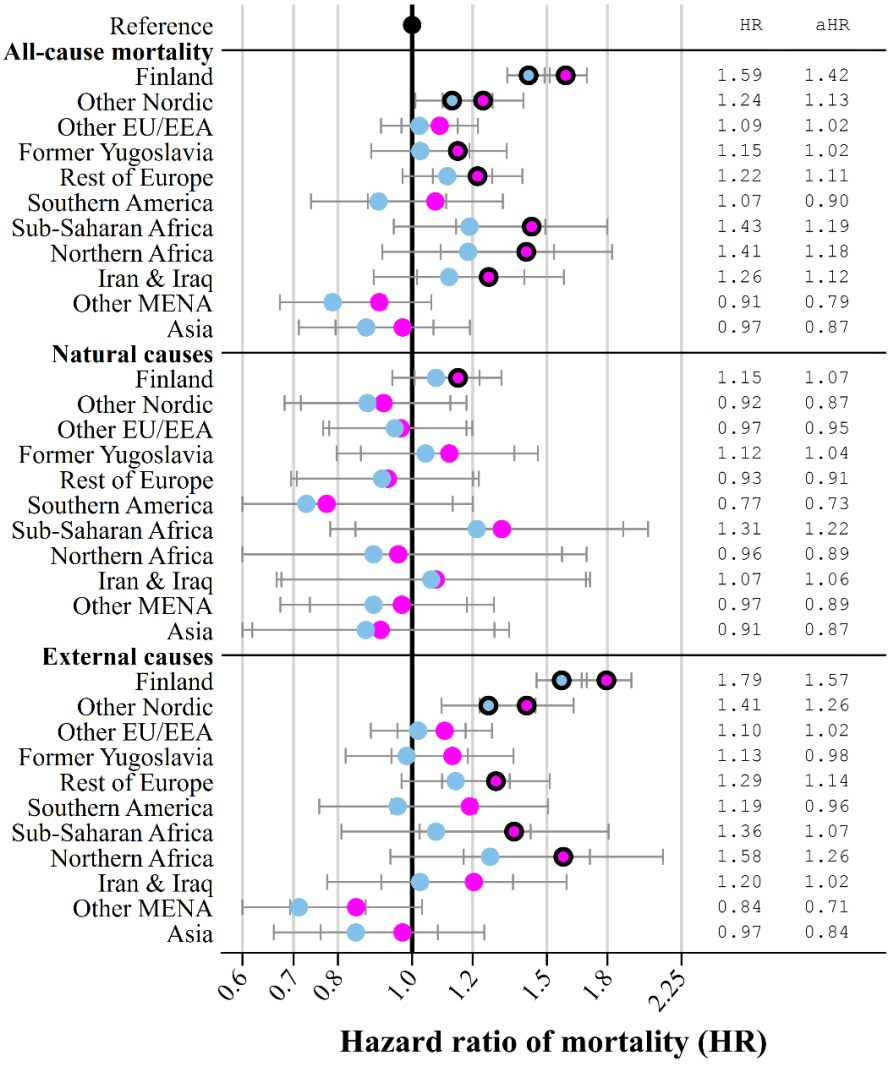

Figure 1. All-cause, natural, and external mortality among the second generation aged 16-41 in Sweden from 1997-2016, before and after considering differences in childhood SEB. Notes: Black borders around specific estimates (pink or blue circles) indicates that they are significant at the 5% level. "Reference" is being born in Sweden to two parents born in Sweden. *Source: authors calculations based upon Swedish register data Ageing Well*

Figure 1 displays the baseline and adjusted hazard ratios for mortality from all-causes, natural causes and external causes, relative to those born in Sweden to two parents born in Sweden. Following adjustment for second-generation status, sex, and the year of birth (in the baseline model), all-cause mortality is higher among **G2** with parent(s) born in Finland (HR=1.59 [1.49-1.69]), the other Nordic countries (HR=1.24 [1.10-1.40]), Former Yugoslavia (HR=1.15 [1.01-1.40]), the Rest of Europe (HR=1.22 [1.06-1.39]), Sub-Saharan Africa (HR=1.43 [1.14-1.80]), Northern Africa (HR=1.41 [1.09-1.83]), and Iran & Iraq (HR=1.26 [1.01-1.58]). After additional adjustment for differences in the family situation, parental education level, parental disposable income, and parental unemployment, only the aHR of mortality for **G2** people with parent(s) who were born in Finland (aHR=1.42 [1.33-1.51]) and other Nordic countries (aHR=1.13 [1.01-1.27]) are significantly different from the aHR of those born in Sweden to two parents born in Sweden.

