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The consequences of sibling rivalry on survival and reproductive success across different ecological contexts: A comparison of the historical Krummhörn and Quebec populations

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Abstract

This article investigates the relationship between large families and the probability of offspring survival, marriage, and fertility across the historical populations of the Quebec (1670-1799) and Krummhörn regions (1720-1874). Both populations exist in agriculturally based economies, but differ in important ways. The Krummhörn population faced a fixed supply of land, which was concentrated amongst a small number of farmers. Most individuals were landless agricultural workers who formed a relatively competitive labor supply for the large farmers. In contrast, individuals in Quebec had access to a large supply of land, but with far fewer available agricultural workers, had to rely on their family to develop and farm that land. Results indicate that more siblings of the same gender were generally associated with increases in mortality during infancy and childhood, later ages of first marriage, and fewer numbers of children ever born. For mortality and age at first marriage, the effects of sibling formation appear strongest in the Krummhörn region. This indicates that although sibship effects appear in both ecological contexts, that the context of the region mattered in determining their magnitude.

1. Introduction

This article investigates the relationship between having more siblings, in particular of the same gender, and the probabilities of survival, marriage, and reproductive success in the historical populations of Quebec, Canada (1670 - 1799) and Krummhörn, Germany (1720-1874). These populations existed in different economic and social contexts. Although both were agriculturally based, they differed in the constraints faced in the amount of land and available labor. The population of the Krummhörn region faced a fixed supply of land and a large supply of agricultural labor to work that land, while the population of the Quebec region had a largely unconstrained supply of land but a limited labor force. Due to these and other differences between the areas, we expect the role of the family to differ across these different contexts, and thus the effect of sibling presence and configuration on survival, marriage, and reproductive success to differ as well.

Families and household typically face limits on assets, thereby constraining the resources available for investment in any individual child. The household economics perspective posits that family members will allocate time and resources as needed to optimize the success of the entire household (Becker 1973, 817); the family strategies perspective makes a similar assumption, emphasizing family action "as a dynamic process, which involves a constantly changing interaction of personalities rather than a view of the family as a monolithic entity" (Hareven 2000, 325). The life course paradigm interrogates the internal dynamics of families, exploring not only the intergenerationally-determined differential distribution of resources across family members, but also intra-generational relationships, namely those of siblings (Kok 2007, 8).

Sibling competition and parental investment effects associated with family size and family dynamics has been linked to a variety of offspring characteristics. Lawson and Mace (2009) and Borgerhoff-Mulder (1998) attempt to link offspring outcomes with parental investment, with the former linking indicators for parental care to offspring outcomes and the latter connecting family size to outcomes such as educational success or property inheritance. Most studies look to compare the effects of additional siblings in different ecological or economic contexts, either over time or across different groups of individuals. Gibson and Gurmu (2011) compare families with inheritable resources to those without, and argue that the presence or absence of inheritable resources modulates the presence of sibling rivalry. Öberg (2015) tracks the relationship between sibship size and height over time during the demographic transition in Sweden to find that resource dilution can at least partly explain the negative association of sibship size with height. Beise and Voland (2008) compare worker families with farmer families to determine that the economic context of the household matters, as sons of farmers were much more likely to migrate in the presence of more brothers relative to sons of non-agricultural workers. The gender and age of the siblings also seems to be important mechanisms through which sibling rivalry occurs. While Lawson and Mace (2008) find no differential effect on outcomes across sibling gender, Beise and Voland (2008), Voland and Dunbar (1995), and Nitsch (2014) find that the presence of older sisters was associated with relatively worse outcomes (e.g. higher probability of migration, lower survival, lower reproductive success) for girls while the presence of older brothers was associated with relatively worse outcomes for boys. Other studies find strong negative effects of older brothers (Gibson and Gurmu 2011; Borgerhoff-Mulder 1998; Rickard, Lumaa, and Russell 2009), but no similar effect from the presence of sisters. Hagen and Barrett (2009), in contrast, find that the presence of adolescent sisters lowers offspring survival, while the presence of brothers increases it.

