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Financial opportunity costs and deaths among close kin are independently associated with reproductive timing in a contemporary high-income society

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Evolutionary demography predicts that variation in reproductive timing stems from socio-ecologically contingent trade-offs between current and future reproduction. In contemporary high-income societies, the costs and benefits of current reproduction are likely to vary by socioeconomic status (SES). Two influential hypotheses, focusing on the parenthood 'wage penalty', and responses to local mortality have separately been proposed to influence the timing of parenthood. Economic costs of reproduction (i.e. income loss) are hypothesized to delay fertility, especially among high childhood SES individuals who experience greater opportunities to build capital through advantageous education and career opportunities. On the other hand, relatively low childhood SES individuals experience higher mortality risk, which may favour earlier reproduction. Here, we examine both hypotheses with a representative register-based, multigenerational dataset from contemporary Finland ($N = 47\,678$). Consistent with each hypothesis, the predicted financial cost of early parenthood was smaller, and mortality among close kin was higher for individuals with lower childhood SES. Within the same dataset, lower predicted adulthood income and more kin deaths were also independently associated with earlier parenthood. Our results provide a robust demonstration of how economic costs and mortality relate to reproductive timing. We discuss the implications of our findings for demographic theory and public policy.

1. Introduction

Whether and when to have a child are some of the most influential and far-reaching decisions any individual makes, and humans exhibit considerable flexibility in their reproductive behaviour. Evolutionary demography states that this variation can be understood in relation to socio-ecologically contingent trade-offs between competing domains of our life history, such as the trade-off between the number of offspring and parental care, mating and parenting effort, and current versus future reproduction [1]. In high-income nations, individuals with relatively low socioeconomic status (SES) backgrounds often have children earlier [2–7]. Two distinct theoretical explanations are provided for this phenomenon. In the economic literature, the timing of childbearing is examined in relation to financial opportunity costs, i.e. projected income loss. Lower perceived opportunity costs of parenthood are hypothesized to associate with earlier childbearing. This could account for SES differences in reproductive timing if individuals from less privileged backgrounds experience relatively limited opportunities to build capital through education and career progression, and thus are faced with smaller opportunity costs of early childbearing [8–10]. Complementing this explanation and extending it to consider fitness consequences, evolutionary life-history theory further relates the timing of reproduction to life

expectancy [11]. It argues that people in relatively harsh, resource scarce and uncertain environments typically have a lower life expectancy, promoting earlier childbearing to ensure reproductive success [10,12]. In this sense, a high local mortality rate acts as a cue for short individual life expectancy [12], as well as for health and kin availability of alloparental support [13]. Here, we investigate whether (i) the economic opportunity costs of the timing of childbearing and (ii) mortality in the family differ by childhood socioeconomic circumstances within one high-income society and (iii) how these potential differences relate to the timing of the first child in men and women.

To date, the hypothesis that the financial opportunity costs of early childbearing are lower among low SES individuals compared to those of higher SES has received limited support. A few studies of contemporary high-income populations have found higher actual [14–16] or self-perceived [2,17] socioeconomic consequences of early childbearing among higher SES individuals (but see [18] for opposite findings). However, these findings are based on survey information and hence subject to selection and recall bias and are often limited to women [19]. Associations between environmental harshness and reproductive timing have also been investigated, but studies concentrating on the effects of mortality, and especially mortality in the proximate environment (i.e. among close kin or social groups), are scarce. Higher local mortality has been shown to be associated with a younger mean age at first reproduction (AFR) in cross-country comparisons [20] as well as within high-income societies [10,21]. Individual exposure to deaths in the proximate social environment has also been associated with earlier reproduction in historical [22] and contemporary samples ([23], but see [24] for contradicting findings). Furthermore, mortality cues have been shown to increase fertility desires, especially among lower SES groups and men, in experimental settings [25,26].

The current study employs a unique multigenerational register dataset from Finland, a secularized Nordic welfare state, to examine simultaneously economic and life-history-related factors in the timing of parenthood for both women and men. Our data consist of almost 50 000 families, allowing us to examine kin networks, with detailed register-based information on dates of birth and death, SES, and yearly income subject to taxation. Building on economic and life-history theories, and earlier research, we hypothesize that (i) lower childhood socioeconomic background is associated with relatively low financial opportunity costs of early childbearing and (ii) lower childhood SES is associated with a faster death rate of close kin. Furthermore, we hypothesize that (iii) financial opportunity costs and deaths among close kin are independently associated with individual reproductive timing.

