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ABSTRACT

Birth Order and Longevity over the Demographic Transition: Evidence from the Netherlands*

We study within-family differences by order of birth in survival and longevity in 19th century Netherlands. Using existing matched birth and death records from the Dutch provinces of Groningen and Drenthe, we report no significant differences in survival to ages 5 or 18 or longevity for those reaching adulthood by their order of birth among all siblings. When we allow the effect to vary by gender of the individual and of the older siblings, we find a small negative (positive) effect driven by same-(different-)gender older siblings, suggesting certain within-gender competition on survival. The effects, however, are small -- around 0.5 percentage points on survival levels above 75% -- and are consistently restricted to early life. Longevity, once the individual reaches adulthood, is not consistently correlated with birth order for more flexible specifications. Importantly, we do not detect any differences by socio-economic status as captured by the father's occupation, nor do we observe a particular trend over time. This lack of observable differences by socio-economic status is noteworthy, especially given the radical changes during the study period, suggesting that it was homogeneously distributed by order of birth.

JEL Classification: N33, I14, J13

Keywords: birth order, demographic transition, historical data, the Netherlands

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1 Introduction

The critical implications of family size and other family characteristics for a wide range of adult outcomes have been extensively examined since the seminal work of Becker (1960). Among these characteristics, the so-called birth order effect, differences between siblings arising from their relative position within the family, has emerged as a potential explanation for observed disparities across families of different sizes, and thus of different average birth orders. In this paper, we investigate the role of birth order in survival to adulthood and longevity within a historical context—nineteenth-century Netherlands—using linked birth and death records to analyse within-family variation for both men and women.

There is ample evidence in modern developed countries of a *negative* birth order effect for outcomes such as earnings and education, with children born later in the same family performing worse than those born earlier. For instance, lower education and earnings have been reported for the United States (Behrman and Taubman, 1986; Pavan, 2016), Norway (Black et al., 2005), the United Kingdom (Booth and Kee, 2009), and the Netherlands (Belmont and Marolla, 1973). In contrast, evidence from developing countries often points toward a *positive* effect (Ejrnæs and Pörtner, 2004; De Haan et al., 2014), suggesting a complex, non-deterministic relationship between birth order and socio-economic outcomes.[1] Recent data availability has made it possible to examine this phenomenon in historical settings, where the quantity–quality trade-off of additional children is well established (see, for instance, Becker et al. (2010) or Fernihough (2017)). Nuevo-Chiquero et al. (2023) explore within-family differences in occupational outcomes in the Netherlands, while Cools et al. (2024) study the evolution of the effect over time in the United States. Both studies report a consistently positive advantage for first-borns in historical contexts.

Understanding the relationship between birth order and longevity is important for several reasons, particularly in a historical setting. First, education and earnings—traditional outcomes in the birth order literature—are closely correlated with health and life expectancy (Lleras-Muney, 2005), though the causal mechanisms remain debated (Cutler et al., 2011; Grossman, 2000). Studying the birth order effect can shed light on these links because it allows us to compare individuals with similar genetic and familial endowments. Second, throughout the period we study, the Netherlands began their fertility transition, with child mortality starting high and declining as time goes by. We illustrate how these improvements were distributed within family. Finally, analysing the role of birth order in child survival helps interpret the historical roots of the birth order effect.

Theoretically, the relationship between birth order, health, and longevity is ambiguous. Older mothers face greater risks during pregnancy and childbirth, yet older parents are typically more experienced and possess more resources to invest in child health.[2] At the same time, the presence of older siblings may dilute household resources and increase disease exposure, but could also provide additional care and attention for younger children. Empirical findings are similarly mixed: Black et al. (2016) report complex effects on health behaviors in Norway, Brenøe and Molitor (2018) find worse health for first-borns up to age seven, and Daysal et al. (2021) show a higher incidence of respiratory hospitalizations among higher-order births. For developing countries, Jayachandran and Pande (2017) report a negative

[1] For instance, Calimeris and Peters (2017) and Fors and Lindskog (2023) report a first-born advantage in Indonesia and India, respectively.

[2] See, for example, Lehmann et al. (2018), Brenøe and Molitor (2018), and Buckles and Kolka (2014), who show that mothers adjust behaviors such as breastfeeding across successive births.

birth order effect on infant height in regions with strong son preference.[3] Thus, the complex association between adult outcomes and birth order likely extends to health and longevity, especially in historical contexts.

Our study is closely related to Noghanibehambari and Fletcher (2023), who use the 1940 U.S. Census linked to Social Security records and find that later-born children live one to three months shorter on average.[4] For a similar period but focusing on Antwerp, Donrovich et al. (2014) report higher mortality after age 50 for earlier-born siblings, while Riswick (2018) show that family size and sibling gender composition influence child mortality. Our analysis, in contrast, isolates the role of birth order using a within-family design that abstracts from family size and examines both childhood survival and adult longevity.

We take advantage of the LINKS dataset constructed by the International Institute of Social History in Amsterdam, which links birth and death records for the provinces of Groningen and Drenthe. The data enable us to identify siblings within families and estimate within-family differences in survival during childhood and longevity (age at death) for those who reached adulthood. Compared with census-based research, this approach captures all siblings, not only those co-resident at a given point in time. We further consider the role of gender, both of the individual and of their siblings, as we can observe the life spans of both men and women. We find a small negative effect on survival to ages 5 and 18 from older same-gender siblings, and a small positive correlation from older siblings of the opposite gender, with little to no effect on adult life expectancy. Our findings reinforce the validity of research measuring the birth order effect on adult outcomes for this period, as we observe limited selection into adulthood by birth order. They also align with evidence from developing countries highlighting the importance of gender dynamics in shaping the birth order effect.

2 Historical context

We study the relationship between birth order and longevity among individuals born in the Netherlands from 1820 to 1880. Some of these cohorts lived well into the 20th century, and thus interacted with major economic, demographic, and health transitions. At the time these cohorts were born, the Netherlands was already a relatively affluent country, having benefited from Atlantic trade and a tradition of human-capital-promoting institutions (see, for instance, Acemoglu et al. (2005); Akçomak et al. (2016)). Yet it remained a relatively latecomer to industrialization. Over the following decades, the country experienced substantial economic growth and structural transformation: GDP per capita rose from 3,395 (2011 US$) in 1820 to 4,982 in 1872 and to 6,807 by 1910, while the share of the male labor force in agriculture declined from 40 percent in 1849 to 13 percent in 1960 (Bolt and Van Zanden, 2025). Although some of these changes occurred after the birth cohorts we study, they illustrate the profound economic and social transformations that shaped the lives of these individuals.

Our data come from the northern provinces of Groningen and Drenthe (Figure 1). These regions were less industrialized than the major trading provinces of Noord- and Zuid-Holland and remained largely agricultural, though their economies were more market-oriented than the subsistence farming typical

[3] The epidemiology literature also points to a negative relationship between birth order and health; see, e.g., Myrskylä et al. (2013) or Jelenkovic et al. (2013).

[4] See also Smith et al. (2009), who find no effect of birth order in a sample of 12,000 siblings in Utah from the mid-19th to 20th centuries.

of some southern areas. In 1849, approximately 48 percent and 58 percent of adult men in Groningen and Drenthe, respectively, worked in agriculture, compared with 40 percent nationwide. By 1960, these figures had fallen to 20 and 29 percent, compared with a national average of 13 percent.[5] Individuals in our sample were therefore born into relatively traditional, agrarian family economies but lived through a period of rapid modernization and economic expansion—a context that is particularly relevant for studying how family structure, and specifically birth order, shaped longevity.

Figure 1: Map of the Netherlands - Groningen and Drenthe

Demographic changes reinforced these structural shifts. The Netherlands experienced a significant population increase during the 19th and early 20th centuries. According to the Dutch Census, the populations of Groningen and Drenthe grew from 188,422 and 82,738 in 1849, respectively, to 223,328 and 125,870 in 1920 (Centraal Bureau voor de Statistiek, 1998). This growth was largely driven by declining mortality, particularly among children. Infant mortality fell by roughly half for children born between 1870 and the early 20th century, from over 20 deaths per 100 births to fewer than 10, though trends were relatively flat prior to 1870, corresponding to our primary period of study (Wintle, 2000). Consequently, life expectancy at birth increased sharply, rising for males from 36.2 years in the 1840s to 51 in the 1900s and reaching 61 just a decade later, with women consistently enjoying a two-year advantage throughout this period. This marked reduction in child mortality raises the question of whether improvements were evenly distributed across children of different birth orders within families.

At the same time, the Netherlands was undergoing a fertility transition, though it lagged behind other European countries. Delventhal et al. (2021) identifies 1869 as the onset of declining mortality and 1883 as the start of declining fertility, roughly coinciding with trends in the United Kingdom. However, the Dutch fertility transition progressed much more slowly, taking up to six decades longer than comparable countries. The transition did not conclude until 1995, compared with 1937 in the UK, 1940 in Belgium, and 1975 in Germany.[6] Consequently, fertility remained high and stable for most of the 19th century, exceeding 30 births per 1,000 population per year. Families were large in terms of children ever born

[5] Authors' calculations based on the 1849 and 1960 Dutch Censuses.

[6] Data from Delventhal et al. (2021) are available at https://sites.google.com/view/demographic-transitions [last accessed 3rd July 2024].

and grew even larger in terms of the number of children reaching adulthood. In Groningen, birth rates followed the national trend, albeit slightly lower, at roughly 90% of the national average. Drenthe exhibited a similar pattern until the turn of the century, when its birth rate rose above the national average (Buissink, 1971). To account for these regional differences, we examine trends over time separately for the two provinces in our analysis.