Although siblings may compete for familial resources (subsequently referred to as sibling competition or sibling rivalry), there can be many different factors that mitigate these effects. For example, differently-aged children may not compete for the same set of resources. In addition, the co-operative breeding theoretical framework (e.g. Kramer 2005, Lukas & Clutton-Brock 2012) emphasizes intra- as well as inter-generational co-operation to maximize survival, reproduction and the family economy. Sibling cooperation is an important aspect of larger families, and was historically especially important for families in the Quebec region to ensure a family's success (Gagnon and Mazan 2009). Thus, siblings are not only competitors but also allies when it comes to conflicts or competitions between families. Therefore we expect the cost-benefit-ratio of additional siblings to be dependent on the environmental context. The benefit of additional siblings is expected to be high in contexts where inter-family competition occurs with familial expansion. Such contexts are found in frontier and expanding populations such as historic Quebec. In contrast, the benefits of additional siblings are expected to be low in contexts where inter-family competition leads to displacement and smaller families, as in the Krummhörn population.

Heuristically it is useful to distinguish between direct and indirect or parentally moderated sibling competition. Sibling competition starts before birth when fetuses demand resources also in demand by their born siblings. Likewise, newborn and young children compete for parental resources (e.g. parental attention) that is shared with their siblings. However, in both cases, sibling competition is moderated through/via the parents. Additionally, the parents are not only moderators of resources, but potentially competitors themselves. Individual offspring hold different reproductive values according to which parents may wish to direct resources (Fisher 1930), and offspring compete with their parents for resources through the parent-offspring-conflict phenomenon (Trivers 1974). Parents thus play two roles: one as moderators as children lobby parents consciously or subconsciously for their attention and resources, and one as agents, as they direct resources across children or to themselves to achieve individual or familial success. These parental effects are expected to be strongest when the offspring are children, and decreases with offspring age. Competition or conflict at older ages is increasingly determined among the siblings themselves.

Correlations between additional siblings and health and reproductive outcomes estimates the combined effect of sibling competition, sibling cooperation, and parental investment. Using variation within families, we control for many of the cooperative benefits of larger sibships and positive effects of larger families. Using offspring outcomes as measures of parental moderation or sibling competition, it is not possible to statistically separate the effects of the two since both mechanisms manifest themselves in the same proxies (numbers of brothers and sisters) and studies such as this must rely on more qualitative assessments. For instance, the effect of additional siblings on infants within families would primarily work through the parents as moderators of infant resources, so would be characterized as parental investment. As children age, adverse effects of additional siblings within families are more likely to be due to sibling competition. This balance then shifts completely to sibling competition when the parents die and are no longer able to actively moderate resources between their children.

To identify the effects of larger sibships on outcomes, net of the positive benefits of larger families in general, this study relies on a thematically and geographically comparative approach. We contrast the effect of having additional siblings across three demographic outcomes (mortality for infants and children, age at first marriage, and the number of children ever born) in order to understand the relative impact of sibship size and configuration on demographic destinies at four different points in the life course: infancy, early childhood, at marriage, and in the course of reproduction.[1] We expect that the individual balance between the costs and benefits of having siblings is dependent on the ecological context of the family, and as such to differ across the different population contexts of the 18th- and early 19th-century Krummhörn region and the 17th to 18th-century St. Lawrence valley. Since the population of the Quebec region faced a labor constraint while the population of the Krummhörn faced a land constraint, we expect the presence of additional siblings to be more strongly associated with increases in mortality, and delays at marriage, while the presence of additional older siblings would be associated with fewer numbers of children ever born.

In addition to differences in the population contexts, we also expect to observe differences between males and females. Both the Krummhörn and Quebec were patriarchal systems, and daughters did not commonly inherit landed property as sons did. Consequently girls may compete to larger degree with their sisters, and boys to a larger degree with their brothers (Beise and Voland 2008). Although there were differences in the transmission of inheritances to men in the two different societies, we do not have a strong reason to anticipate significantly different gender distinctions in the two societies, and therefore expect relatively uniform results across gender. These contexts are discussed in more detail below.

2. A comparison of the Québec and Krummhörn study populations

The historical populations of the Quebec and Krummhörn regions were agriculturally based societies, but differed socially and institutionally. The implications from these differences have previously been used to study the relationship between child survival and parental death and

[1] Although not presented in the article, sibship effects for the outcome of age at first birth have also been estimated and are qualitatively the same as those for age at first marriage.

remarriage (Willführ and Gagnon 2012, 2013), and the presence of maternal or paternal grandmothers (Voland and Beise 2005; Beise 2005).