2. Material and methods

(a) Data

The data are FinnFamily, a register-based multigenerational representative dataset from twentieth century Finland. Finland is a relatively egalitarian society with an extensive social welfare system and free education, including tertiary education. Absolute poverty is rare, but between 10% and 15% of the population experienced relative poverty during the study period [27]. The teenage pregnancy rate is around 5%, similar to other Western European countries [28]. Young adults with a low socioeconomic position enter, and wish to enter, parenthood considerably earlier than people with a higher SES [29]. Despite a strong welfare system, the socioeconomic differences in Finnish life expectancy, and healthy life expectancy in particular, are relatively large for a high-income society, mainly due to differences in alcohol-related causes of deaths and in incidences of cardiovascular diseases and cancers [30,31].

FinnFamily is derived from the National Population Register of Finland, which contains demographic individual-level data on all Finnish citizens. The data consist of 60 000 randomly selected individuals who were born in Finland (focal persons) from six birth cohorts (1955, 1960, 1965, 1970, 1975, and 1980; 10 000 people per cohort; 11–16% of the total cohort) and their family members. We used the cohorts of 1960–1980, for whom information on childhood SES was available ($N = 47\,678$). For analyses concerning adulthood income, the cohorts of 1960, −65, and −70 were used ($n = 29\,245$). The data end on 31 December 2012. The descriptive statistics of the sample can be found in table 1. Finnish

Table 1. Characteristics of the study sample by sex. Note. AFR, age at first reproduction; SES, socioeconomic status; s.d., standard deviation.

	women	men
N	23 379	24 299
birth cohort		
1960	4796	4993
1965	4793	4994
1970	4771	4898
1975	4567	4829
1980	4452	4585
births by age 25	6370	3556
mean focal's AFR (s.d.)	26.96 (5.01)	28.92 (5.02)
mean mother's age at focal's birth (s.d.)	27.36 (5.74)	27.41 (5.73)
childhood SES (*N*, %)		
low (agricultural)	2620 (11.2)	2686 (11.1)
low (manual)	9550 (40.9)	10 116 (41.6)
middle (self-employed)	1798 (7.7)	1817 (7.5)
middle (other)	3894 (16.7)	3945 (16.2)
highest	3435 (14.7)	3644 (15.0)
other	1963 (0.1)	1966 (0.1)
mean total adulthood income, € (s.d.)	381 226 (164 236)	503 930 (213 002)
mean number of close kin (s.d.)	4.06 (1.81)	4.08 (1.77)
kin deaths at focal age (*N*)		
0–4	124	145
5–9	248	307
10–14	566	579
15–19	854	886
20–24	1241	1246
25–29	1628	1692
30–34	1864	1981
35–39	1952	2071

law does not require ethical permission nor informed consent on research that only uses anonymized register data [32].

(b) Measures

Register data on dates of births were used to record *the timing of first reproduction* (month and year) of the focal person and *focal persons' age*. Register data on *date of first emigration* and *focal person's death* were used for right-censoring.

(i) Childhood SES

Information on SES is available in the National Population Register of Finland from 1970 onwards. Childhood SES at focal age 10 was operationalized as the father's SES, and if that was missing ($n = 2889$), the mother's (for those who had SES information on both parents, in over 80% cases, the mother and the father were from the same or neighbouring socioeconomic classes). If still missing, SES information was imputed by parental SES at focal age 5 and then at age 15 (195 imputed values). Information on childhood SES was missing in 244 cases. SES is recorded according to Statistics Finland's Classification of Socioeconomic Groups, takes into account the person's main type of activity, occupation, and occupational status, and correlates with educational level and income. The socioeconomic groups are here grouped to Manual workers and Agricultural workers and employers (lowest SES), Lower white-collar employees (administrative and clerical occupations), Entrepreneurs and self-employed (middle SES), and Upper white-collar employees (administrative, managerial, and professional occupations; highest SES). In addition, the classification includes pensioners, students, and other unclassified people (e.g. unemployed or conscripts) who were included in the analyses, but the results for these small and miscellaneous SES groups are not shown (available from the corresponding author on request).

(ii) Kin deaths

The focal persons' parents, siblings, and half-siblings were considered as close kin whose deaths were examined. Death dates were obtained from the National Population Register. The average total number of close kin members was 4.06 (standard deviation 1.81) among all participants. We calculated the percentage of childhood family members deceased at each age of the focal person between ages 0–40. For example, if the focal person had three siblings, a mother and a father, and one of the siblings died at focal age 15, the measure for that person would be 0 until the age of 15 and 0.2 after that, until another family death. When predicting AFR, kin deaths were categorized into 5-year age windows (0–4, 5–9, etc.) of the focal person and treated as binary variables (no deaths versus at least one kin death during that age window).