For natural causes-of-death, there is little evidence of increased mortality among the **G2** in **Figure 1**. The hazard ratios for most of the subgroups are close to or below HR=1.00. Natural cause mortality is elevated among **G2** with parent(s) born in Finland (HR=1.15 [1.01-1.31]) in the baseline model, but this is no longer the case in the adjusted model (aHR=1.07 [0.94-1.23]). For external causes-of-death, there is more evidence of higher mortality in the **G2**. In the baseline model, **G2** with parent(s) born in Finland (HR=1.79 [1.67-1.93]), the other Nordic countries (HR=1.41 [1.23-1.63]), the Rest of Europe (HR=1.29 [1.09-1.51]), Sub-Saharan Africa (HR=1.36 [1.02-1.81]), and Northern Africa (HR=1.58 [1.17-2.13]) have higher mortality than people born in Sweden to two parents born in Sweden. Only aHRs for **G2** with parent(s) born in Finland (aHR=1.57 [1.45-1.69]) and the other Nordic countries (aHR=1.26 [1.09-1.45]) remain significantly different from individuals born in Sweden to two parents born in Sweden (p=0.05) after adjustment for their living situation and their childhood socioeconomic factors.

Supplementary **Table S2** displays the aHRs for the predictor variables in the adjusted models. aHRs for men are higher than for women in all-cause, natural, and particularly external causes. A more recent birth year predicts lower mortality for both all-cause and

natural causes, but not for external causes. For all-cause, natural, and external mortality, aHRs decrease with increasing parental education level, increase with increasing levels of parental unemployment and increase across categories of living situation (from living with a married parent, to living with a cohabiting parent, living with a single parent, and living alone). There is a gradient of increasing mortality from highest to lowest parental disposable income quintile in all-cause and external causes, but not natural causes-of-death. Supplementary **Table S3** adjusts for each predictor separately. Parental education level is consistently the weakest of the predictors, resulting in almost no change to the all-cause, natural or external mortality HRs across different parental countries of birth groups. Parental disposable income is consistently the strongest of the childhood SEB predictors.

To explore parental disposable income further, we stratified our analysis. We combined the lowest and lower disposable income quintiles into one group and highest and higher disposable income quintiles into another group and fitted two separate models (**Figure 2**). Supplementary **Figure S1**, shows the estimates for a third model (the middle-income group). For **G2** with parent(s) born in Finland and the other Nordic countries (who had higher mortality in **Figure 1**), all-cause and external mortality is consistently higher—and of a similar magnitude—across different income groups relative to people born in Sweden to two parents born in Sweden. For example, see the size and direction of the all-cause mortality aHRs for **G2** with parent(s) born in Finland relative to people born in Sweden to two parents born in Sweden in the lower (HR=1.49 [1.37-1.62]), medium (HR=1.31 [1.11-1.55]), and higher (HR=1.36 [1.20-1.54]) parental disposable income groups. For those **G2** with parent(s) born in former Yugoslavia, Sub-Saharan Africa and Northern Africa (who also had higher mortality in **Figure 1**), their higher mortality relative to people born in Sweden to two parents born in Sweden is concentrated in the medium and higher disposable income group. For example, see the all-cause mortality aHRs for **G2** with parent(s) born in Sub-Saharan Africa relative to individuals born in Sweden to two parents born in Sweden in the lower (HR=0.98 [0.73-1.31]), medium (HR=1.86 [1.06-3.29]), and higher (HR=1.96 [1.20-3.20]) parental disposable income groups.