Willführ and Gagnon (2013) find that while in both populations maternal loss was associated with increased infant and child mortality, the remarriage of the father differed across the two contexts. Paternal remarriage was a more or less a neutral event in Quebec, but was associated with increased child mortality in the Krummhörn region. Negative effects related to the presence of a stepmother are often referred to as the Cinderella effect (Daly & Wilson 1998), and the differences in the results across the two different populations suggests that the strength of this effect depends the specific economic and ecological circumstances. The population of the St. Lawrence valley was a frontier society where the success of the family was dependent on the number of children and relatives willing and able to work. Stepmothers in Quebec therefore had reason to care for the children of the husband's former marriage since they were potentially valuable sources of labor. The Krummhörn population had higher levels of population density and more limited farmland and working opportunities, so the children of a husband's former marriage and the stepmother's children born into the recomposed families were more competitors than allies, and the stepmother would intervene on behalf her children in this (half-) sibling conflict.

The impact of paternal grandmothers also appears to differ across the Krummhörn and Quebec population contexts for similar reasons. Since the paternal grandmother is not genetically related to the mother, they are in potential conflict over intra-familial resources and labor participation. In the Krummhörn population, this conflict appeared to be quite tense, but more relaxed in the Quebec population. For demographic and for socio-economic reasons mothers-in-law in Quebec had a reason to treat their daughters-in-law more favorably and their presence was associated with reduced child mortality (Beise 2005). Meanwhile, in the Krummhörn population, the presence of paternal grandmothers was associated with increased stillbirth mortality (Beise and Voland 2005).

2.1 The Krummhörn region [1720-1874]

The data derive from a family reconstitution study based on Protestant church registers, tax rolls, and other records of the Krummhörn region in Ostfriesland (East Frisia, Germany) from the eighteenth and nineteenth centuries. For a detailed description of the construction of the dataset, we refer interested readers to Voland (2000). The historical Krummhörn was divided into 33 neighboring parishes, of which all are part of the dataset. This dataset includes 34,708 marriages and 80,486 birth records for cohorts between 1720 and 1850 (sample extends to 1874).

Children from the Krummhörn region are included in the analysis if their sex is known and they derive from first marriages contracted after 1720. Before 1720 records are often incomplete and important families are overrepresented. After 1874, the church was no longer responsible for the records of births, deaths, and marriages, and this task had been transferred to the civil administration (Standesämter) whose records are not available. Because of this censoring, we exclude persons born after 1849 from the models that estimate child (age 1 to 15) survival) and exclude individuals born after 1829 from the models that estimate age at marriage and the number of offspring (up to age of 45). Also excluded are individuals born to recomposed families (17,291 persons and individuals part of the wealthy landowning class (2,214 persons).[2] Columns 1 and 2 of Table 1 list the number of males and females by birth cohort included in the analyses.

Geographically the region is bordered to the North and West by the North Sea, to the South by the River Ems, and to the East the Krummhörn by sandy and infertile soil which was in former times impenetrable moorlands. Within the Krummhörn region the environment consisted of very fertile marsh soil, good for both crops and livestock. Settlement of the area had been completed in the late medieval period (Ohling 1963), and there was no significant population growth during the study period. The region is therefore a saturated habitat in which the population faced a binding constraint on land and local resource competition (Voland and Dunbar 1995). Because access to land was limited, a stratified social structure arose among the population of the Krummhörn. At the one extreme existed the social upper class of large-scale farmers with capital and status, while at the other was a lower social class made up of small-scale farmers, tenants, craftsmen, and landless workers. About 70 percent of the families in the 18th century were part of this lower social class with either no land at all, or farms too small to ensure subsistence which required supplemental for the large-scale farmers of the social upper class (Willführ and Störmer 2015). Although there are no recorded periods of famine or wars, like in all other parts of Europe, smallpox and other virulent agents took a significant toll within the parishes of the region during the eighteenth century. Overall, the average family size was about four children (Voland and Dunbar, 1995). With regards to social institutions, a form of ultimogeniture was practiced in which the youngest son inherited the undivided farm from the father (Ohling 1963). All of the other offspring had to be recompensed, often with cash. Daughters could expect to receive half as much as a son. As a consequence, the Krummhörn population in general was characterized by a late age at first marriage and relatively small families, with late reproduction and low birth rates.