(iii) Adulthood income

Information on yearly income subject to state taxation is available in the National Population Register of Finland from 1987 onwards. Inflation-adjusted yearly incomes in adulthood, between ages 27 and 42, were summed into one measure capturing total adult income. Information for these ages was available for the cohorts 1960, 1965, and 1970. Missing information was imputed by calculating the average income of the two previous or proceeding years (1628 imputed income values, representing 0.4% of all income information). If information was missing for more than 2 years, the summed income variable was set to missing ($n = 2069$, 7.1% of the people eligible for these analyses).

(iv) Other covariates

In all analyses, we controlled for the *focal person's birth cohort* in order to account for the rise in age at first birth, income, and education levels through our follow-up period. *Mother's age at the birth of the focal person* and *the number of siblings and half-siblings* were controlled for, to account for the intergenerational transmission and genetic heritability of fertility behaviour [33,34].

(c) Statistical analyses

To investigate the financial costs of reproductive timing, we regressed individual's total adulthood income on their AFR (people with full information on total adulthood income between ages 27–42 with at least one child were included in these analyses, $n = 22\,037$). To see if AFR was differently associated with adulthood income in different SES groups, an interaction between AFR and childhood SES was included in the model. Quadratic AFR (and interaction between childhood SES and quadratic AFR) was also included to allow nonlinear associations between AFR and adulthood income.

The death rate among close kin was also examined with linear regression. In these analyses, each person was represented by multiple observations equalling the number of follow-up years (from focal person's birth until their emigration, own death, or end of data on 31 December 2012, whichever occurred first). The focal person's age was a time-varying covariate ranging from zero to age at the end of follow-up, equalling full years when no kin deaths were observed and the exact age at focal death and end of follow-up at those events. Focal age was the main predictor variable and the dependent variable was the proportion of deceased kin at each age, increasing through focal age when individuals experienced multiple kin deaths. Quadratic age, focal person's birth cohort, maternal age at focal person's birth, childhood SES, and an interaction between age and childhood SES (to allow the kin death rates to differ between SES groups) were also included in the model. Linear regression with robust error estimation was used (sandwich estimator; in order to account for multiple observations from each individual).

Finally, to examine whether and how financial opportunity costs and kin deaths were associated with AFR, single-event Cox regression predicting first birth until 25th birthday was used. We chose age 25 as the exit point because after that point the proportional hazards assumption of Cox regression was violated (i.e. the postponers started to have more first children, and the early starters less), and to examine relatively early versus late entry to parenthood, follow-up until age 25 was sufficient to identify overall patterns of reproductive timing. Timing of first birth was recorded in months, starting from the 12th birthday. The Efron method was used to handle ties (i.e. simultaneous events in the dataset [35]). The main predictors were kin deaths (dummy variables indicating whether or not at least one parental or sibling death had occurred at different 5-year age windows of the focal person) and predicted adulthood income. Predicted adulthood income was estimated separately for men and women as the individuals' predicted total adulthood income by their birth year, childhood SES and region of residence at 10, and categorized into quartiles within birth cohorts. Additionally, the Cox models controlled for the focal person's sex, birth cohort, mother's age at focal person's birth, the number of siblings, and the number of half-siblings. All analyses were carried out on Stata15 [36].

3. Results

(a) Financial costs of early reproduction

People with a lower childhood SES were, on average, younger at first birth compared to people with the highest SES background, and these socioeconomic differences were greater in women than in men. Women also had their first children earlier, on average, than men (electronic