Finally, regarding migration, there was little mobility out of the provinces of Groningen and Drenthe before the 1870s (Wintle, 2000). After that, as the Netherlands industrialized starting in the 1880s, migration towards more industrial areas became more frequent, as well as abroad (mainly the US and Germany).[7] Urbanization added another layer of change to the environment in which these cohorts matured. In 1849, 26% of the national population lived in urban areas. In Groningen and Drenthe, only 17% of the population resided in one of the four cities in the two provinces, with the remainder living in rural areas. By 1947, urbanization had expanded substantially, with 56% of the population living in one of seventeen cities.[8] Taken together, these demographic, fertility, and urbanization trends provide essential context for examining how birth order shaped longevity during a period of profound social and economic transformation.

3 Data

We use the LINKS dataset Genes, Germs and Resources, assembled by the International Institute of Social History (IISH) in Amsterdam (Mandemakers and Laan, 2017). The dataset includes birth, death, and marriage certificates starting in 1811, with birth records available until 1912, marriage records until 1937, and death records until 1962. The certificates were collected by municipalities within the *Burgelijke Stand* (Civil Registry) for the provinces of Groningen and Drenthe. The IISH linked birth, death, and marriage certificates whenever possible for both men and women, who did not change their names.[9] The dataset accessed for this research was anonymized.

Registry records include details about the event and information on the individuals involved. Birth certificates report the date and location of birth, the names of the child and parents, and, when available, the parents' occupations. Death certificates provide the date and location of death, as well as the name, age, and occupation of the deceased. When the deceased was a child, the names and occupations of the parents were also recorded.[10] Figures A.1 and A.2 in the Appendix show examples of birth and death certificates for individuals born in a Groningen municipality.[11]

Variables of interest

Birth records are linked to the corresponding marriage records of the parents, allowing us to identify complete families at birth—even when some birth records are not matched with death records. We con-

[7] The Dutch migration to America has attracted scholastic attention, at least partially due to data availability. However, the migration estimates situate the country in line with Denmark or Sweden, rather than with major emigrating countries such as Germany or Ireland (Swierenga, 1985).

[8] Following Dutch census definitions, a 'city' is a municipality with more than 10,000 inhabitants.

[9] Details on the record-linkage process can be found in Mandemakers et al. (2023).

[10] Records indicate the municipality where the event occurred. Over the period, several municipalities were merged or divided. Since past boundaries cannot always be reconstructed, merged municipalities are treated as unified from the start, and split municipalities are considered jointly throughout the entire period.

[11] Images of some original records for Groningen can be accessed at `https://www.allegroningers.nl` [last accessed 23 October 2025].

struct measures of birth order using the reported dates of birth on all birth records matched to the same father. We observe multiple instances of children with closely spaced birth and death dates, suggesting that all births were registered, including those of infants who died shortly after birth. Moreover, our estimated child mortality rates are consistent with external sources, suggesting no systematic underreporting. We define families as all children born to the same father, although some include step-siblings. Our results are robust to excluding such families.[12]

Age at death is calculated from matched birth and death records. Approximately 70% of birth records are successfully matched to a death record. Missing death certificates can result from misspellings in names or places of birth, which would affect all siblings equally, or from migration out of the provinces of Groningen and Drenthe. Because we only observe deaths registered in these provinces, individuals who migrated elsewhere may appear as missing. These individuals likely had longer life spans, as suggested by the strong positive correlation between the share of unmatched death records and average longevity.[13] If migration decisions were correlated with birth order, this could bias our estimates; however, since individual migration typically occurred in adulthood, this issue primarily concerns longevity among individuals who survived beyond age 18. We return to this issue below.

Occupations are reported for parents on birth certificates and for the deceased (along with their partner, if a married adult or their parents, if a child) on death certificates. We use the father's occupation as a proxy for household economic resources during childhood. When multiple occupations are reported for the same individual, we use the one closest to age 40, following Bengtsson et al. (2018). Parental occupation is available for 73% of birth certificates linked to death records. Each occupation is classified using the Historical International Standard Classification of Occupations (HISCO), which aligns historical job titles with the International Labour Organization's ISCO68 scheme (Van Leeuwen et al., 2004). In the analysis, we employ the Historical International Social Class Scheme (HISCLASS) (Van Leeuwen and Maas, 2011), which groups occupations into classes of similar economic resources and living standards. We further collapse the 13 HISCLASS categories into three groups: (i) non-manual workers, (ii) farmers, and (iii) manual workers.[14] The original and aggregated classifications are presented in Table A.1 in the Appendix.

Sample selection and descriptive statistics

Our main estimation sample includes individuals with known age at death and birth order, requiring both a birth and death certificate. Birth order is defined using all known siblings, even if some lack a matched death record. Results are robust to restricting the sample to families with complete birth and death information. We exclude twins, individuals with implausible ages at death (over 100 years), and those with missing key variables. We further restrict to births between 1820 and 1880 to avoid boundary censoring. These restrictions yield a final sample of 142,397 individuals.

Individuals in our sample lived an average of 44 years, with a high incidence of child mortality. Approximately 77.8% survived to age 5 and 70.4% to age 18. Infant and child mortality rates are slightly

[12] Some families may have migrated after having part of their children, but these children are unlikely to be observed as adults and thus are not included in our sample. Our results therefore may not apply to migrant families.

[13] Figure A.3 in the Appendix plots cohort trends in the probability of having a missing death certificate alongside average age at death. The similarity of the two series supports the interpretation that unmatched cases correspond to higher longevity.

[14] Among non-manual workers, the most common occupations were merchant (25.3%) and skipper (28.2%). Among manual workers, the most common were labourer (54.4%) and day-labourer (19.6%). "Land-owning farmers" include all farmers not working for others; no information is available on farm size.

higher than national averages reported by Wintle (2000), which may reflect the relatively poorer economic conditions in Groningen and Drenthe or the requirement of complete records. Because children who died young were less likely to migrate, early deaths may be somewhat overrepresented. Consistent with national trends, we observe a marked decline in child mortality over time. Conditional on survival to age 18, life expectancy exceeded 60 years. Families were large, averaging more than five children, with a mean birth order of around three. For our estimation, we capped the order of birth measure at 6, including all individuals with order 6 or higher.

Figure 2 presents the distribution of longevity by order of birth for this main sample. This graph reflect the high levels of child mortality, particularly during the first 5 years of live.[15] Among individuals that reached adulthood, deaths are concentrated starting age 60. By order of birth, we observe some descriptive differences, with children of high orders of birth (6 or higher) experiencing higher child mortality. On the other hand, earlier orders of birth appears to experience lower mortality and longer life expectancy. Since these children are likely to have different characteristics (for instance, age of the mother), we will study this phenomenon in a regression setting to shed light on the share of these differences that might be driven by observable characteristics or time-invariant family characteristics.

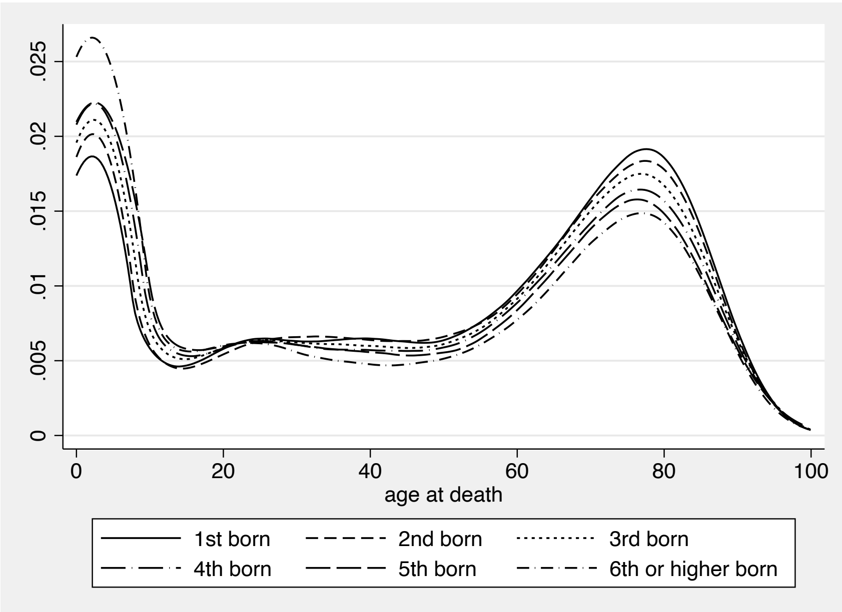

Figure 2: Kernel density of longevity by order of birth

For heterogeneity analysis by socio-economic background, we restrict to families with a valid paternal occupation.[16] This subsample includes 103,662 individuals. These individuals exhibit slightly lower survival rates to ages 5 and 18 and shorter life spans conditional on survival. They were also more likely to reside in urban areas, which may account for their lower average longevity. Differences in sample composition help explain disparities across socio-economic groups: children of land-owning farmers lived the longest on average, while children of non-manual workers had the shortest life expectancy. Although this may appear counterintuitive—since paternal occupation proxies household resources—it

[15] Note that child mortality is also high at age 0, suggesting that births were reported even if the child were to pass away shortly after.

[16] Fathers without a valid occupation either had missing information or their occupation could not be matched to the HISCO classification due to spelling inconsistencies.

reflects the higher mortality risks in urban areas, where non-manual occupations were concentrated. Survival patterns by socio-economic class are similar across age thresholds, and differences narrow among those who survived infancy and childhood. Notably, families of non-manual workers tended to be larger than those of farmers or manual workers, a pattern that will be relevant for our subsequent analysis.