2.2 The Québec region [1670-1799]

Data for the historical population of Québec come from the Registre de la population du Québec ancien (RPQA), created by the Programme de Recherche en Démographique Historique (PRDH) at the University of Montreal. The RPQA is a family reconstitution database with more than 700,000 linked Catholic baptisms, marriages, and burials registered in the Québec parishes

[2] The wealthy landowning class is considered significantly different from the rest of the population, so for that reason are omitted. These families are those that own more than 75 grasen of farmland (1 gras ~ 0.36 ha).The borderline of 75 grasen is arbitrary, but fits well with historic sources concerning the definition of the social and economic upper class (for references, see Beise 2001: pp. 53). Inclusion of the wealthy landowners does not qualitatively change the results.

of the St. Lawrence Valley from settlement in 1621 up to 1799, as well as death acts from 1800 to 1850 of persons who died at age 50+ years (Dillon, Gentil-Amorevieta, Caron, Lewis, Guay-Giroux, Desjardins and Gagnon 2015). The RPQA covers the complete population over the whole territory on which the colony was established at the time, eliminating the usual problem of exits of observation through emigration (Dillon et. al. 2015). The population was very small at the beginning, with 3,246 inhabitants at the time of the first census in 1666 (Charbonneau and Légaré 1967, pp. 1033). With relatively low levels of immigration and only a minority of immigrants founding families within the colony, Quebec grew largely through natural increase, reaching a population size of more than 70,000 by 1760 (Charbonneau, Desjardins, Légaré and Denis 2000 pp. 104). The database identifies both inter- and intragenerationally linked family members and thus allows us to operationalize variables pertaining to life events of family members, as well as the subject themselves. With regards to this study, individuals from Quebec are included if they have been born to first marriages which have been contracted between 1670 and 1750 and have a known sex. This excludes 17,652 individuals, leaving 50,187 males and 51,840 females born to 14,456 families available for analysis. The number of individuals by birth cohort is given in columns 3 and 4 in Table 1. Some of the individuals born in the 1770 and 1780 cohorts may not have had time to get married, and would not have had time to bear all of their children, but comprise a relatively small proportion of the population. These dates are chosen to mitigate the effects of in and out migration in the region during the early colonial period when individuals were still arriving from France as well possible effects on marriage resulting from the French-Indian war during the 1750s; these dates also allow a sufficient window of analysis for individuals born to marriages contracted up to 1750.

In contrast to the Krummhörn region, French settlers of Canada faced few land constraints. Patterns of settlement in the Quebec colony were initially circumscribed by dependence on the St. Lawrence River for transportation and the need to avoid Amerindian raids, more frequent on the south side of the river (Laberge and Mathieu 1996 pp. 47). The western part of the St. Lawrence region, around Montreal, was favored for settlement on account of its longer growing season and proximity to one of the two cities of the colony (Laberge and Mathieu 1996 pp. 48). As conflicts with Amerindians subsided, colonization progressed along both sides of the St. Lawrence, creating a continuous series of settlements between Quebec City and Montreal (Laberge, Gouger, and Boisvert 1996 pp. 58). The majority of Quebec's inhabitants were farmers, with a smaller proportion of artisans, merchants, officers, professional, and the ruling elite living in urban areas. Montréal and Québec City were the only urban regions in the St. Lawrence Valley, and nearly 80 percent of the children within our sample were born in the countryside. Along the banks of the St. Lawrence River, development of the land was limited by available workforce. Work to clear new land of trees, pull stumps, burn vegetation debris, remove rocks from the soil and create farm fields could take a French-Canadian family 15 to 20 years (Boudreau, Courville and Séguin 1997 pp. 55). Inter- and intra-generational solidarity was necessary to achieve this goal. Quebec family solidarity is observed indirectly in a number of ways. For example, nearly a quarter of all families contracting marriages for their children between 1675 and 1799 contracted a marriage between sets of brothers and sisters, known as an exchange marriage (Caron and Dillon 2013 pp. 14). The settlement of the Quebec territory by families in extended kin groupings is evident in the concentration of particular last names within the seigneuries (Laberge and Mathieu 1996 pp. 53). Immigration of non-Catholic persons was extremely limited and marriage arrangements were therefore culturally endogamous (Charbonneau, Desjardins, Légaré and Denis 2000 pp. 110-111). Alongside the demands of settlement, Quebec society was dominated by both a strong Catholic church and a patriarchal family system which together enforced religious observance and paternal familial control, limiting the number of prenuptial conceptions and promoting high birth rates (Bates 1986 pp.263 and 268-9; Bouchard 2000 pp. 195; Cliche 1988 pp. 66).