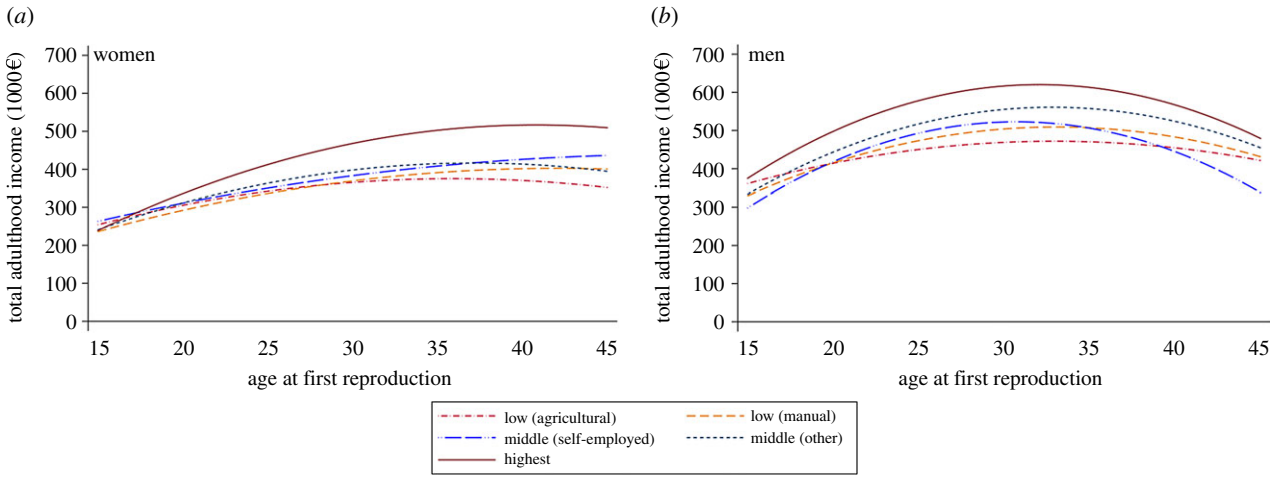

Figure 1. (*a*,*b*) Total adulthood income by AFR and childhood SES, parents only. In women with the highest childhood SES, younger AFR was more strongly associated with lower total adulthood income than in all other SES groups. In men, the association between AFR and total adulthood income was similar to the highest SES group in all groups except the agricultural SES group (see table 2). (Online version in colour.)

Table 2. Results from regressions predicting total adulthood income by AFR and childhood SES, parents only. Note: total adulthood income in thousands of euros. Childhood SES at age 10. AFR, age at first reproduction. All models additionally control for focal person's birth cohort. Women's model $R^2 = 0.12$; Men's model $R^2 = 0.11$.

	women		men	
	b (95% CI)	*p*	*b* (95% CI)	*p*
AFR	11.57 (9.21, 13.93)	<0.001	4.77 (2.03, 7.52)	0.001
AFR^2	−0.42 (−0.68, −0.16)	0.002	−0.84 (−1.15, −0.54)	<0.001
childhood SES				
low (agricultural)	−83.49 (−97.18, −69.80)	<0.001	−146.23 (−163.97, −128.49)	<0.001
low (manual)	−85.94 (−97.12, −74.77)	<0.001	−112.34 (−126.87, −97.82)	<0.001
middle (self-employed)	−72.30 (−88.84, −55.76)	<0.001	−92.70 (−114.83, −70.57)	<0.001
middle (other)	−57.44 (−70.54, −44.34)	<0.001	−61.67 (−78.81, −44.52)	<0.001
highest	ref.		ref.	
AFR × childhood SES				
low (agricultural)	−6.60 (−9.43, −3.77)	<0.001	−2.23 (−5.68, 1.23)	0.206
low (manual)	−4.69 (−7.19, −2.19)	<0.001	−0.55 (−3.50, 2.41)	0.717
middle (self-employed)	−4.88 (−8.11, −1.64)	0.003	−2.05 (−6.17, 2.07)	0.330
middle (other)	−4.26 (−7.06, −1.46)	0.003	0.36 (−3.05, 3.76)	0.837
highest	ref.		ref.	
AFR^2 × childhood SES				
low (agricultural)	0.14 (−0.19, 0.47)	0.411	0.50 (0.10, 0.90)	0.014
low (manual)	0.19 (−0.09, 0.47)	0.189	0.29 (−0.05, 0.63)	0.090
middle (self-employed)	0.27 (−0.13, 0.67)	0.190	−0.07 (−0.56, 0.43)	0.795
middle (other)	0.06 (−0.26, 0.38)	0.714	0.13 (−0.27, 0.53)	0.534
highest	ref.		ref.	

supplementary material, table S1). Higher childhood SES significantly predicted higher total adulthood income (between ages 27–42) in men and women. Net of this effect, younger AFR was associated with lower adulthood income (figure 1*a*,*b* and table 2). This was true for both sexes, but the effect was smaller in men compared to women. In women, the association between early AFR and lower adulthood income was strongest in the highest childhood SES group compared to all other SES groups, as was hypothesized (figure 1*a* and table 2). In men, AFR was similarly associated with adulthood income in all SES groups compared to the highest SES, except for those with an agricultural background, for whom earlier AFR was more weakly associated with income (figure 1*b* and table 2). The associations between childhood SES, AFR, and total adulthood income remained significant even after controlling for

the final number of children and focal person's own education (electronic supplementary material, tables S2 and S3).

We also examined the projected financial cost of entering parenthood at any given moment. This is illustrated by the slope of the functions in figure 1: at younger ages, the slope was steeper (especially for the women with the highest SES background), meaning higher financial opportunity cost for entering parenthood then, and then gradually lowered, meaning that as individuals aged, postponing parenthood became less and less beneficial financially (mathematically, this is illustrated by the derivatives of the functions in figure 1; shown in electronic supplementary material, figure S1). Finally, the estimated cost of starting childbearing turned negative, so after that point, individuals who entered parenthood at any given moment earned more (and not less) than those who further delayed childbearing. Among women, this turn happened in their late 30s and early 40s, depending on childhood SES, and among men, in their early 30s for all SES groups (electronic supplementary material, figure S1; see table S4 for the exact estimated ages).