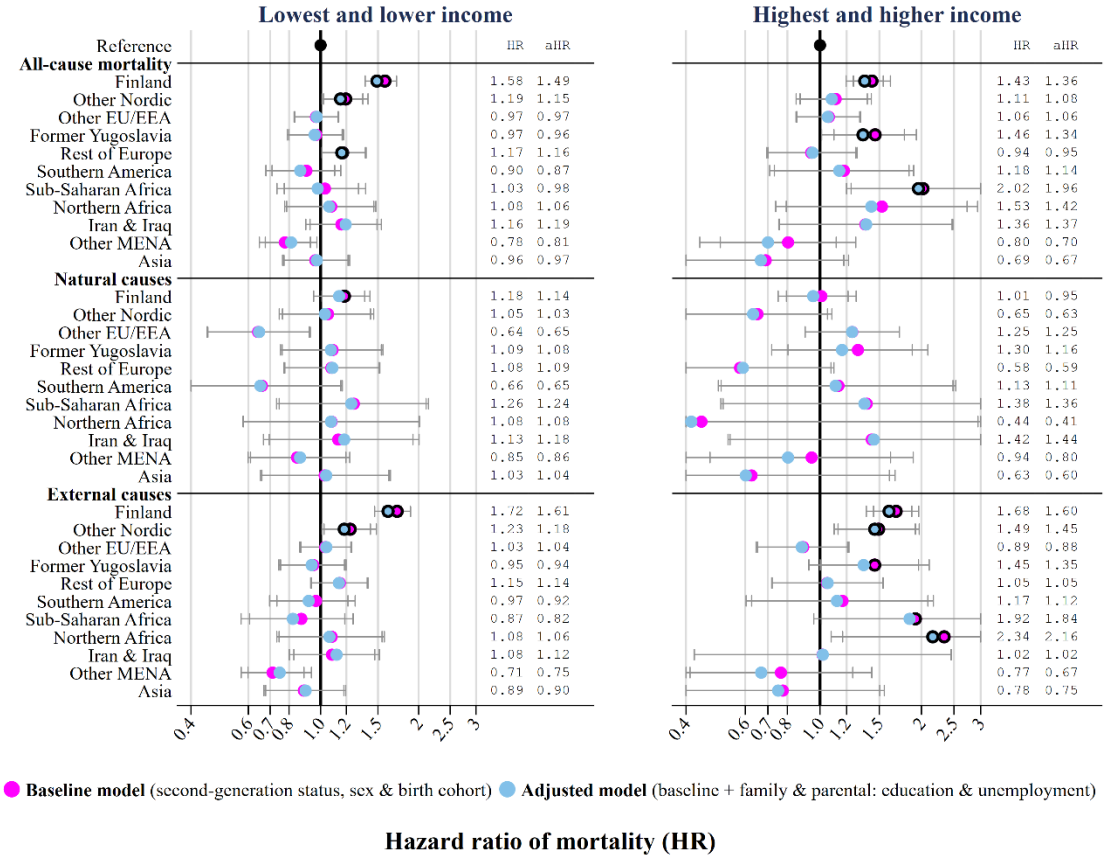

Figure 2. All-cause, natural, and external mortality among second generation aged 16-41 in Sweden, 1997-2016, for those at the lower and higher ends of parental disposable income distribution. Notes: Black bands around specific estimates indicate significance to 95% level. The results for middle-income quintile can be found in the supplementary **Figure S2**. "Reference" group is being born in Sweden to two parents born in Sweden. *Source: authors calculations based upon the Swedish register data collection Ageing Well.*

To help interpret this interesting finding, we calculated gradients in each groups death rate by parental disposable income quintiles across parental birth country groups (**Table S4**). Mortality decreases with increasing parental disposable income among those with two Swedish-born parents, as well as among **G2** with parent(s) born in Finland, other Nordic countries, other EU/EEA countries, the Rest of Europe, other MENA, and Asia. These groups exhibit a "classic" inverse mortality gradient in socioeconomic status. In contrast, **G2** with parent(s) born in former Yugoslavia exhibit a "U-shaped" mortality, there is no clear gradient among **G2** with parent(s) born in Northern Africa, and there is a reversed gradient among **G2** with parent(s) born in Sub-Saharan Africa, in which

mortality rates instead appear to increase with increasing parental disposable income quintiles.

In a sensitivity analysis (**Figure S2**), we stratify **Figure 1** by sex to reveal a high degree of consistency between the mortality patterns of **G2** men and women. Both of the sexes display hazard ratios of similar magnitudes to their respective reference groups. Yet, two groups offer exceptions. **G2** women with parent(s) born in Asia have high all-cause mortality (HR=1.37 [1.01-1.89]); **G2** men do not (HR=0.81 [0.63-1.06]). **G2** men with parent(s) born in South America have increased all-cause mortality (HR=1.21 [0.97 - 1.83]); **G2** women do not (HR=0.72 [0.46-1.15]). In both cases, the disparity is driven by variation in external causes, with elevated external mortality among **G2** women—but not men—with parent(s) born in Asia (HR=1.48 [1.01-2.23]) and among **G2** men—but not women—with parent(s) born in South America (HR=1.27 [1.01-1.63]). Other differences between men and women are smaller, but of note are larger relative HRs for women with parent(s) born in the other Nordic countries, Rest of Europe, and Northern Africa.

Discussion

We have investigated whether childhood socioeconomic disadvantage (as measured by parental education, unemployment, and disposable income) is associated with variation in young adult mortality between individuals born in Sweden to at least one parent born abroad (the **G2**) and people born in Sweden to two parents born in Sweden. We studied mortality between 1992 and 2016. We observed initial higher mortality among **G2** with parent(s) born in Finland, the Other Nordic countries, Former Yugoslavia, the Rest of Europe, Sub-Saharan Africa, Northern Africa, and Iran & Iraq relative to those born in Sweden to two parents born in Sweden. Their higher all-cause mortality was driven by increased mortality from external causes-of-death. After adjusting for parental socio-economic background, higher levels of all-cause mortality only persisted among **G2** with parent(s) born in Finland and Other Nordic countries. Of the variables examined, parental disposable income played the most salient role in moderating higher mortality levels among the **G2**. Additional stratified analysis revealed that **G2** with parent(s) born in Finland and Other Nordic countries showed a consistently increased mortality across

all income groups. For **G2** with parents born in former Yugoslavia, Sub-Saharan Africa and Northern Africa, their higher mortality was limited to the medium to higher income groups.