The demands of settlement as well as conservative cultural expectations fostered early ages at marriage and high fertility. Individuals who belonged to a large sibship and who settled on the pioneer front tended to encourage the settlement of a large number of their own children in proximity. This led to an intergenerational transmission of total reproductive success in the colony (Gagnon and Heyer 2001). Average ages of first marriage were especially low for the early cohorts, as mean age at marriage for women in 1660 was under 15. The summary statistics in Table 2 are more heavily weighted towards the later cohorts, which were marrying relatively later as the sex ratio stabilized. For all of the different cohorts however, French Canadian women married at younger ages and with greater intensity than their European counterparts. French Canadian men were less than five years older than their wives during the mid-eighteenth century. On the other hand, owing to their intense natural fertility regime as well as the resultant increases in population density, French Canadians exhibited relatively high infant mortality rates. These rates increased over the course of the 17th and 18th centuries from 50 to 200 deaths per 1,000 for children born in the years before 1685 to 250 to 350 per 1,000 for children born between 1740 and 1780 (Amorevieta-Gentil 2009 pp. 131). Diverse factors were associated with high infant mortality in French- and English-regime Quebec. For instance, infant mortality risks were higher for boys, for children born after 1740, for children with a birth rank of 8 or higher, for children with a preceding intergenetic interval less than 22 months, and for children for whom the preceding infant had died (Amorevieta-Gentil 2009, pp. 219). Comparing across families in Quebec, we might therefore expect large sibships to be associated with higher infant and child mortality risks, but not strongly associated with delays in marriage or reductions in the number of children ever born. Recent work on the impact of sibship size and configuration on the hazard of marriage in colonial Quebec shows the influence of siblings depended on the sex and birth rank of the subject, the sex of the siblings, and whether the siblings were married or not (Dillon 2010 pp. 27-31). Focusing on the variation between families, negative effects of large sibships on women's hazard of marriage was controlling for by the presence of married siblings. The effect of birth rank, as opposed to sibship size, was statistically significant even in fully saturated models, with eldest daughters and sons enjoying the shortest waiting time to marriage. The hazard of marriage tended to be amplified if the subject had married older siblings, and attenuated by the presence of unmarried older and marriage younger siblings. These findings emphasize the role of paternal authority in the Quebec region, with children marrying in birth order and with first-born sons and daughters manifesting the shortest waiting time to marriage. Dillon (2010) also shows evidence for a "passed over" effect of siblings who saw a younger same-sex sibling get married before themselves, as well as a longer waiting time to marriage among younger siblings, perhaps due to property arrangements needed to settle near the family patrimony. Dillon's results, then, highlight the role of family cooperation, but also suggest certain siblings were "winners" or "losers", with sacrifices being made for the betterment of the whole. A full analysis of the effects from sibling marital dynamics is outside the scope of this article, but it will nevertheless be important to determine how much they are contributing to any identified within-family effect between the presence of siblings and the hazard of marriage.

2.3 Descriptive comparison of survival and marriage in Krummhörn versus Québec

The contrasting environments, social contexts and family dynamics of Krummhörn and Quebec are evident when we compare summary statistics of infant and child mortality and marriage in the two populations. Table 2 presents proportions dying in infancy and in childhood, proportions marrying and ages at marriage for the 25,557 women and men in the Krummhörn sample and the 102,027 women and men in the Quebec sample. We immediately view a strong contrast between the two populations in terms of infant mortality. Of the 12,872 males and 12,685 females in the Krummhörn sample, 13.5% of males and 12.1% of females died before age 1. Nearly twice as many Quebec children succumbed during their first year: of the 50,187 males and 51,840 females in the Quebec sample, 24.1% of males and 20.7% of females died before age 1. The two regions manifested more similar proportions of subjects lost to child mortality. Among the 12,872 males and 12,685 females in the Krummhörn sample, 19.3% of males and 12.1% of females died between the ages of one and fifteen. In Quebec, among the 50,187 males and 51,840 females, 15.7% of males and 14.9% of girls died between age 1 and 15.