As both the estimated financial costs and mean AFR varied by childhood SES, we next examined the projected costs of entering parenthood at the mean AFR of the highest and lowest childhood SES group. This was done to assess if, for example, the younger mean AFR of low SES background women was associated with comparable projected costs to the later mean AFR of high SES women. At the mean AFR (29.2 years) of women with the highest childhood SES, the projected financial cost of entering motherhood was 9658€ (electronic supplementary material, figure S1a: the *y*-value at mean AFR of the highest SES group). Among women with the lowest childhood SES, this same projected cost was related to having a first birth at age 20.9 (the 'predicted AFR' for the lowest childhood SES group in electronic supplementary material, figure S1a). This 'predicted AFR' was more than 6 years earlier than the actual mean AFR of the lowest childhood SES group (27.0 years). From the perspective of women with the lowest childhood SES, entering motherhood at the mean AFR of this group (27.0 years) was related to a projected cost of 7160€ (electronic supplementary material, figure S1a: the *y*-value at mean AFR of the lowest SES group). The same projected cost was related to having a first birth at 32.2 years for women with the highest childhood SES (the 'predicted AFR' for the highest childhood SES group in electronic supplementary material, figure S1a)—3 years later than the actual mean AFR of this group.

In men, the projected costs of entering parenthood were higher than in women at very early ages, but they diminished at a faster rate, so that at the mean AFR of all SES groups, the projected costs were smaller than in women. Also, only the group with the lowest (agricultural) childhood SES differed significantly from the highest SES group, and even here, the differences between the groups were small (electronic supplementary material, figure S1b; table 2). At the mean AFR of men with the highest childhood SES (30.8 years), the projected cost of having a child was 2072€ (electronic supplementary material, figure S1b). For men with the lowest (agricultural) childhood SES, the same cost was related to having a first child at a slightly younger age, 29.9 years (the 'predicted AFR' for the lowest childhood SES group in electronic supplementary material, figure S1b). The mean AFR for men with an agricultural background was 29.1, at which point entering fatherhood was associated with a projected cost of 2602€, corresponding to becoming a father at 30.5 years in men with the highest SES background (the 'predicted AFR' for the highest childhood SES group in electronic supplementary material, figure S1b).

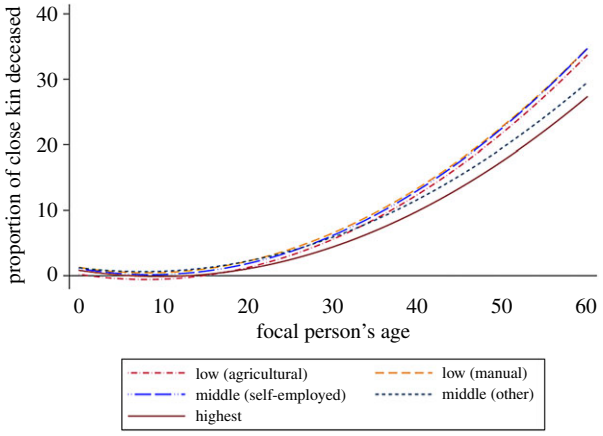

Figure 2. The percentage of deceased close kin (parents, siblings, and half-siblings) increased across time for all SES groups, but especially fast among those with a relatively low childhood SES. All SES groups differed significantly from the highest group (see table 3). (Online version in colour.)

(b) Death rate of close kin

The differences in the overall size of the focal person's childhood family were small but significant between socioeconomic groups, with lower SES groups having more close kin than higher SES groups, as expected (electronic supplementary material, table S1). Figure 2 (table 3) illustrates the proportion of deceased close kin through focal individuals' age. The projected death rate of kin (i.e. increase in the proportion of deceased close kin) through a focal individual's life is illustrated by the slope of the function in figure 2. The slope was gentle in childhood, and gradually increased as the focal individual's aged, meaning that individual's ageing was associated with losing close kin at an accelerating pace (mathematically, this is illustrated by the derivatives of the functions in figure 2; see electronic supplementary material, figure S2). As hypothesized, close kin of individuals from lower socioeconomic backgrounds deceased at a faster rate compared to individuals with a higher socioeconomic background (table 3).