Table 1: Descriptive statistics

	All	Fathers w/ occupation			
		All	Non-manual	Farmers	Manual
	(1)	(2)	(3)	(4)	(5)
Age at death	44.764	43.387	40.526	48.866	42.465
	(31.796)	(32.110)	(32.384)	(30.353)	(32.374)
Survival over 5	0.778	0.764	0.727	0.835	0.753
	(0.416)	(0.424)	(0.445)	(0.371)	(0.432)
Age of death if above 5	57.192	56.363	55.263	58.296	55.987
	(24.595)	(25.180)	(25.399)	(23.773)	(25.559)
Survival above 18	0.704	0.683	0.644	0.769	0.666
	(0.457)	(0.465)	(0.479)	(0.422)	(0.471)
Age of death if above 18	62.113	61.841	60.998	62.357	61.881
	(20.315)	(20.654)	(20.911)	(20.076)	(20.783)
Order of birth	2.917	3.010	3.119	2.977	2.989
	(1.663)	(1.700)	(1.745)	(1.689)	(1.690)
No. older brothers	1.045	1.105	1.178	1.086	1.091
	(1.232)	(1.270)	(1.328)	(1.269)	(1.253)
No. older sisters	1.000	1.051	1.128	1.036	1.035
	(1.196)	(1.232)	(1.277)	(1.217)	(1.223)
Age difference with older sibling	2.222	2.117	2.006	2.096	2.154
	(2.107)	(1.856)	(1.726)	(1.908)	(1.873)
Age difference older brother	2.338	2.341	2.286	2.281	2.375
	(2.988)	(2.884)	(2.781)	(2.857)	(2.920)
Female	0.492	0.490	0.500	0.489	0.487
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
Children in family	5.326	5.628	5.924	5.486	5.590
	(2.473)	(2.474)	(2.574)	(2.504)	(2.429)
Year of birth	1851.898	1853.628	1852.997	1853.438	1853.863
	(17.005)	(16.476)	(16.787)	(16.672)	(16.321)
Born in city (pop >10000)	0.128	0.141	0.229	0.021	0.153
	(0.334)	(0.348)	(0.420)	(0.144)	(0.360)
N	142397	103662	18097	20418	65147

Note: Averages and standard deviations are reported in parentheses. The first column includes the entire sample, while columns (2) to (5) include only individuals whose father had a known occupation.

4 Results

4.1 Estimation strategy

This section outlines the estimation strategy used to evaluate the correlation between birth order and survival or longevity. We employ a family (father) fixed-effects approach, which allows us to compare siblings of different birth orders within the same family, thereby controlling for all time-invariant family-specific characteristics. We estimate the following equation:

$$Y_{ifmc} = \alpha + \beta \text{birth order}_{ifmc} + \gamma X_{ifmc} + \mu_f + \delta_c + \psi_m + \varepsilon_{ifmc}$$

where Y_{ifmc} denotes alternative measures of longevity or survival for individual i in family f, municipality

m, and cohort c. Order of birth will entry the regression both linearly and as a series of dummies. As our preferred specification relies exclusively on within-family variation, the X_{ifmc} represents individual-level controls described in Table 1, and μ_f, δ_c, and ψ_m denote family (father), cohort, and municipality fixed effects, respectively. Standard errors are clustered at the family level.

We allow the relationship between birth order and longevity to vary by (1) the gender of the individual and (2) the gender composition of siblings. Our data include information for both men and women, since Dutch women do not change their legal names, enabling accurate linkage of their records. Likewise, our birth order measure includes both older brothers and sisters. Given the period under study, gender may influence the correlation between birth order and longevity. This may arise if son preference affected parental investments, or if men and women responded differently to early-life conditions that varied by birth order. To capture these potential differences, we first interact birth order with the individual's gender. We then estimate the effect of birth order separately by the number of older brothers and older sisters, and finally estimate our most flexible specification, in which these variables are allowed to have distinct effects for men and women.

4.2 Baseline results

This section presents the results for our main sample of men and women for whom baseline controls are available. Table 2 reports both OLS estimates (for completeness) and our preferred father fixed effects estimates for the probability of survival beyond ages 5 and 18, as well as longevity conditional on surviving to adulthood.[17] The OLS results (on odd columns) show the expected negative correlation between birth order and survival, consistent with the age-at-death distributions in Figure 2. Being born later in the family is associated with lower survival probabilities at ages 5 and 18 (by around 3 percentage points) and with slightly lower life expectancy among those reaching adulthood. These OLS effects, however, partly reflect differences in family size and other unobserved family characteristics.

When we turn to the father fixed effects specification (even columns), the estimated effects become small and statistically insignificant. The probability of surviving beyond age 5 shows a negative, not significant correlation of less than 0.1 percentage points (relative to an average survival rate of 77.8%). The probability of reaching age 18 decreases by 0.5 percentage points (relative to an average of 70.4%) or about 0.7% with respect to their immediately older sibling. Similarly, the correlation between birth order and longevity conditional on reaching age 18 is negligible (about 2.4 months per additional older sibling) and not significant.

Figure 3 presents a more flexible specification allowing the effect of birth order to vary by each specific order, relative to the firstborn, in regressions including controls and father fixed effects. The plotted estimates correspond to differences in survival to ages 5 and 18 (left axis) and in longevity conditional on reaching adulthood (right axis). As expected, the point estimates become less precise, reflected in wider confidence intervals. We only detect a significant difference in survival to age 18 for individuals born fourth in the family; all other coefficients are statistically indistinguishable from zero. These results suggest that the linear specification does not mask more complex nonlinear effects of birth order on longevity.

Given the historical period under study, parental treatment of sons and daughters might have differed,

[17] Results on longevity including all individuals and those surviving to age 5 are presented in Table A.2 in the Appendix.

Table 2: Birth order effects on survival and longevity

	P(Survival >5)		P(Survival >18)		Longevity if >18	
	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Birth order	-0.029***	-0.000	-0.030***	-0.005**	-0.293***	-0.198
	(0.001)	(0.002)	(0.001)	(0.002)	(0.056)	(0.134)
N	142397	142397	142397	142397	100188	100188
Birth order*male	-0.030***	-0.003	-0.031***	-0.007***	-0.463***	-0.344**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.068)	(0.143)
Birth order*female	-0.027***	0.002	-0.028***	-0.003	-0.122*	-0.062
	(0.001)	(0.002)	(0.001)	(0.002)	(0.068)	(0.143)
N	142397	142397	142397	142397	100188	100188
No. older brothers	-0.027***	-0.000	-0.028***	-0.004	-0.213***	-0.077
	(0.001)	(0.003)	(0.001)	(0.003)	(0.067)	(0.170)
No. older sisters	-0.022***	0.008***	-0.022***	0.004	-0.235***	-0.109
	(0.001)	(0.003)	(0.001)	(0.003)	(0.065)	(0.169)
N	142397	142397	142397	142397	100188	100188
No. older brothers*male	-0.033***	-0.008***	-0.035***	-0.012***	-0.465***	-0.217
	(0.001)	(0.003)	(0.002)	(0.003)	(0.088)	(0.179)
No. older sisters*male	-0.018***	0.013***	-0.018***	0.010***	-0.274***	-0.198
	(0.001)	(0.003)	(0.002)	(0.003)	(0.087)	(0.192)
No. older brothers*female	-0.021***	0.012***	-0.021***	0.009***	0.031	0.273
	(0.001)	(0.003)	(0.002)	(0.003)	(0.087)	(0.199)
No. older sisters*female	-0.026***	-0.001	-0.026***	-0.006*	-0.192**	-0.203
	(0.001)	(0.003)	(0.002)	(0.003)	(0.087)	(0.179)
N	142397	142397	142397	142397	100188	100188

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5%, and *** at 1%. FE specifications include father-fixed effects. All specifications control for gender, age difference with the preceding sibling, and year of birth and location dummies.

with unequal resources devoted to children by gender at both early and later stages of life.[18] The second panel of Table 2 allows the birth order effect to differ by the child's gender.[19] Women show no effect of being born later in the family during early or late childhood or longevity, with non-significant, small point estimates. For survival to adulthood, men experience a small but statistically significant disadvantage of 0.7 percentage points, concentrated on later childhood. The same pattern appears for longevity, where later-born men live slightly shorter lives, by about four months on average (mean life expectancy 61.8 years).[20] These gender differences are similar to those reported by Noghanibehambari and Fletcher (2023) for later U.S. cohorts, and may reflect women's greater biological resilience or unequal intra-household resource allocation.

To further explore the role of gender composition, the third panel of Table 2 allows the effect of birth order to vary with the number of older siblings of each gender. We find a positive and significant effect of having older sisters on the probability of surviving to age 5, suggesting a protective role of older sisters in early childhood. The number of older sisters has no significant effect at later ages, while older brothers

[18]The Dutch Civil Code of 1838 allowed individuals to dispose of their inheritance freely, without being subjected to a primogeniture rule. In case of death without will (which might reflect the social norm), the inheritance was equally distributed between the survival spouse and the children of the deceased.

[19]Figure A.4 presents the corresponding flexible specification with birth order dummies. Although less precise, the results are consistent with the more restrictive model.

[20]Differences by gender in the father fixed effects estimates are statistically significant, with F-statistics of 8.29, 5.31, and 7.91 for survival beyond ages 5, 18, and for longevity, respectively.