Overall, these findings reveal that childhood SEB *does* play a role in moderating higher adult mortality among the **G2** in Sweden, although not always in a way we might expect. For **G2** with parent(s) from Finland and Other Nordic countries, their mortality risk is associated with parental socioeconomic *disadvantage*. Their mortality risk reflects the mortality patterns of the previous generation of **G1** in Sweden from existing studies (10,17–19), which includes higher all-cause mortality and a higher mortality risk from external causes such as accidents, suicides and drug use (10). Increased **G1** mortality is attributed to a negative selection of unemployed, low educated and blue-collar workers from Denmark, Finland and Norway to Sweden up to 1980 and the associations of these important social determinants of health with higher mortality. Many of the **G2** included in this study are the children of migrants arriving before 1980. Their mortality risk might represent a perpetuation of this disadvantage across generations and the links between SEB disadvantage and risk of e.g., suicide or being in an accident at younger adult ages (20).

Among **G2** with parent(s) from Former Yugoslavia, Northern Africa and Sub-Saharan Africa, their higher mortality risk is conversely associated with parental socioeconomic *advantage*. Furthermore, unlike **G2** with parent(s) from Finland and the Other Nordic countries, their higher mortality is not reflective of the previous generation. **G1** migrants born in Former Yugoslavia, Northern Africa, and Sub-Saharan Africa living in Sweden all have comparable to lower all-cause mortality (i.e., a HIE) than non-migrants born in Sweden (10) and considerably lower mortality from accidents, suicides, and drug use (10).

So, how do we begin to explain elevated mortality in the aforementioned **G2** groups in the absence of higher mortality among the **G1**? Some scholars hypothesise that the **G2** are more vulnerable to the psychological effects of institutional, structural and personal racism than the **G1** are. This is because, unlike the **G1**, the **G2**—through merit of being born in the host country—are potentially exposed to these barriers as children (8,10,21),

have higher expectations (e.g., in terms of labour market opportunities), evaluate their social status relative to individuals born in the host country to two parents born in the host country, and are less willing to accept social inequality as a cost of their parent(s)' migration (22,23). It stands to reason that these negative psychological effects—which include stress, anxiety, depression, and the feelings of alienation and hopelessness (24–27)—would be more profound among **G2** belonging to groups that most regularly suffer from discrimination in Sweden, including the origin groups highlighted above (28–30). These effects, which may lead *directly* (in the case of suicide) and *indirectly* (in the case of other causes) to higher external mortality, may be compounded among **G2** with high-earning parents, who have overcome such barriers and may hold similar aspirations for their children, exerting greater pressure on the **G2** to try to replicate the success of their parents.

Additionally, prior research in the US has also revealed that the socioeconomic health gradient is disrupted among **G1** and **G2**, most notably among Hispanics (31–36). A line of thought from the US studies is that "cultural protection"—from the psychological and social challenges of being an ethnic minority—is amplified within neighbourhoods where networks of **G1** and **G2** are particularly dense. Interestingly, where this theory has been tested it has been found to be most beneficial among the **G2** (35). With respect to our findings, future research could look to examine mortality among the **G2** at the intersection of segregation and parental disposable income, with the hypothesis that **G2** with higher-earning parents are living in neighbourhoods that are less ethnically dense (and so more exposed to the psychological and social challenges of their ethnic minority status).

Internationally, our findings add to an emerging body of evidence that calls attention to the mortality situation of the **G2** in Europe. Our findings are consistent with studies that reveal elevated all-cause mortality among the **G2** (4–6,8–10,37–41), particularly those with parent(s) born in MENA countries and Sub-Saharan Africa (4–6,9,10,37,38). In a literature that has focused exclusively upon adult SEB and its association with **G2** adult mortality (4,6–9), our primary contribution is to examine its association with childhood SEB.

Although our results are consistent with previous research, the ability to generalise them might be affected by factors unique to Sweden. They include the presence of a universal socio-democratic welfare state in a country that implements an integration policy of inclusive multiculturalism, differences in Sweden's migration history relative to other countries, and the ages analysed in the study. Ages 16-41 encompass the "mortality accident hump", an age range of mortality that is dictated by mortality from accidents, suicides, and drug use (42). Consequently, our results will not be generalisable to older **G2**, even though the **G2** are concentrated around these younger ages in many European nations.