Again, we then examined the projected death rate of close kin at mean AFR of different SES groups, to see how the differential mean ages at first reproduction corresponded to differences in the death rate of close kin. The rate of kin deaths was 0.42% at the mean AFR of women with the highest SES background, 28.9 years (the *y*-value at the mean AFR of the highest SES group in electronic supplementary material, figure S2a; the slight difference in the mean AFR compared to the analyses concerning adulthood income results from including all birth cohorts in these analyses). This kin death rate was reached at age 24.5 in women with the lowest childhood SES (the 'predicted AFR' for low SES women in electronic supplementary material, figure S2a). At the mean AFR of the lowest SES group of women (26.4 years), the kin death rate was at 0.47%, which, in turn, corresponded to age 31.1 years for women with the highest SES

Table 3. Results from a regression predicting the percentage of close kin deceased by focal person's age and childhood SES. Note: the model additionally controls for focal's birth year and mother's age at focal's birth. Close kin = parents, siblings, and half-siblings. Model $R^2 = 0.22$.

	b (95% CI)	*p*
focal's age	−0.20 (−0.23, −0.18)	<0.001
quadratic focal's age	0.01 (0.01, 0.01)	<0.001
childhood SES		
low (agricultural)	−0.61 (−0.82, −0.41)	<0.001
low (manual)	0.44 (0.27, 0.60)	<0.001
middle (self-employed)	0.27 (0.03, 0.51)	0.027
middle (other)	0.39 (0.19, 0.59)	<0.001
highest	ref.	
interaction with focal's age and		
low (agricultural)	0.00 (−0.04, 0.04)	0.885
low (manual)	0.00 (−0.04, 0.03)	0.835
middle (self-employed)	−0.02 (−0.07, 0.03)	0.444
middle (other)	0.04 (0.01, 0.08)	0.026
highest	ref.	
interaction with quadratic focal's age and		
low (agricultural)	0.00 (0.00, 0.00)	<0.001
low (manual)	0.00 (0.00, 0.00)	<0.001
middle (self-employed)	0.00 (0.00, 0.00)	0.001
middle (other)	0.00 (0.00, 0.00)	0.672
highest	ref.	

background (the 'predicted AFR' for high SES women in electronic supplementary material, figure S2a). For men, the kin death rate was 0.45% of kin at mean AFR, 30.3 years, among those with the highest childhood SES. The same death rate of family members was reached at 25.6 years among those with the lowest childhood SES (the 'predicted AFR' for low SES men in electronic supplementary material, figure S2b). At the latter's mean AFR, 28.5 years, the kin death rate was 0.52% of kin, which corresponded to age 33.7 among men with the highest SES background (the 'predicted AFR' for high SES men in electronic supplementary material, figure S2b).

(c) Reproductive timing

Finally, we examined whether and how an individual's predicted adulthood income and deaths among close kin were associated with individual's timing of entry to parenthood. Predicted adulthood income was defined by an individual's birth cohort, childhood SES, and childhood residence at 10, separately for men and women, and then divided into quartiles. Higher adulthood income was predicted by a higher childhood SES and by living in certain regions (electronic supplementary material, table S5).

The similarity of associations between predicted income and kin deaths and reproductive timing in men and women were examined by interaction terms between predictors and sex, and all significant interaction terms were included in the final model (electronic supplementary material, table S6). Cox regression results indicate that lower predicted adulthood income and kin deaths were independently associated with a higher likelihood of having a first child until age 25 in both men and women (figure 3*a*,*b* and table 4). Considerably fewer men than women had a first child by the age of 25, but the associations between predicted adulthood income and kin deaths and timing of entry to parenthood were for the most part similar in magnitude in both sexes (see electronic supplementary material, table S6 for the exceptions). Women and men with the lowest predicted adulthood income and at least one kin death before age 5 were 2.16 and 1.99 times, respectively, more likely to have a first birth by the age of 25 than were women (men) with the highest predicted adulthood income and no kin deaths before age 5. We also tested whether kin deaths were differentially associated with the timing of first reproduction in different predicted income groups by adding interaction terms between kin deaths and predicted adulthood income in the model (electronic supplementary material, table S7). None of the tested interactions proved significant, suggesting that kin deaths were similarly associated with the timing of reproduction in all income groups.

4. Discussion

The timing of entry to parenthood is one of the life events that fundamentally shape the life course [37]. For a long time, (very) early parenthood has been a major public health issue and a target of policy concern because it is associated with poor maternal and child health and socioeconomic outcomes (e.g. [38–41]). More recently, the continuing trend of rising age at first birth in high-income Western countries, particularly among highly educated women, has also raised medical and policy concern [3,5,7,42]. However, the extreme ends of reproductive timing may not always be detrimental from the individual's own perspective. Rather, they can represent rational behaviour in relation to the costs and benefits of reproduction in a specific socio-ecological context. This study, using a large, highly reliable register dataset, strongly suggests that the costs and benefits of early and late reproduction vary by childhood socioeconomic situation, in line with hypotheses from economic and evolutionary demography.