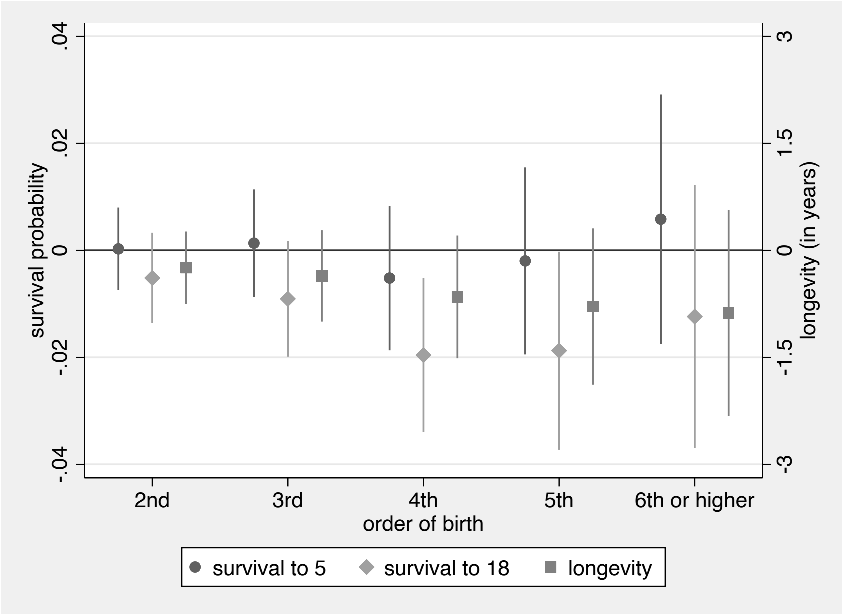

Figure 3: Flexible order of birth effect, father-fixed effect estimates and 95% confidence intervals

show very limited effects at any stage.[21]

The bottom panel examines the joint role of the child's gender and the gender of older siblings. The results suggest some competition within gender. For men, each additional older brother is associated with slightly lower survival to ages 5 and 18 (0.8 and 1.2 percentage points, respectively). For women, each additional older sister is associated with a small and significant decline in survival to adulthood (0.6 percentage points). Conversely, having older siblings of the opposite gender is associated with a modest survival advantage: around 1 percentage point for both men and women, mainly driven by early childhood. Correlations with longevity remain insignificant, suggesting that the protective (detrimental) effect of opposite (same) gender siblings operates during childhood, via interactions or childhood investments. The detrimental effect of same gender siblings could be driven by a parental preference for a mix-gender set of children, as it becomes insignificant when we add controls for whether the boy or girl was the first of their kind in the family (results available upon request). However, the protective effect of opposite gender siblings are robust to this inclusion.

Finally, we address the potential selection bias due to missing death certificates. When including all controls, we find that a higher birth order is slightly positively correlated with a missing death certificate. Given the observed relationship over time between the share of missing death certificates and average age at death among those with certificates (figure A.3 in the Appendix), it might be the case that individuals with missing records were, if anything, more likely to survive to adulthood. If this is the case, our estimates should be interpreted as lower bounds of the true effect of birth order on survival and longevity, reinforcing the conclusion that any effect is likely negligible. We also estimate bounds for the baseline survival regressions (to ages 5 and 18) imputing individuals without a death certificate as having survived to the corresponding age or as having passed away before that. The results are available in Table A.3 in the Appendix. The bounds are relatively tight, oscillating between a positive 0.3 percentage point

[21] The p-values for the test of differences between the effects of older brothers and older sisters are 0.006 and 0.019 for survival to ages 5 and 18, respectively, and 0.864 for longevity among those reaching adulthood. Results from the flexible specification with birth order dummies are consistent with these findings.

per order of birth to a negative 1 percentage point per order of birth in survival to age 5. More flexible specifications presents similar patterns.[22] Therefore, even if all individuals for whom we cannot observe a death certificate would have passed away early in life, the effect would be about 1.3% per order of birth. However, it is worth noting that this would imply that potential reasons for missing death certificates, such as migration during adulthood play absolutely no role on the missing certificates. Nevertheless, given the observed trends in missing death certificates, temporal patterns in survival should be interpreted with caution.

We further try restricting the estimating sample to families for whom longevity is observed for all siblings (Table A.4 in the Appendix). This estimation yields slightly larger but mostly similar effects. Importantly, we find no significant relationship between survival and birth order in this restricted sample, suggesting again limited attenuation bias in our results.[23] Within this sample, we construct orders of birth at ages 5 and 18, accounting for siblings that might have passed away during childhood. These measures of order of birth are correlated in a similar manner with longevity (available upon request). We also exclude families reporting more than one mother—i.e., sets of children with the same father but different mothers, possibly due to remarriage or parental death. Results for families where all children share both parents are very similar (see Table A.5 in the Appendix).

In sum, the results in Table 2 indicate that the overall effects of birth order on survival to age 5 or adulthood are small in magnitude but heterogeneous. The null aggregate effect conceals gender-specific patterns: children appear to benefit from opposite-gender older siblings and to face mild competition from same-gender siblings. Although the overall magnitudes are modest—around one percentage point relative to survival rates above 70%—the findings suggest some within-gender competition for parental resources and/or a preference for mixed-gender sibling sets. Most of these effects appear to operate early in life, as differences in longevity among adults are negligible.

4.3 Family background

We now move to study whether the relation between birth order and survival and longevity is heterogeneous by family background. First, we explore the role of family size before moving on to the role of parental resources as proxied by father's occupation. Family size was still large at the time, with an average of 5.3 children in per family. Figure A.5 in the Appendix present the distribution of family sizes.

Figure 4 presents our linear, fixed-effects estimates of the birth order effect when we allow them to vary by completed family size for our outcomes of interest.[24] Two patterns are apparent in this graph and are observed consistently when we estimate more flexible specifications in order of birth (results available upon request). First, the effects on survival to ages 5 or 18 are relatively stable across all family sizes. If anything, significance tend to be more apparent among families with 4 or 5 children, but we do not observe significant differences by family size. On the other hand, when estimating differences in longevity among individuals that reached adulthood, these are concentrated among small families. The point estimate is large and significant among the 2 children from the smallest of families in our

[22] The bounds are particularly close around the protective effect of having older siblings of the opposite gender, that appears for both upper and lower bound.

[23] The complete-family sample represents about half of the full sample. Given the demanding nature of the father fixed effects specification, we present subsequent analyses using the full sample.

[24] The estimated equation is as follows: $Y_{ifmc} = \alpha + \sum_{j=2}^{8} \beta_j \text{birth order}_{ifmc} 1 * (\text{family size}_{ifmc} = j) + \gamma X_{ifmc} + \mu_f + \delta_c + \psi_m + \varepsilon_{ifmc}$. Thus β_j would reflect the difference between an individual and their immediately older sibling in outcome Y for a family of size j. Family size is capped at 8 for this estimation.

estimates, but dismiss quickly for larger families. We observe the rest of our results for longevity also being driven by small families. Since families were on average larger at the time, it might be the case that the underlying reason for small families to be small (e.g., death of a parent) might also be driving the differences among siblings.

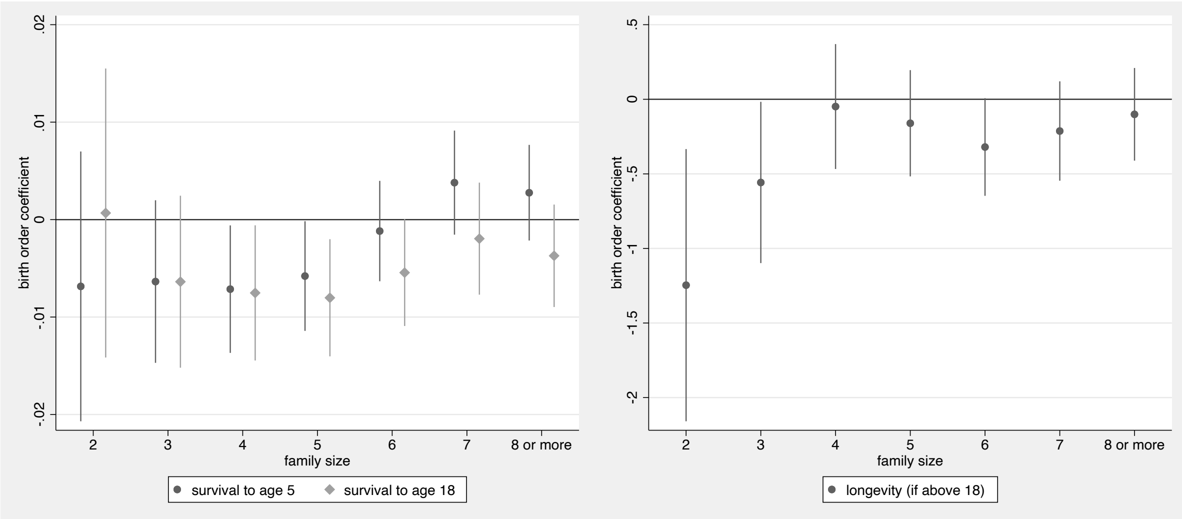

Figure 4: Linear estimates of the birth order effect by family size on survival (left) and longevity among adults (right), fixed-effect estimates and 95% confidence intervals.

For the exploration of heterogeneous effect by parental occupation, we restrict our sample to those individuals for whom we observe the occupation of their father on at least one instance, and we allow the birth order effect to vary by it. We divided the sample into three groups, including families whose father had a non-manual occupation (17.5%), families whose father was a land-owning farmer (19.7%) and families whose father had a manual occupation (62.8%).[25] For conciseness, only father-fixed effect specifications are reported.

The top panel of Table 3 present our baseline, linear results of birth order on survival and longevity when we allow them to vary by family background, the second panel allows the effect to vary also by gender of the individual, and the third panel by gender of the siblings. When we allow our results to vary along both dimensions, we do not find any significant differences (table A.7 in the Appendix). We find limited and relatively inconsistent evidence that family background modulates the birth order effect on longevity and survival. The only instance in which the differences were above what would be expected due to randomness is the reversal of the gendered effect in the case of farmers. This suggests that the effect is not driven by scarcity but might reflect gender roles or preferences; however, these more demanding specifications might suffer from a lack of power to capture heterogeneous effects on already minor differences.[26]

[25]The descriptive statistics for each group are presented in Table 1. The results of the sample with the father's occupation (Table A.6 in the Appendix) are similar to our complete sample when we estimate our original estimation equation, with a bit more precision in some of the longevity results.