Strengths of this study include the use of total population register data that cover the entire population of Sweden. In this case, an examination of mortality among *all* those individuals who turned 16 in Sweden between 1992 and 2016. The high quality of the registers means that very few individuals were excluded due to missing information on relevant variables. Further strengths include analysis of detailed parental birth country groups, the incorporation of multiple measures of parental socioeconomic disadvantage, and a specific investigation of how mortality risks changes *within* parental birth country groups *across* different levels of one of said measures (i.e., parental disposable income). The main **weakness** of the study is its inability to look at more detailed causes-of-death (i.e., beyond natural and external). This is a consequence of mortality being a very rare event at the ages we analyse, combined with the smaller population sizes of many **G2** groups. In addition, we note that between 3% (for those born in Sweden to two parents born in Sweden) and 11% of deaths (for **G2** with parent(s) born in Iran & Iraq) could not be classified because the cause-of-death could not be determined (i.e., "R99" codes). If these deaths could be properly assigned, it is unclear how the HRs would change. Nevertheless, these "R99" deaths *were* incorporated in the formal analyses of all-cause mortality.

Overall, we have documented salient disparities in mortality risks from all and external causes across a wide range of **G2** parental birth country groups in Sweden. This higher mortality is concentrated at ages in which the absolute levels of mortality are small, but nevertheless imply decades of potential life lost. It is driven by causes-of-death that are

preventable. In general, these disparities can be explained by early life disadvantages in **G2** living conditions, parental education, parental income, and parental unemployment. This suggests that exposure to childhood socioeconomic disadvantage has a profound and lasting effect upon the young adult mortality risks of the second generation born in Sweden. For most subgroups, social policies aimed at improving the socioeconomic situation of migrant **G1** parents could help to improve the mortality prospects of the **G2** children. For other groups, however, more research is needed to understand why their mortality disparities are conversely associated with higher levels of parental disposable income.

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Supplementary materials

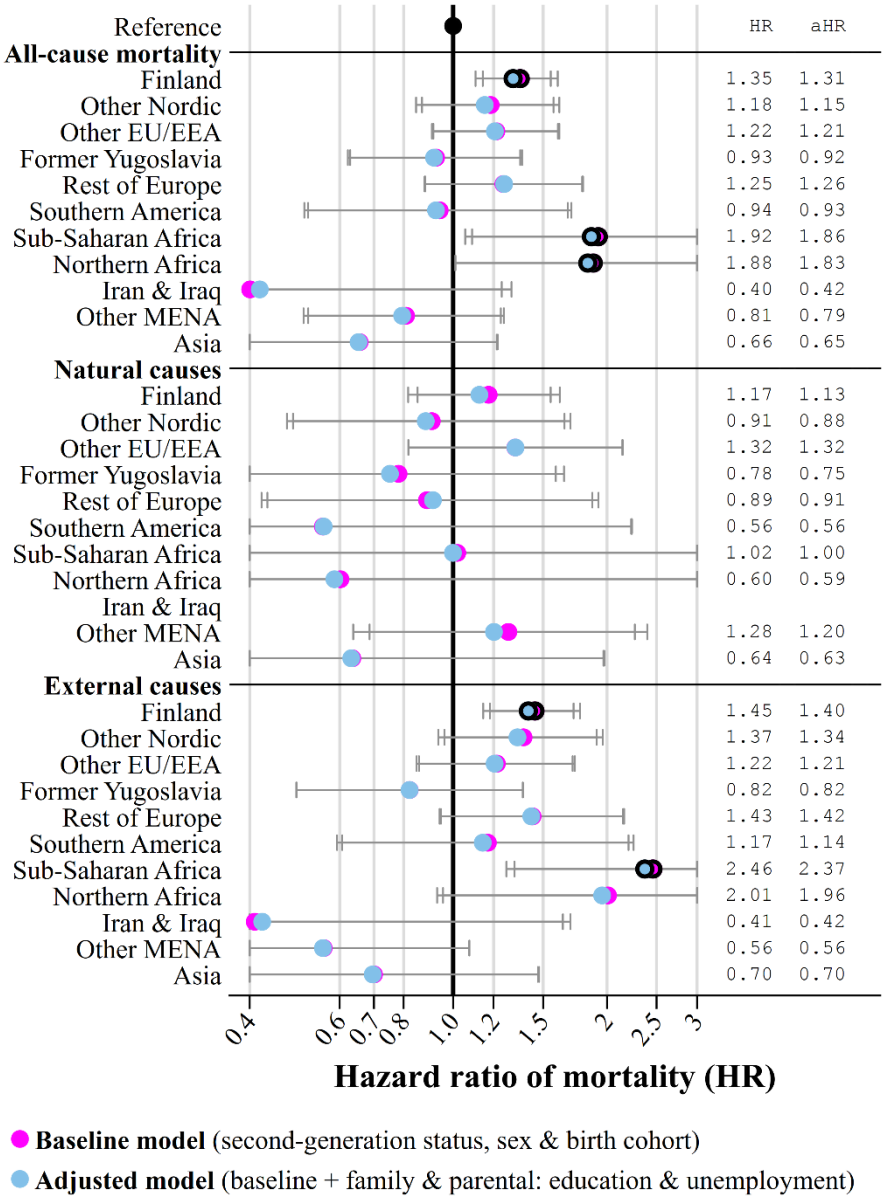

Figure S1. All-cause, natural, and external mortality among the second-generation men and women in Sweden from 1997-2016, before and after considering effect of parental SEB.