All our hypotheses were confirmed. First, the estimated financial opportunity costs of early childbearing were lower for individuals with a lower childhood SES. Associations between parenthood and income are known to be different in men and women, with motherhood typically associated with lower and fatherhood with higher adulthood income [43–46]. These associations may be explained by motherhood having a negative impact on cumulative income through time spent outside the workforce, and fatherhood is associated with higher income because higher-income men are selected into fatherhood [47–50]. Here, we found that also the timing of parenthood within parents was associated with adulthood income. Postponing the entry to parenthood was beneficial for both women and men, but the estimated benefits of postponement diminished at a faster rate in men than in women (see electronic supplementary material, figure S1). Future studies should look deeper into how much causal and selection effects drive these associations. Second, mortality among close kin was more frequent in individuals with a lower

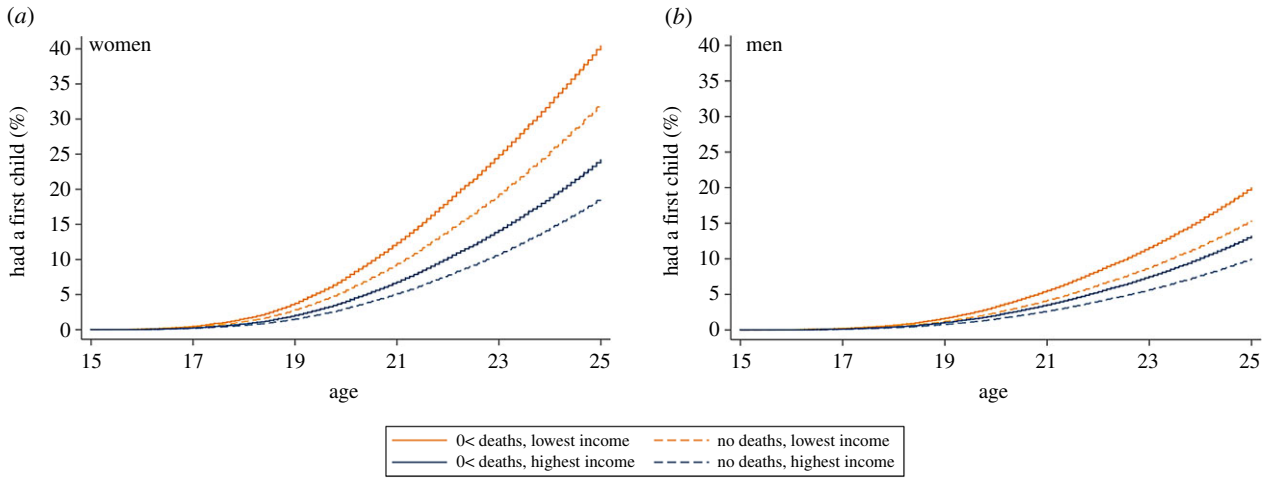

Figure 3. (*a*,*b*) In both men and women, the likelihood of becoming a parent by age 25 was higher among individuals with lower predicted adulthood income and those who had experienced kin deaths in childhood. Results from Cox regression (table 4) are depicted here for the highest and lowest income groups and deaths at focal age 0–4. All predicted income groups significantly differed from the highest predicted income quartile, but the hazard ratio between the lowest and highest income group was somewhat smaller in men than in women (table 4; electronic supplementary material, table S6 for details). (Online version in colour.)

Table 4. Hazard ratios (HR) from Cox regressions predicting first birth until age 25, by predicted adulthood income and kin deaths. Note: separate estimates for men are shown only if the effects were statistically significantly different for men and women (see electronic supplementary material, table S6 for the interactions). The model additionally controls for focal person's birth year, mother's age at focal's birth, and the number of siblings and half-siblings.

	women		men	
	HR (95% CI)	*p*	HR (95% CI)	*p*
predicted income				
lowest quartile	1.86 (1.73, 2.01)	<0.001	1.60 (1.45, 1.77)	<0.001
second quartile	1.68 (1.56, 1.82)	<0.001		
third quartile	1.44 (1.33, 1.56)	<0.001		
highest quartile	ref.			
kin deaths				
at focal age 0–4	1.34 (1.04, 1.72)	0.024		
5–9	1.27 (1.06, 1.52)	0.008		
10–14	1.24 (1.07, 1.44)	0.005	0.90 (0.72, 1.13)	0.360
15–19	1.27 (1.15, 1.40)	<0.001		
20–24	1.17 (1.07, 1.27)	<0.001		
25–29	1.21 (1.12, 1.30)	<0.001		
30–34	1.29 (1.18, 1.40)	<0.001	1.08 (0.96, 1.21)	0.195
35–39	1.19 (1.09, 1.29)	<0.001	1.03 (0.92, 1.15)	0.652

childhood SES. Third, lower predicted adulthood income and higher mortality in the family were both independently associated with a younger AFR. To our knowledge, the current study is the first to examine these two central factors associated with the timing of childbearing simultaneously and with individual-level representative data. Our results are mostly in accordance with previous studies on smaller samples with survey-data or macro-level data ([10,14–16,20,21,23], but see [24]).