[26]Our analysis does not include unemployed individuals. Since this group is the most deprived, it is possible that some effect driven by scarcity does not appear in our results.

Table 3: Birth order effects on longevity, by family background (father-fixed effects estimates)

	P(survival > 5)	P(survival > 18)	Longevity if above 18
Birth order*			
father non-manual worker	0.004	-0.001	-0.225
	(0.003)	(0.003)	(0.201)
father farmer	0.006*	0.001	-0.370**
	(0.003)	(0.003)	(0.187)
father manual worker	0.001	-0.004	-0.283*
	(0.003)	(0.003)	(0.164)
N	103662	103662	70778
Birth order*men*			
father non-manual worker	0.001	-0.004	-0.600***
	(0.003)	(0.004)	(0.219)
father farmer	0.005	0.001	-0.108
	(0.003)	(0.004)	(0.198)
father manual worker	-0.000	-0.005	-0.455***
	(0.003)	(0.003)	(0.176)
Birth order*female*			
father non-manual worker	0.008**	0.002	0.113
	(0.003)	(0.004)	(0.215)
father farmer	0.006*	0.001	-0.675***
	(0.003)	(0.003)	(0.204)
father manual worker	0.002	-0.002	-0.130
	(0.003)	(0.003)	(0.175)
N	103662	103662	70778
No. older brothers*			
father non-manual worker	0.009*	0.004	0.288
	(0.005)	(0.005)	(0.308)
father farmer	0.009**	0.003	-0.709***
	(0.004)	(0.005)	(0.271)
father manual worker	0.004	0.001	-0.073
	(0.003)	(0.004)	(0.223)
No. older sisters*			
father non-manual worker	0.009*	0.007	-0.415
	(0.005)	(0.005)	(0.317)
father farmer	0.013***	0.013***	0.284
	(0.004)	(0.005)	(0.281)
father manual worker	0.012***	0.008**	-0.231
	(0.003)	(0.004)	(0.219)
N	103662	103662	70778

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%. All columns control for gender of the individual, and age difference with the immediate precedent sibling, and dummies for year of birth, father and municipality. Estimating sample excludes families for whom an occupation for the father could not be located.

4.4 Evolution over time

We finally move to consider whether the small effect estimated in Table 2 changes over time, estimating order of birth differences allowing them to change by lustrum (5 year groups). We estimate the following equation:

$$y_{ifmc} = \alpha + \sum_{d=1820}^{1880} \beta_d \text{birth order}_{ifmc} * 1 * (\text{lustrum of birth} = d) + \gamma X_{ifmc} + \mu_f + \delta_c + \psi_m + \varepsilon_{ifmc}$$

when we allow the coefficient for birth order to change by the lustrum of birth of the individual. The estimation includes our usual controls and fixed effects for father, municipality and cohort. However, since the probability of having a missing death certificate increases over time, these results should be interpreted with caution.

Figure 5 presents the results for the probability of survival at ages 5 and 18 (left panel) and ages at death for those reaching adulthood. As expected, our results at the tales of the sample period are quite imprecise. For most of our sample period and all our outcomes of interest, we observe a remarkable lack of consistent trend over time. Towards the end of the sample, we observe a noisy positive effect of birth order on survivability (along with a corresponding, non-significant negative effect on longevity). This could reflect changes in parental expectations about the number of children and therefore investing additional resources in later children. Although not in a linear manner, during a time in which child mortality was decreasing and life expectancy was increasing over the board, there is limited impact on differences by birth order. On the one hand, differences are limited to begin with, but the lack of a trend over time could be interpreted as those driving forces of life expectancy being available to children of all orders of birth. However, as mentioned above, the risk for bias is higher in the second part of our sample period, thus this results should be interpreted with caution particularly at the end of the sample.

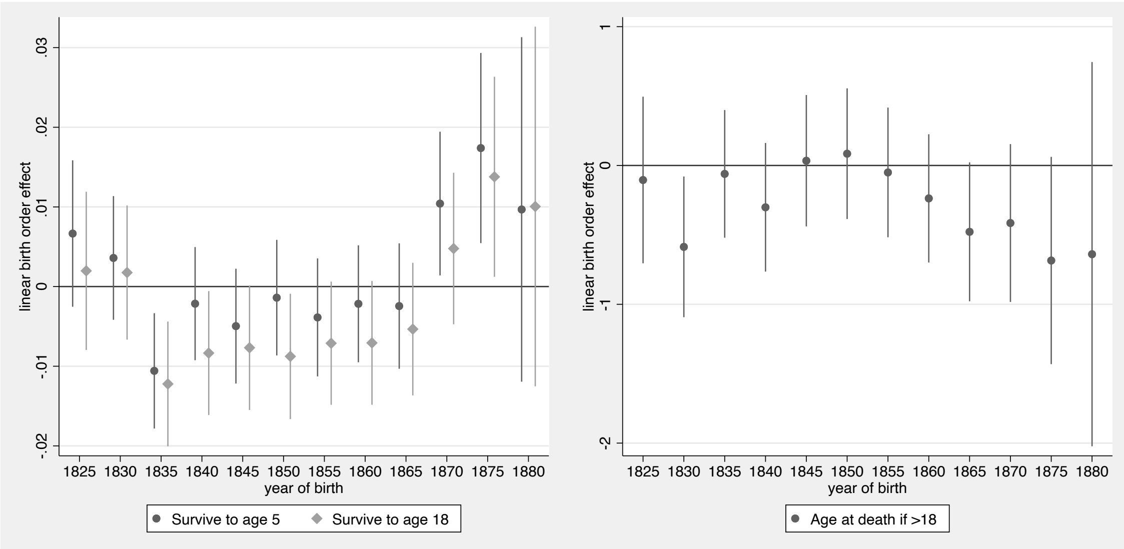

Figure 5: Birth order effect on survival (left) and longevity among adults (right) over time (father-fixed effects estimates and 95% confidence interval).

We perform the same exercise for the rest of our specifications, allowing the effects to change by the gender of the individual and the siblings. We also fail to capture any consistent trends over time, particularly for the period for which our sample is more consistent, with some variation at both ends of the distribution. These results are available upon request. Therefore, the small differences reported in our baseline results appear consistent particularly for cohorts born 1830 to 1870. As presented above, over a period where survival and life expectancy increased substantially, but this appeared to have little contemporaneous effects on within-family differences.

5 Discussion

This paper studies the relationship between birth order among siblings and life expectancy in a historical setting. Family-linked birth and death records from the provinces of Groningen and Drenthe in the Netherlands, covering cohorts born between 1820 and 1880, allow us to estimate differences in survival during infancy (to age 5) and childhood (to age 18), as well as longevity for those reaching adulthood.

Our work contributes to the economic literature on differences in outcomes by birth order. In developed countries, the so-called *birth order effect* typically favors earlier-born children, while its direction remains more uncertain in developing contexts. We add to a growing branch of this literature that examines historical populations. Cools et al. (2024) for the United States and Nuevo-Chiquero et al. (2023) for the Netherlands document advantages for firstborns in adult outcomes, particularly occupations. Since both studies focus on adulthood, understanding how birth order shapes early survival and longevity helps to shed light on the mechanisms driving these differences. Moreover, the impact of birth order on health—both in childhood and later in life—has received considerable attention.[27] In a period when infant survival was far from guaranteed, measuring the birth order effect contributes to understanding the scope and persistence of these differences.

We find a small but heterogeneous effect of birth order on survival and longevity, consistent with the results of Noghanibehambari and Fletcher (2023) for later U.S. cohorts. On average, being born later in the family does not significantly affect survival, but composition matters: having older same-gender siblings is associated with a small negative effect, while having older siblings of a different gender has a small positive effect. For both ages 5 and 18, these effects are at most about one percentage point per older sibling, compared with baseline survival rates of 78% and 70%, respectively. The effects are therefore small. Longevity among individuals who reached adulthood is also not significantly correlated with birth order, even in our most flexible specifications. The point estimates are small—around three months at most—and fail all significance tests.

Average family size in the Netherlands at the time exceeded five children. We observe limited differences by family size: smaller-than-average families display slightly larger effects, though not significantly so. The only notable difference appears in longevity, where two-child families show a gap between the first and second born, unlike larger families. Because family size is often correlated with socioeconomic status, we further explore differences by father's occupation (non-manual, farmers, and manual workers) and find little evidence that family background moderates the birth order effect.

To our knowledge, this is the first study to examine the relationship between birth order and longevity as far back as the 19th century. In this setting, understanding birth order's role in childhood survival is crucial. Given the high mortality rates of the time, studying these within-family differences helps illuminate the historical roots of the birth order effect. The demographic transition—which partly overlaps with our study period—entailed a reduction in infant and child mortality that may not have been equally distributed across or within families. Our design, which includes father fixed effects, allows us to control for time-invariant family characteristics and to study how within-family differences in longevity evolved over time. Finally, while most recent research finds limited gender differences in the birth order effect, our setting allows to investigate gendered patterns in life expectancy within the family. Our results suggest, if anything, a preference for a mix set of children, with a higher order within the child's gender correlating with a small decrease in the probability of reaching adulthood. Importantly, the limited heterogeneity we find by socioeconomic background suggests that such differences were not solely driven by resource constraints.

[27] See, for instance, Brenøe and Molitor (2018), Pruckner et al. (2021), or Björkegren and Svaleryd (2023).