Notes: Black bands around specific estimates indicates significance to 95% level.

Source: authors' calculations based upon Swedish register data collection Ageing Well.

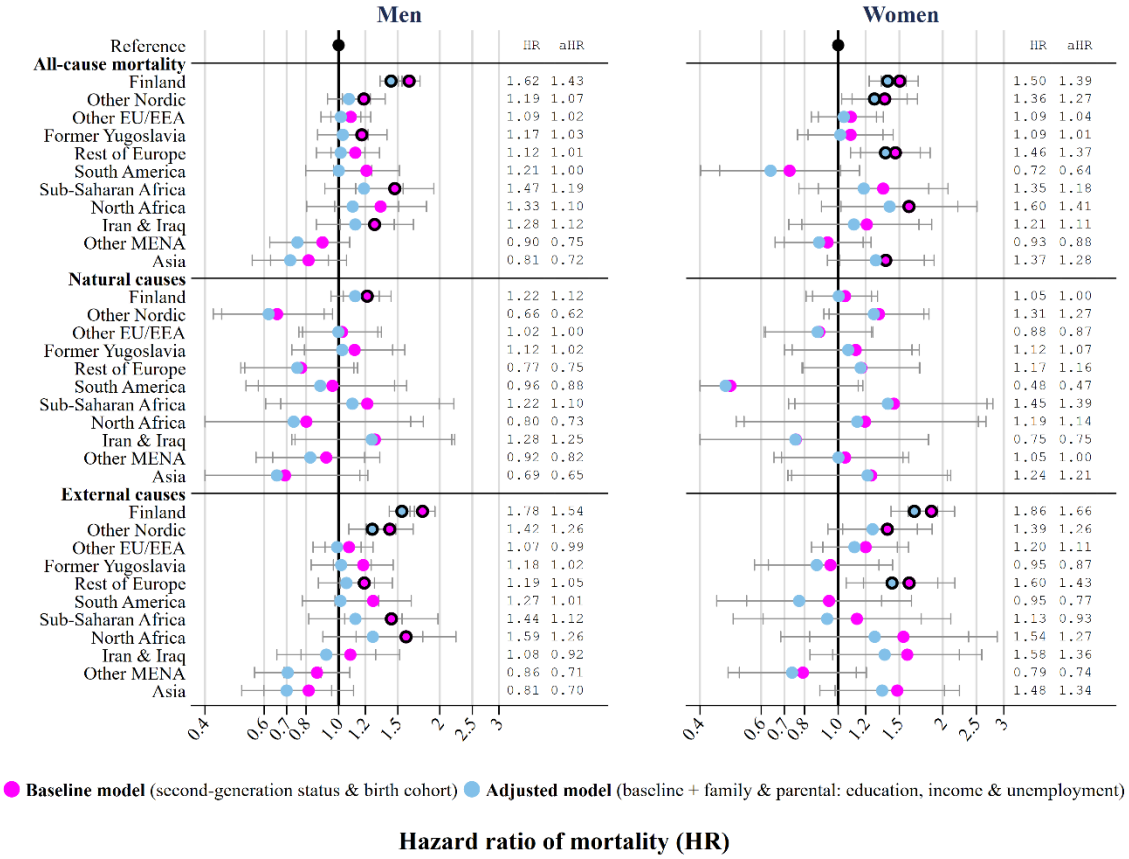

Figure S2. All-cause, natural, and external mortality among the second-generation men and women in Sweden, 1997-2016, for those in the middle parental disposable income quintile.

Notes: Black bands around specific estimates indicates significance to 95% level.

Source: authors' calculations based upon Swedish register data collection Ageing Well.

Table S1. Distribution of cause-of-death groupings within G2 parental origin groups.