After setting aside infants and children who died before attaining maturity, we observe that higher proportions of men and women married in Quebec. In Krummhörn, of the 8,988 males who survived until the age of 15, 42.7% married at least once, 35.2% died without having married, and the residual 23% likely outmigrated, as their date of death and marital status was unknown. In Quebec, of the 32,099 males who survived until the age of 15, 85.7% married at least once while 14.3% died without having married. The same contrast is evident among women. Of the 9,091 Krummhörn females who survived until the age of 15, 46.9% married at least once, 30% died without having married, and the residual 22% likely outmigrated, as their date of death and marital status was unknown. In Quebec, on the other hand, of the 34,959 females who survived until the age of 15, 87.7% married at least once while 11.3% died without having married. The Krummhörn-Quebec contrast in marriage intensity is quite stark: even if all of the individuals in the Krummhörn population who outmigrated and thus lack marital data eventually did end up getting married, the Quebec population was marrying at rates about 15 to 20 percentage points higher. Finally, we observe an important difference in women's mean age at marriage in the two populations. Although some women and men did marry relatively early in the Krummhörn region, the average age at first marriage here was almost 27 for women, and nearly 29 for men. In contrast, women's average age at first marriage in Quebec was 23, fully 4 years younger than that seen among their counterparts in the Krummhörn region. Quebec men's mean age at marriage was 27, just two years younger than that observed among men in the Krummhörn region. Quebec women's particularly young age at marriage produced a larger conjugal age gap than that seen in Krummhörn.

These descriptive statistics for the Krummhörn region and Quebec resonate with our understanding of the Krummhörn region as a context marked by limited access to land, ultimogeniture and outmigration, and of the Quebec region as a context characterized by relatively ready access to land, efforts to settle all children through a variety of transmission practices, strong religious and patriarchal controls and high infant mortality risks. Beneath the surface of these starkly contrasting mortality and marriage patterns lie complex family and demographic dynamics. We now turn our attention to those subterranean dynamics, exploring the across-family and within-family influences of sibship size on the distinct risks of mortality, marriage and fertility in two very different populations.

3. Multivariate analyses

This section estimates the association between sibship size and configuration, and survival, age at first marriage, and the number of children born over the reproductive life course. For the first two demographic outcomes, Cox proportional hazard models are specified which consider the events to depend upon the number and configuration of siblings (by younger and older and by gender), whether an individual was born in an urban or rural environment, maternal and paternal mortality, maternal and paternal age, an individual's birth cohort, and an individual's birth rank. Whether an individual was born in an urban or rural environment, their birth cohort, and birth rank are time-constant variables, but the rest of the covariates change over the course of that individual's life. As brothers and sisters are born or die prematurely, the size and configuration of the sibship changes. In addition, parent age is included, as well as whether one or both parents die prior to the individual reaching the age of 15. The variables of interest are those for the number of siblings, stratified by older and younger and by brothers and sisters. To estimate the remaining outcome of the number of children born, we specify a Poisson model with independent variables indicating the number of siblings, maternal and paternal age, an individual's birth cohort, and an individual's birth rank. As in the Cox proportional hazard models, the number of siblings is stratified by older and younger and by brothers and sisters.

For each of the pairs of models for the Krummhörn and Quebec populations, the differences between the coefficients on sibship size are tested for statistical significance. This is done through the specification of additional models that include a full set of interactions for all of the different independent variables with a dummy variable equal to 1 for being in the Quebec population. The results from these models are not presented, but when the differences between the populations are statistically significant at the 5 percent level, the coefficient estimates in the different tables are in bold.

As outlined above, there are many ways in which family size can affect each of the different events, as well as other possible confounding factors associated with both. For example, in Quebec larger families entailed a higher likelihood of disease exposure and more potential for sibling competition or diffusion of parental resources; at the same time, the larger size of Quebec families also meant the availability of children to act cooperatively as workers on the farm and an increase in the overall productivity of the household. These contrasting and concurrent possible outcomes may become visible when comparing the between-family variation to the within-family variation. Regression models which identify from between-family variation will likely pool all of the different beneficial and adverse aspects of being in a larger family, while models which identify from within-family variation are going to control for all of the benefits and costs of family size and instead focus on the unique effect for each individual of having an additional sibling within a family. By the inclusion or exclusion of family fixed effects, it is possible to compare the relationship between sibship size and configuration and the different outcomes while controlling or not controlling for the effects of family size.[3] For the fixed effect models, the familial mean is differenced out of the different dependent variables in the subsections below. This results in all singulate observations being omitted from the family fixed effect analysis, and so there is some difference in the sample size between the different models. In addition, the family fixed effects model controls for a large portion of the variation in individual outcomes. As such, in the sections below, we wish to emphasize the direction, significance, and difference in magnitude between the two populations rather than the specific hazard ratio estimates themselves.