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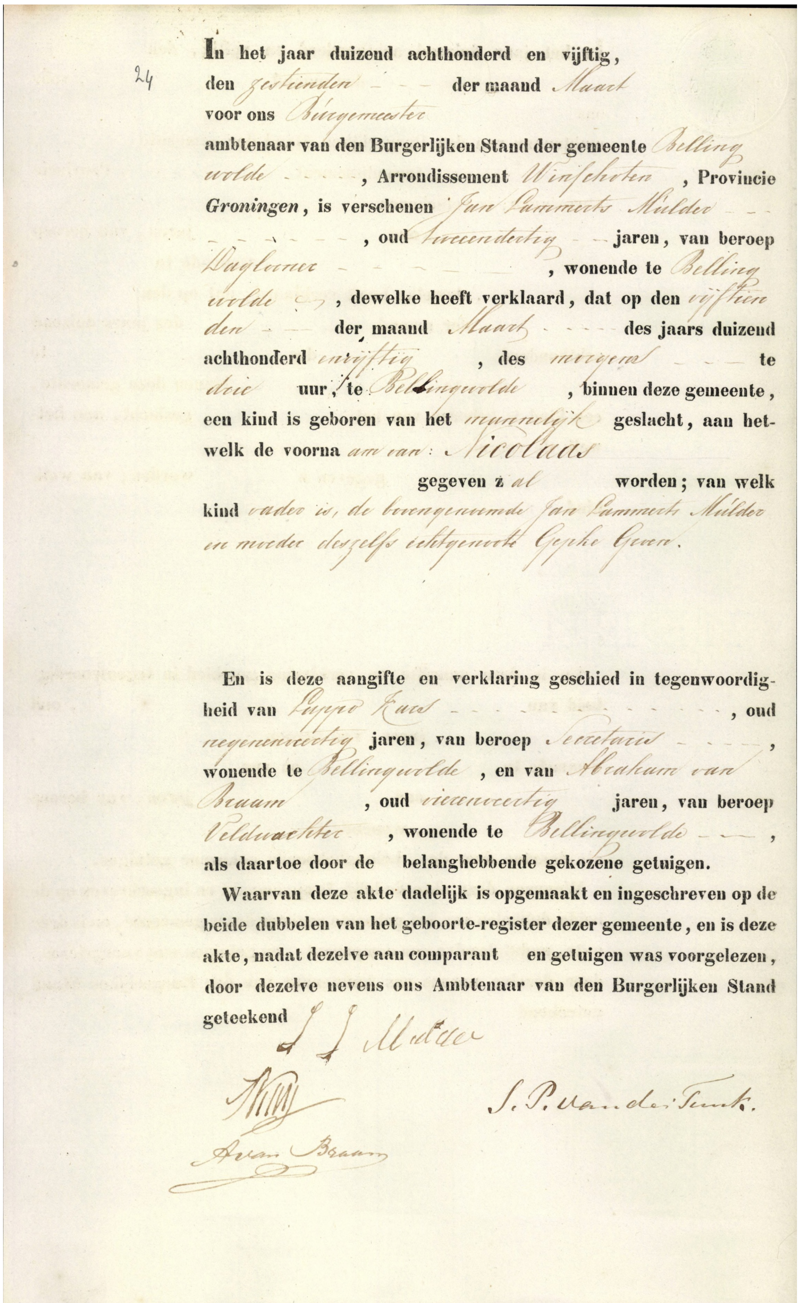
Appendix



24 In het jaar duizend achthonderd en vijftig,
den zestienden der maand Maart
voor ons Burgemeester
ambtenaar van den Burgerlijken Stand der gemeente Bellingwolde, Arrondissement Winschoten, Provincie Groningen, is verschenen Jan Rammerts Mulder, oud tweeëndertig jaren, van beroep Daglooner, wonende te Bellingwolde, dewelke heeft verklaard, dat op den vijftienden der maand Maart des jaars duizend achthonderd vijftig, des morgens te drie uur, te Bellingwolde, binnen deze gemeente, een kind is geboren van het mannelijk geslacht, aan hetwelk de voornaam van: Nicolaas gegeven zal worden; van welk kind vader is, de voorgenoemde Jan Rammerts Mulder en moeder deszelfs echtgenoote Gepke Geerts.

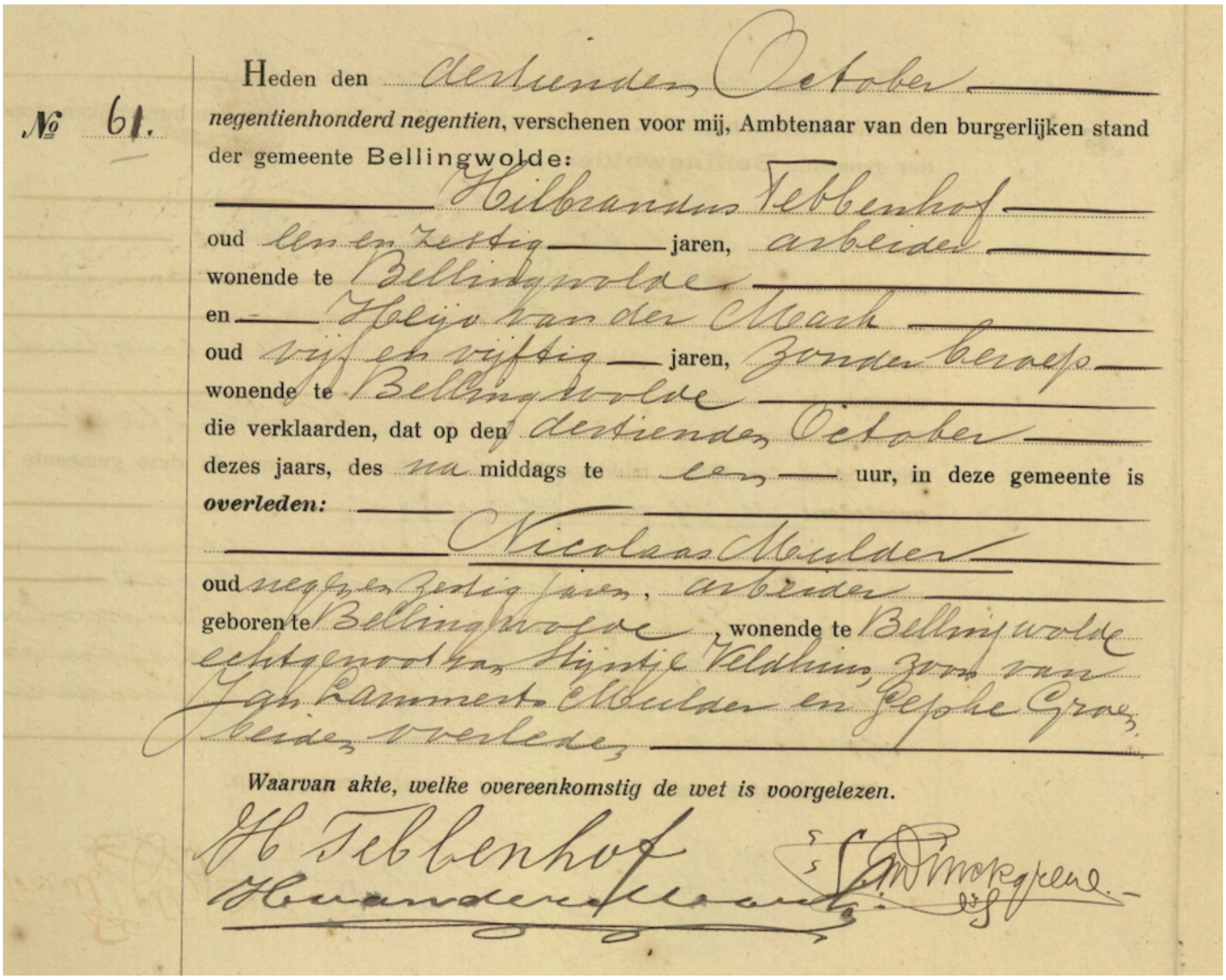
En is deze aangifte en verklaring geschied in tegenwoordigheid van Luppo Ewes, oud negenenveertig jaren, van beroep Secretaris, wonende te Bellingwolde, en van Abraham van Baarn, oud vierenveertig jaren, van beroep Veldwachter, wonende te Bellingwolde, als daartoe door de belanghebbende gekozene getuigen.
Waarvan deze akte dadelijk is opgemaakt en ingeschreven op de beide dubbelen van het geboorte-register dezer gemeente, en is deze akte, nadat dezelve aan comparant en getuigen was voorgelezen, door dezelve nevens ons Ambtenaar van den Burgerlijken Stand geteekend

J J Mulder

S.P. van der Feen.

A van Baarn

Figure A.1: Example of birth certificate, Groningen, downloaded from https://www.allegroningers.nl [last accessed 23 October 2025]. English translation: In the year eighteen hundred and fifty, on the sixteenth of the month March, before us, Mayor, official of the Civil Registry of the municipality of Bellingwolde, District of Winschoten, Province of Groningen, appeared Jan Rammerts Mulder, aged thirty-two years, occupation day laborer, living in Bellingwolde, who declared that on the fifteenth of March of the year eighteen hundred and fifty, at three o'clock in the afternoon, in Bellingwolde, within this municipality, a child was born of the male sex, to whom the given name Nicolaas will be given; of which child the father is the declarant, Jan Rammerts Mulder, and the mother is his wife Gepke Geerts. This declaration was made in the presence of Luppo Ewes, aged forty-nine years, occupation secretary, living in Bellingwolde, and Haltum van Baarn, aged forty-four years, occupation constable, living in Bellingwolde, as witnesses chosen by the interested party. Of which deed this record was immediately drawn up and entered in both copies of the birth register of this municipality, and after it had been read aloud to the declarant and the witnesses, it was signed by them and by us, the Civil Registry official: J. Mulder [signature] Aron Baarn S.P. van der Feen (official)



№ 61.