Our results indicate socioeconomic selection into early and late childbearing in contemporary Finland. Compared to individuals with a low childhood SES, individuals with a higher socioeconomic background experienced greater financial penalties of early childbearing, while also experiencing fewer deaths of family members that could encourage earlier reproduction according to life-history theory [12]. However, there were important differences between various socioeconomic strata with respect to how these factors were associated with the timing of entry to parenthood. Women with a low socioeconomic background did enter parenthood earlier than women with a high socioeconomic background, as expected. Yet, when looking at projected financial costs and kin death rate, they still postponed parenthood 2–6 years more than predicted compared to high SES women (see electronic supplementary material, figures S1a and S2a). From this perspective, hence, the question is not so much why individuals from less privileged backgrounds enter parenthood earlier than other individuals

do, but why do they not enter parenthood *even earlier*. Similarly, the projected financial costs of having a first child among women with a high childhood SES decreased to the level of women with a lower childhood SES only around age 32—3 years after their mean AFR (electronic supplementary material, figure S1a). In this light, the increasing average age at first births among high SES women [3,5,7] is unsurprising. High financial opportunity costs may encourage the postponement of reproduction even with high risks to fecundity and achieving the desired numbers of children [51,52].

While financial opportunity costs may encourage the postponement of parenthood, our results suggest that kin mortality might act as an opposing impetus restricting reproductive postponement. Kin deaths can relate to the timing of childbearing by at least two mechanisms. Firstly, we have assumed that kin deaths may act as a cue of short life expectancy for oneself, and thus encourage a faster life-history strategy [12]. In addition, kin deaths can also inform individuals about the amounts of potential help in childrearing that will be available. Humans, in all environments, rely on others in rearing children, especially close kin [13,24]. We found that the pool of potential kin alloparents, i.e. people other than the mother who participate in childrearing, diminished at a faster rate among people with a low childhood SES compared to individuals with high childhood status. Hypothetically, this may represent an incentive to speed-up reproduction.

The reliable and large register data enabled us to examine associations between reproductive timing and kin mortality and economic opportunity costs with high precision (not affected by selective attrition or recall bias) and power. Although results confirmed our hypotheses, one should be careful not to draw conclusions on the causality of the associations detected. Longevity as well as reproductive behaviour, especially in contemporary Western settings with low fertility and considerable reproductive choice, are heritable [53–55]. Several heritable candidates, such as differences in personality (e.g. impulsivity), intelligence, or education, could affect the childhood socioeconomic background and increase or decrease both the likelihood of kin deaths and early childbearing in the focal person [54–57]. Taking into account these genetic confounders will be crucial for future studies. Also, different types of deaths (e.g. internal versus external causes of deaths) in the family presumably reflect differential genetic and environmental risks, and impose different psychological ramifications on children [58,59], which we were not able to assess. Future studies should examine the associations between different causes of kin deaths and reproductive timing.

The current study has combined explanatory models from economic and evolutionary demography in order to better understand childbearing in contemporary, high-income societies. We found strong evidence that, even in the presence of strong social welfare, both the financial opportunity costs and the experience of kin mortality vary by childhood SES. Furthermore, reproductive patterns that are often considered suboptimal choices by policymakers were meaningfully associated with this variance—a variance that persists even in a highly egalitarian welfare society. Taking this variation into account is crucial for addressing undesirable outcomes of both early and late fertility, including social inequality, medical concerns, and unwanted childlessness.

Ethics. By Finnish law, no ethical approval or informed consent was required because this study only analyses existing and anonymized register data.

Data accessibility. The data are owned by Statistics Finland and cannot be publicly shared due to the 'Recommendation of the Commission of the European committees on the independence, integrity and accountability of the national and Community statistical authorities (COM(2005) 217 final)' but permission to use the data can be applied from Statistics Finland. Contact tiina.helamaa(at)vaestoliitto.fi for instructions.

Authors' contributions. V.B., D.W.L., and A.R. conceived and designed the study; V.B. carried out the statistical analyses and drafted the manuscript; D.W.L. critically revised the manuscript; A.R. critically revised the manuscript and supervised the study. All authors gave final approval for publication and agree to be held accountable for the work performed therein.

Competing interests. We declare we have no competing interests.

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