To explore our hypothesized differences between sisters and brothers, all of the different models presented below separate the samples between males and females. Tables 3 through 5 each feature eight models, with the first four devoted to the sample of females and the last four devoted to the sample of males. Within each of these sets are two pairs of models, the first pair which does not include the family fixed effect, and the second pair which does. Within each pair is a model using the sample of individuals from Krummhörn, and one using the sample of individuals from Quebec.

3.1 Mortality for infants and children aged 1 to 15

Tables 3 and 4 present estimates from Cox proportional hazard models on the hazard of death prior to age 1 and between the ages of 1 and age 15, respectively. Columns 1 and 2 (girls) and 5 and 6 (boys) in Table 3 focus on between-family variation (non-fixed effects), and show that female and male infants in both populations faced lower probabilities of death if they were born

[3] Especially large families may have a disproportionate impact on the results in the following sections, as these provide more observations for comparison and thus exert a greater weight in the calculation of the estimates. Limiting to families with fewer than 10 children did not affect the results.

into families with more brothers and sisters, all other variables being equal. In addition, this effect was stronger in the population of the Krummhörn. Infants and children in Krummhörn may have been even more likely to survive when they had a greater number of brothers and sisters because they were situated within particularly successful families: in this case, having a large family in a low fertility context signified a family's success to a greater extent than it did in Quebec.

Controlling for the family fixed effect, the relationship between the number of siblings and infant mortality reverses direction. These estimates are given in columns 3 and 4 (girls) and 7 and 8 (boys). Within families, the presence of an additional older brother or older sister was associated with increased infant mortality for both girls and boys, although the association between older brothers and female infant mortality was not statistically significant. [4] From the estimates in columns 3, 4, 7, and 8, there is evidence of differences between both populations and sexes. The hazard of death for girls was most significantly affected by the presence of older sisters, while for boys, by the presence of older brothers. Although the effects were present in both populations, they were across the board weaker within the population of Quebec. And for boys in Quebec, having additional older sisters was not significant in magnitude or statistically. Other variables with statistically significant coefficients and associated with an increased hazard of death were whether an individual was born in an urban environment (Quebec only), the loss of a mother or father, higher levels of maternal age (Quebec only), and for Krummhörn, whether an individual was part of a later birth cohort. Variables with statistically significant coefficients that were associated with a decreased hazard of death were an indicator for whether the next oldest sibling had died and the birth rank of the child. Since birth rank is included in combination with the sibling variables, it acts as a proxy for the number of siblings who have died in the non-fixed effects models and a measure of placement within the family in the models controlling for family-fixed effects.

Table 4 presents estimates for the hazard of dying for children between ages 1 and 15. From columns 1 and 2 (girls) and 5 and 6 (boys) family size was generally associated with a lower hazard of death for both boys and girls, and although the association seems to be slightly stronger for the Krummhörn that difference was not statistically significant. With the inclusion of the family fixed effects the relationship again reversed so that more brothers and sisters was mostly associated with increased child mortality. Two exceptions to this were the number of older sisters for girls and the number of younger sisters for boys. These exceptions appeared in both populations, and were not statistically significantly different. The population did differ significantly regarding the association between the number of brothers and child mortality. The hazard of death for children was higher with additional brothers (both older and younger), but was relatively less strong for the individuals in Quebec.

[4] The number of siblings can also affect infant survival through the replacement effect, as parents may invest more in an infant if their next older sibling has perished. As such we include a variable to control for this possible mechanism.

Across both populations, the association between having additional siblings and infant and child mortality was negative if the family effect was controlled for, and positive if not. There is also evidence of differential impact by gender. For the fixed effects models, both brothers and sisters negatively impacted infant mortality, but brothers had the strongest effect for male infants and sisters the strongest for female infants. This relationship was slightly more complex for children aged 1 to 15, as the effect of additional older brothers was most strong for boys, but the negative impact of additional younger brothers was most strong for girls. Younger sisters were associated with an increased hazard of death for girls, but a decreased hazard of death for boys. Lastly, although evidence of sibship effects associated with increased mortality is present in both populations, the magnitude of the effects are strongest for children of the Krummhörn.

3.2 Age at first marriage

Table 5 presents estimates from Cox proportional hazard models on the hazard of marriage. Because of the problem of outmigration in the Krummhörn region for individuals over the age of 15, the sample is limited to those individuals who eventually married. As such, the hazard ratios presented in Table 5 reflect the waiting time to marriage.