Heden den ... October negentienhonderd negentien, verschenen voor mij, Ambtenaar van den burgerlijken stand der gemeente Bellingwolde:
Hilbrandus Tebbenhof
oud ... jaren, arbeider
wonende te Bellingwolde
en ...
oud vijf en vijftig jaren, zonder beroep
wonende te Bellingwolde
die verklaarden, dat op den ... October
dezes jaars, des na middags te een uur, in deze gemeente is
overleden:
Nicolaas Mulder
oud ... jaren, arbeider
geboren te Bellingwolde, wonende te Bellingwolde
...
Waarvan akte, welke overeenkomstig de wet is voorgelezen.

H Tebbenhof

Figure A.2: Example of death certificate, Groningen, downloaded from https://www.allegroningers.nl [last accessed 23 October 2025]. English translation: Today, the 18th of October, nineteen hundred and nineteen, appeared before me, the Registrar of the Civil Registry of the municipality of Bellingwolde: Hilbrandus Tebbenhof, aged thirty-one years, laborer, residing in Bellingwolde, and Habje van der Klaauw, aged fifty-five years, without occupation, residing in Bellingwolde, who declared that on the 17th of October of this year, at one o'clock in the afternoon, in this municipality died: Nicolaas Mulder, aged seventy-nine years, laborer, born in Bellingwolde, residing in Bellingwolde, husband of Wijntje Veldhuis, son of Jan Rammerts Mulder and Gepke Geerts, both deceased. Of which record, which has been read aloud in accordance with the law.(Signatures)

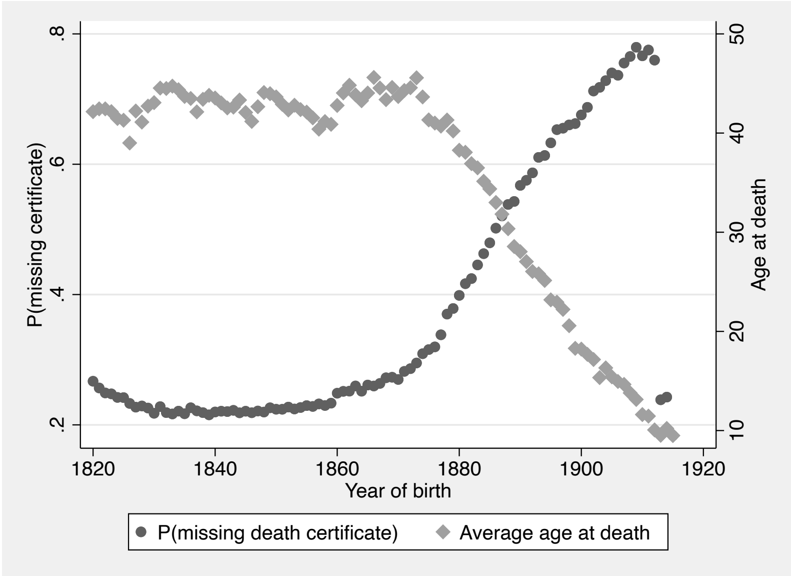


Figure A.3: Missing death certificates and average age at death by birth cohort

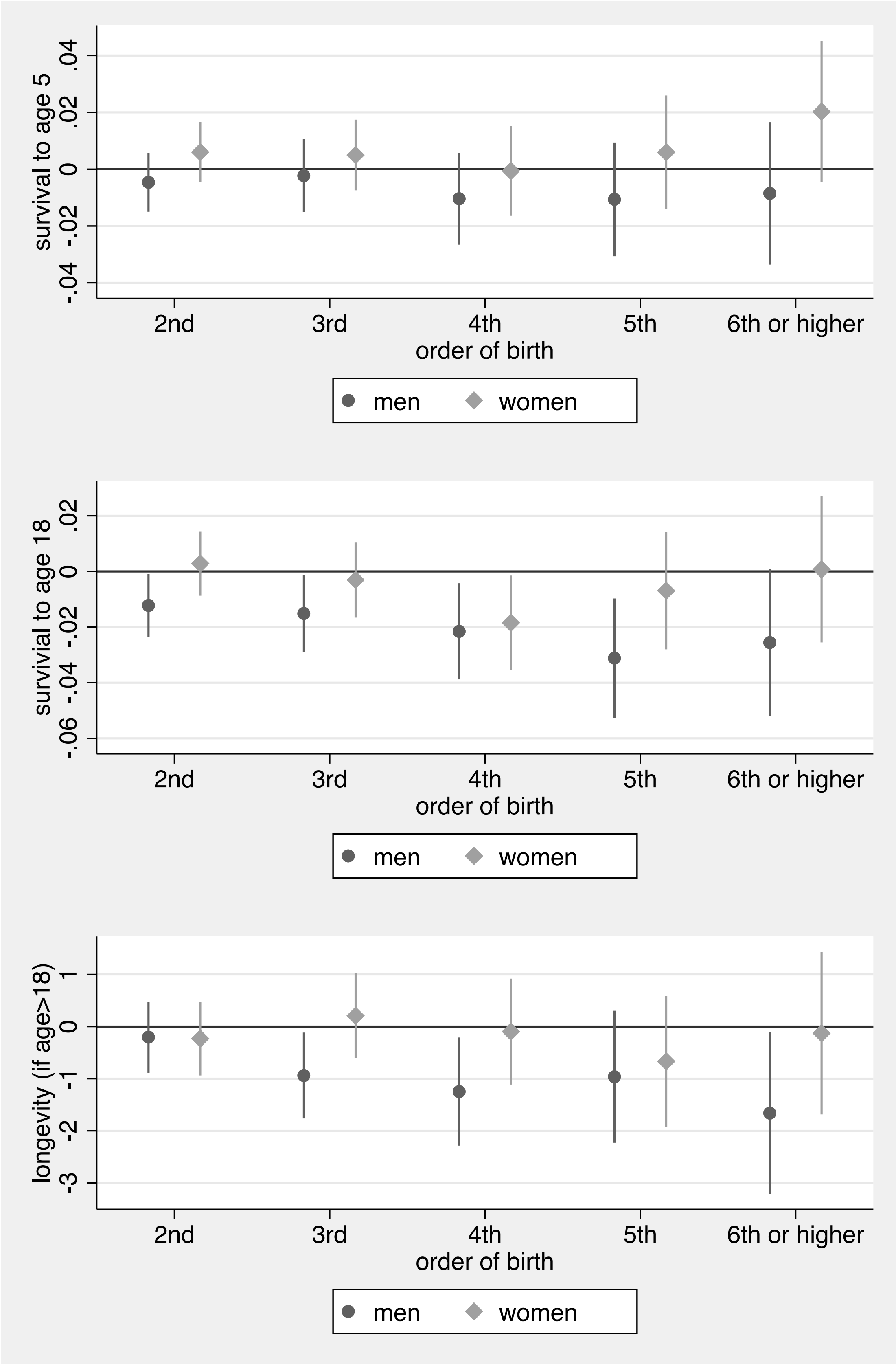


Figure A.4: Birth order effect on longevity and childhood survival, by gender (FE specification)

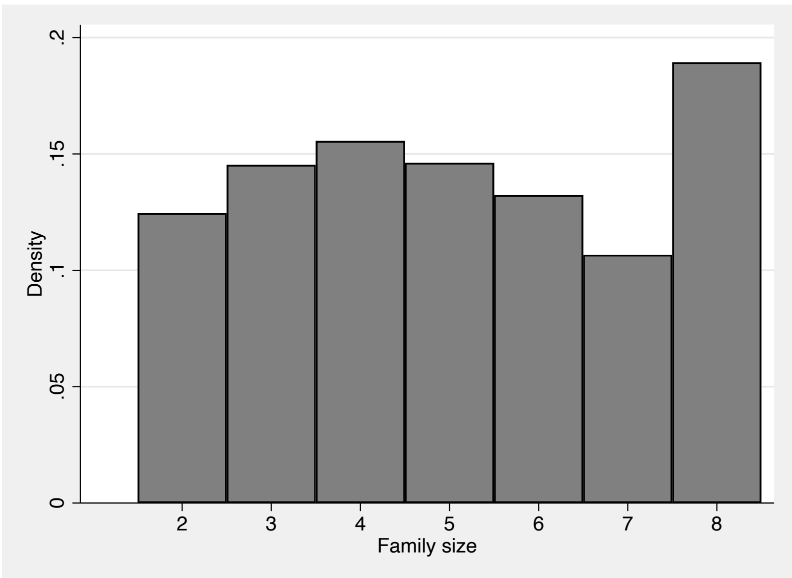


Figure A.5: Distribution of family size (8 includes families with 8 or more children)

Table A.1: Occupation classifications

	HISCLASS group	Frequency	Occupation category
1	Higher manager	0.43	
2	Higher professional	0.89	
3	Lower manager	6.29	Non-Manual worker
4	Lower professional, cleric, salesman	8.83	
5	Lower cleric, lower salesman	1.01	
8	Farmer	19.70	Farmer
6	Foreman	0.17	
7	Skilled worker	14.7	
9	Low skilled worker	9.73	Manual worker
10	Low skilled farm worker	0.22	
11	Unskilled worker	3.82	
12	Unskilled farm worker	0.71	
13	Worker	33.49	

Table A.2: Birth order effects on longevity

	Longevity, all ages		Longevity if age>5	
	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)
Birth order	-1.981***	-0.357**	-0.578***	-0.546***
	(0.070)	(0.154)	(0.063)	(0.148)
N	142397	142397	110736	110736
Birth order*male	-2.176***	-0.555***	-0.766***	-0.691***
	(0.084)	(0.166)	(0.078)	(0.158)
Birth order*female	-1.776***	-0.169	-0.390***	-0.410***
	(0.086)	(0.164)	(0.078)	(0.158)
N	142397	142397	110736	110736
No. older brothers	-1.798***	-0.189	-0.467***	-0.490***
	(0.082)	(0.194)	(0.077)	(0.188)
No. older sisters	-1.478***	0.240	-0.405***	-0.367*
	(0.081)	(0.198)	(0.075)	(0.189)
N	142397	142397	110736	110736
No. older brothers*male	-2.355***	-0.787***	-0.813***	-0.715***
	(0.107)	(0.203)	(0.100)	(0.198)
No. older sisters*male	-1.248***	0.614***	-0.385***	-0.349
	(0.107)	(0.226)	(0.099)	(0.215)
No. older brothers*female	-1.219***	0.798***	-0.130	-0.051
	(0.108)	(0.228)	(0.099)	(0.219)
No. older sisters*female	-1.709***	-0.397*	-0.421***	-0.562***
	(0.109)	(0.210)	(0.100)	(0.200)
N	142397	142397	110736	110736

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%.