Causes-of-death	Anc. Swedes	Finland	Other Nordic	Other EU/EEA	F. Yugoslavia	Rest of Europe	South America	Sub-Saharan Africa	North Africa	Iran & Iraq	Other MENA	Asia
Cancer	12	7	11	9	12	10	4	5	5	7	13	7
Circulatory diseases	6	5	3	5	4	3	3	9	0	5	8	5
Other diseases & medical conditions	14	12	11	15	12	10	14	12	16	13	11	14
Accidents & Injuries	19	15	21	19	13	15	16	15	16	9	21	13
Suicides	24	28	28	23	18	28	27	23	21	29	10	33
Drug Use	17	25	20	18	26	24	24	9	26	12	14	20
Other external causes-of-death	4	5	4	6	9	3	7	17	12	14	16	3
Ill-defined causes-of-death	3	4	2	6	5	7	4	9	5	11	6	5

Source: authors' calculations based upon Swedish register data collection Ageing Well.

Table S2. HRs for the predictor variables in the fully-adjusted models.

	All-cause		Natural		External	
	HR	95%CIs	HR	95%CIs	HR	95%CIs
Sex						
Female	(ref)		(ref)		(ref)	
Male	2.38	2.29 - 0.47	1.42	1.33 - 1.51	3.13	2.98 - 3.29
Birth year	0.99	0.99 - 1.00	1.00	0.99 - 1.00	1.01	1.00 - 1.01
Family situation						
Living with married parents	(ref)		(ref)		(ref)	
Living with cohabiting parents	1.17	1.10 - 1.24	1.10	0.99 - 1.23	1.19	1.10 - 1.28
Living with single parent	1.36	1.30 - 1.43	1.27	1.17 - 1.39	1.40	1.32 - 1.48
Living alone	2.39	2.06 - 2.77	1.89	1.40 - 2.57	2.68	2.25 - 3.19
Parental education level						
Post-secondary	(ref)		(ref)		(ref)	
Secondary	1.24	1.11 - 1.38	1.32	1.23 - 1.42	1.24	1.18 - 1.30
Primary	1.24	1.19 - 1.29	1.46	1.21 - 1.76	1.18	1.03 - 1.36
Parental disposable income quintile						
Highest	(ref)		(ref)		(ref)	
Higher	1.02	0.96 - 1.08	0.91	0.82 - 1.00	1.11	1.02 - 1.20
Medium	1.03	0.97 - 1.09	0.82	0.74 - 0.91	1.19	1.10 - 1.28
Lower	1.17	1.10 - 1.25	0.88	0.79 - 0.98	1.40	1.30 - 1.52
Lowest	1.37	1.28 - 1.47	0.91	0.81 - 1.03	1.69	1.55 - 1.84
Parental unemployment						
0-years of unemployment	(ref)		(ref)		(ref)	
0.5-1 years	1.17	1.12 - 1.22	1.12	1.03 - 1.22	1.20	1.14 - 1.27
1.5-2 years	1.24	1.15 - 1.34	1.10	0.94 - 1.28	1.28	1.16 - 1.40
2.5-3 years	1.67	1.41 - 1.97	1.16	0.79 - 1.71	1.86	1.53 - 2.26

Source: authors' calculations based upon Swedish register data collection Ageing Well.

Table S3. Models with the SEB predictors adjusted for separately.

	Baseline	Family	Educ.	Unemp.	Income
Ancestral Swedes	(ref)	(ref)	(ref)	(ref)	(ref)
All-cause					
Finland	1.59	1.50	1.53	1.54	1.48
Other Nordic	1.24	1.18	1.21	1.21	1.15
Other EU/EEA	1.09	1.04	1.10	1.07	1.01
Former Yugoslavia	1.15	1.13	1.07	1.11	1.04
The Rest of Europe	1.22	1.14	1.25	1.17	1.10
South America	1.07	0.95	1.08	1.01	0.92
Sub-Saharan Africa	1.43	1.26	1.43	1.34	1.22
North Africa	1.41	1.29	1.38	1.33	1.19
Iran & Iraq	1.26	1.20	1.30	1.17	1.08
Other MENA	0.91	0.94	0.83	0.83	0.78
Asia	0.97	0.95	0.95	0.92	0.86
Natural					
Finland	1.15	1.11	1.11	1.13	1.12
Other Nordic	0.92	0.89	0.90	0.91	0.89
Other EU/EEA	0.97	0.94	0.97	0.96	0.94
Former Yugoslavia	1.12	1.11	1.05	1.10	1.08
The Rest of Europe	0.93	0.90	0.95	0.91	0.89
South America	0.77	0.73	0.78	0.75	0.73
Sub-Saharan Africa	1.31	1.23	1.31	1.27	1.23
North Africa	0.96	0.91	0.94	0.93	0.90
Iran & Iraq	1.07	1.05	1.11	1.03	1.00
Other MENA	0.97	0.99	0.89	0.93	0.91
Asia	0.91	0.90	0.89	0.89	0.87
External					
Finland	1.79	1.67	1.73	1.72	1.64
Other Nordic	1.41	1.32	1.38	1.37	1.29
Other EU/EEA	1.10	1.04	1.12	1.08	1.01
Former Yugoslavia	1.13	1.11	1.05	1.08	0.99
The Rest of Europe	1.29	1.18	1.33	1.23	1.13
South America	1.19	1.03	1.20	1.10	0.98
Sub-Saharan Africa	1.36	1.16	1.36	1.24	1.11
North Africa	1.58	1.41	1.54	1.47	1.27
Iran & Iraq	1.20	1.14	1.25	1.09	0.99
Other MENA	0.84	0.88	0.77	0.76	0.69
Asia	0.97	0.94	0.95	0.91	0.83

Source: authors' calculations based upon Swedish register data collection Ageing Well.