Table A.3: Birth order effects on survival, extended sample with imputed survival for missing death certificates (father-fixed effects estimates)

	P(survival to age 5)		P(survival to age 18)	
	missings as 1	missings as 0	missings as 1	missings as 0
	(1)	(2)	(3)	(4)
Birth order	0.003**	-0.010***	0.001	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
N	198810	198810	198810	198810
Birth order*male	0.001	-0.011***	-0.001	-0.014***
	(0.002)	(0.002)	(0.002)	(0.002)
Birth order*female	0.005***	-0.008***	0.003	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)
N	198810	198810	198810	198810
No. older brothers	0.004**	-0.006***	0.002	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
No. older sisters	0.011***	-0.002	0.009***	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
N	198810	198810	198810	198810
No. older brothers*male	-0.001	-0.015***	-0.004*	-0.018***
	(0.002)	(0.002)	(0.002)	(0.002)
No. older sisters*male	0.014***	0.005*	0.012***	0.004
	(0.002)	(0.003)	(0.003)	(0.003)
No. older brothers*female	0.013***	0.006**	0.011***	0.004
	(0.002)	(0.003)	(0.003)	(0.003)
No. older sisters*female	0.006***	-0.012***	0.003	-0.015***
	(0.002)	(0.002)	(0.002)	(0.002)
N	198810	198810	198810	198810

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%. Columns labeled "missings as 1" assumes individuals without a death certificate did survive to the corresponding age, while the columns "missings as 0" assumes they did not. All columns control for gender of the individual, and age difference with the immediate precedent sibling, and dummies for year of birth, father and municipality.

Table A.4: Birth order effects on longevity, complete families only (father-fixed effects estimates)

	P(survival >5)	P(survival > 18)	Longevity if over 18
Birth order	0.001	-0.002	-0.085
	(0.003)	(0.003)	(0.202)
N	95132	95132	67823
Birth order*male	-0.002	-0.004	-0.199
	(0.003)	(0.004)	(0.215)
Birth order*female	0.003	-0.000	0.038
	(0.003)	(0.004)	(0.215)
N	95132	95132	67823
No. older brothers	-0.003	-0.005	-0.063
	(0.004)	(0.004)	(0.237)
No. older sisters	0.006	0.002	-0.273
	(0.004)	(0.004)	(0.239)
N	95132	95132	67823
No. older brothers*male	-0.012***	-0.015***	-0.155
	(0.004)	(0.004)	(0.250)
No. older sisters*male	0.011**	0.010**	-0.475*
	(0.004)	(0.005)	(0.285)
No. older brothers*female	0.009**	0.007	0.252
	(0.004)	(0.005)	(0.289)
No. older sisters*female	-0.003	-0.008*	-0.280
	(0.004)	(0.004)	(0.255)
N	95132	95132	67823

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%. All columns control for gender of the individual, and age difference with the immediate precedent sibling, and dummies for year of birth, father and municipality.

Table A.5: Birth order effects on survival and longevity – one mother families

	P(Survival >5)		P(Survival >18)		Longevity if over 18	
	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Birth order	-0.030***	0.004*	-0.032***	-0.001	-0.295***	-0.184
	(0.001)	(0.002)	(0.001)	(0.002)	(0.059)	(0.144)
N	131300	131300	131300	131300	93700	93700
Birth order*male	-0.031***	0.002	-0.033***	-0.003	-0.475***	-0.327**
	(0.001)	(0.002)	(0.001)	(0.003)	(0.071)	(0.153)
Birth order*female	-0.029***	0.006***	-0.030***	0.001	-0.115	-0.053
	(0.001)	(0.002)	(0.001)	(0.003)	(0.072)	(0.152)
N	131300	131300	131300	131300	93700	93700
No. older brothers	-0.029***	0.005*	-0.031***	0.001	-0.211***	-0.027
	(0.001)	(0.003)	(0.001)	(0.003)	(0.072)	(0.181)
No. older sisters	-0.023***	0.013***	-0.023***	0.009***	-0.227***	-0.007
	(0.001)	(0.003)	(0.001)	(0.003)	(0.069)	(0.179)
N	131300	131300	131300	131300	93700	93700
No. older brothers*male	-0.036***	-0.004	-0.038***	-0.008**	-0.442***	-0.150
	(0.001)	(0.003)	(0.002)	(0.003)	(0.094)	(0.190)
No. older sisters*male	-0.019***	0.019***	-0.018***	0.016***	-0.306***	-0.107
	(0.001)	(0.003)	(0.002)	(0.003)	(0.091)	(0.204)
No. older brothers*female	-0.023***	0.018***	-0.023***	0.014***	0.012	0.286
	(0.001)	(0.003)	(0.002)	(0.003)	(0.092)	(0.211)
No. older sisters*female	-0.027***	0.004	-0.028***	-0.001	-0.143	-0.086
	(0.002)	(0.003)	(0.002)	(0.003)	(0.092)	(0.189)
N	131300	131300	131300	131300	93700	93700

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%. All columns control for gender of the individual, and age difference with the immediate precedent sibling, and dummies for year of birth, father and municipality.

Table A.6: Birth order effects on survival, father with occupation

	P(Survival >5)		P(Survival >18)		Longevity if age >18	
	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Birth order	-0.028***	0.003	-0.029***	-0.002	-0.284***	-0.293*
	(0.001)	(0.002)	(0.001)	(0.003)	(0.067)	(0.154)
N	103662	103662	103662	103662	70778	70778
Birth order	-0.029***	0.001	-0.030***	-0.003	-0.407***	-0.395**
	(0.001)	(0.003)	(0.001)	(0.003)	(0.081)	(0.165)
Birth order*female	0.002	0.003	0.003*	0.003	0.248***	0.199*
	(0.001)	(0.002)	(0.002)	(0.002)	(0.092)	(0.115)
N	103662	103662	103662	103662	70778	70778
No. older brothers	-0.026***	0.006*	-0.026***	0.002	-0.222***	-0.166
	(0.001)	(0.003)	(0.001)	(0.003)	(0.078)	(0.201)
No. older sisters	-0.023***	0.012***	-0.022***	0.009***	-0.197**	-0.144
	(0.001)	(0.003)	(0.001)	(0.003)	(0.077)	(0.201)
N	103662	103662	103662	103662	70778	70778
No. older brothers	-0.033***	-0.003	-0.035***	-0.008**	-0.429***	-0.278
	(0.002)	(0.003)	(0.002)	(0.004)	(0.103)	(0.210)
No. older sisters	-0.017***	0.019***	-0.017***	0.018***	-0.194*	-0.153
	(0.002)	(0.004)	(0.002)	(0.004)	(0.102)	(0.226)
No. older brothers*female	0.014***	0.022***	0.018***	0.023***	0.406***	0.358**
	(0.002)	(0.003)	(0.002)	(0.003)	(0.131)	(0.165)
No. older sisters*female	-0.011***	-0.018***	-0.012***	-0.020***	-0.005	-0.085
	(0.002)	(0.003)	(0.002)	(0.003)	(0.135)	(0.163)
N	103662	103662	103662	103662	70778	70778

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%.

Table A.7: Birth order effects on longevity, by family background (father-fixed effects estimates)

	P(survival > 5)	P(survival > 18)	Longevity if above 18
No. older brothers*men			
father non-manual worker	-0.007	-0.014**	-0.275
	(0.006)	(0.006)	(0.371)
father farmer	0.004	-0.004	-0.161
	(0.005)	(0.005)	(0.316)
father manual worker	-0.004	-0.008*	-0.317
	(0.004)	(0.004)	(0.241)
No. older sisters*men			
father non-manual worker	0.025***	0.027***	0.033
	(0.007)	(0.007)	(0.434)
father farmer	0.017***	0.015**	-0.368
	(0.006)	(0.006)	(0.354)
father manual worker	0.019***	0.017***	-0.097
	(0.004)	(0.004)	(0.261)
No. older brothers*female			
father non-manual worker	0.030***	0.032***	0.240
	(0.006)	(0.007)	(0.386)
father farmer	0.020***	0.024***	0.428
	(0.005)	(0.006)	(0.320)
father manual worker	0.020***	0.020***	0.317
	(0.003)	(0.004)	(0.215)
No. older sisters*female			
father non-manual worker	-0.027***	-0.032***	0.061
	(0.007)	(0.007)	(0.387)
father farmer	-0.015***	-0.015***	-0.291
	(0.005)	(0.006)	(0.330)
father manual worker	-0.016***	-0.019***	-0.072
	(0.003)	(0.004)	(0.212)
N	103662	103662	70778

Note: Robust standard errors clustered at the family (father) level are reported in parentheses. * denotes significance at 10%, ** at 5% and *** at 1%. All columns control for gender of the individual, and age difference with the immediate precedent sibling, and dummies for year of birth, father and municipality.