Table S4. All-cause mortality gradients in parental income quintiles by origin groups.

Income Quintile	PYs	Deaths	Crude death rate & 95% CIs			PYs	Deaths	Crude death rate & 95% CIs		
			Sweden					**South America**		
Lowest	8,550,953	2737	0.00032	0.00031	0.00033	171,058	48	0.00028	0.00021	0.00037
Lower	9,692,264	2383	0.00025	0.00024	0.00026	105,186	18	0.00017	0.00011	0.00027
Medium	10,082,582	1940	0.00019	0.00018	0.00020	65,998	11	0.00017	0.00009	0.00030
Higher	10,278,961	1879	0.00018	0.00017	0.00019	51,611	10	0.00019	0.00010	0.00036
Highest	11,119,632	1844	0.00017	0.00016	0.00017	37,815	7	0.00019	0.00009	0.00039
			Finland					**Sub-Saharan Africa**		
Lowest	787,817	392	0.00050	0.00045	0.00055	117,525	29	0.00025	0.00017	0.00036
Lower	630,907	245	0.00039	0.00034	0.00044	70,107	18	0.00026	0.00016	0.00041
Medium	541,396	145	0.00027	0.00023	0.00032	38,595	12	0.00031	0.00018	0.00055
Higher	533,023	129	0.00024	0.00020	0.00029	28,584	8	0.00028	0.00014	0.00056
Highest	479,240	128	0.00027	0.00022	0.00032	23,074	8	0.00035	0.00017	0.00069
			Other Nordic					**North Africa**		
Lowest	261,237	100	0.00038	0.00031	0.00047	83,697	26	0.00031	0.00021	0.00046
Lower	216,975	60	0.00028	0.00021	0.00036	51,878	13	0.00025	0.00015	0.00043
Medium	177,819	41	0.00023	0.00017	0.00031	29,005	10	0.00034	0.00019	0.00064
Higher	167,901	37	0.00022	0.00016	0.00030	20,373	5	0.00025	0.00010	0.00059
Highest	171,967	29	0.00017	0.00012	0.00024	14,743	4	0.00027	0.00010	0.00072
			Other EU/EEA					**Iran & Iraq**		
Lowest	327,544	107	0.00033	0.00027	0.00039	139,863	47	0.00034	0.00025	0.00045
Lower	272,161	58	0.00021	0.00016	0.00028	82,260	15	0.00018	0.00011	0.00030
Medium	204,878	49	0.00024	0.00018	0.00032	48,823	3	0.00006	0.00002	0.00019
Higher	205,498	30	0.00015	0.00010	0.00021	32,036	4	0.00012	0.00005	0.00033
Highest	238,634	53	0.00022	0.00017	0.00029	23,800	7	0.00029	0.00014	0.00062
			Former Yugoslavia					**Other MENA**		
Lowest	222,198	67	0.00030	0.00024	0.00038	319,583	81	0.00025	0.00020	0.00032
Lower	181,952	38	0.00021	0.00015	0.00029	270,231	40	0.00015	0.00011	0.00020
Medium	157,366	26	0.00017	0.00011	0.00024	138,460	20	0.00014	0.00009	0.00022
Higher	124,525	25	0.00020	0.00014	0.00030	85,380	15	0.00018	0.00011	0.00029
Highest	72,225	24	0.00033	0.00022	0.00050	53,295	3	0.00006	0.00002	0.00017
			Rest of Europe					**Asia**		
Lowest	267,311	90	0.00034	0.00027	0.00041	167,897	50	0.00030	0.00023	0.00039
Lower	173,631	53	0.00031	0.00023	0.00040	126,285	23	0.00018	0.00012	0.00027
Medium	130,628	31	0.00024	0.00017	0.00034	88,801	10	0.00011	0.00006	0.00021
Higher	113,197	17	0.00015	0.00009	0.00024	61,797	7	0.00011	0.00005	0.00024
Highest	141,196	25	0.00018	0.00012	0.00026	48,817	5	0.00010	0.00004	0.00025

Source: authors' calculations based upon Swedish register data collection Ageing Well.

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