For all of the different models presented, fixed effect and non-fixed effect alike, larger families were associated with delayed age at first marriage. Across the different sibling variables, the only statistically significant hazard ratio estimates which represented exceptions to this were for younger sisters in the Quebec region for girls with the family fixed effect controlled for (column 4), and for younger brothers in the Quebec region for boys for both the fixed effect and non-fixed effect models (columns 6 and 8). Having 1+ older sisters was generally associated with delayed age at marriage for both boys and girls, although the estimated hazard ratios were not statistically different than one for girls in the Quebec population (columns 4 and 8). The estimated hazard ratios on the number of older brothers were statistically significant and associated with delays in marriage for both boys and girls across both the fixed effect and non-fixed effect specifications.

The association between marital timing and the presence of brothers was significantly different between the Krummhörn and Quebec populations. This is most clearly seen looking at the estimated hazard ratios on the number of younger brothers. While in Quebec additional younger brothers are associated with an earlier age at first marriage, in Krummhörn the estimated association was for a delayed age at first marriage. And while the estimated effect from the number of older brothers is statistically significant and in the same direction for both populations, the magnitude of the effect is weaker in Quebec. The only other statistically significant differences between the populations were on the estimated hazard ratios for the number of older sisters for girls and the number of younger sisters for boys. Both were associated with increased waiting time to first marriage.

Other estimated hazard ratios that remain statistically significant once the family fixed effects are controlled for (columns 3, 4, 7, and 8) include those for maternal and paternal mortality and maternal and paternal age. In both populations the event of a parent death is associated with an earlier age at first marriage. Individuals whose parents are older also tend to get married relatively early.

These models focus only on the presence or absence of siblings and as such do not fully capture family dynamics over time. As mentioned in Section 2, the incidence and timing of sibling marriages informs family dynamics, and could be the mechanism responsible for the associations described above. The results are not presented in the tables below, but the presence of married siblings does seem to be an important mechanism linking sibship size to marital outcomes. Having married siblings is strongly associated with a longer waiting time to marriage for both males and females, and seems most important in explaining the relationship between the number of married younger sisters and the waiting time to marriage for girls and the number of married younger brothers and the waiting time to marriage for boys. Controlling for family-fixed effects and the number of married siblings by age and sex, the presence of unmarried older sisters are associated with a shorter waiting time to marriage for girls in both populations (not statistically significant in the Krummhörn population). In the corresponding specification for boys, older brothers are associated with a shorter waiting time to marriage for boys in the Quebec population, but a longer waiting time to marriage for boys in the Krummhörn.

3.3 Number of children over the life course

Estimates from the Poisson model with the number of children, both born and surviving until adulthood, are given in Table 6. These models are estimated using the number of births for individuals over the age of 15. Table 5 contains 8 columns, with the first four devoted to the sample of females and the last four devoted to the sample of males. Within each of the sets of four, are two columns with estimates that do not control for family-fixed effects, and two columns of estimates that do.

From the non-fixed effects models (columns 1 and 2 for females and 5 and 6 for males), persons born to families with larger numbers of brothers tended to have fewer births if they were in the Krummhörn population, but more births if they were in the Quebec population. These results were statistically significant at the 5% level only for girls, however.[5] For these models, the presence of sisters was significantly associated with fewer births for girls in the Krummhörn, and higher numbers of births for boys in the Quebec region. From the coefficients on the variables controlling for the number of siblings at age 15, losing siblings was generally associated with fewer numbers of births for both boys and girls. Comparing the models that

[5] This is evidence of overall reproductive success in the Quebec population: in accordance with the "useful reproduction" literature, successfully reproducing families tended to produce more successfully reproducing generations

control for the effect of the family to those that do not, the importance of family effects in determining the association between sibling presence and birth outcomes seem most important for the population in Quebec. While in the non-fixed effects models larger numbers of brothers or sisters tended to be associated with higher numbers of births, in the fixed effects models the opposite was the case. From column 4, additional sisters tend to reduce the number of births for girls, and from column 8, additional brothers tend to reduce the number of births for boys. For both the fixed effect and non-fixed effect models, boys who had more sisters tended to have more children.

4. Discussion/Conclusion

Intra-familial competition over resources has been demonstrated in contexts ranging from historical populations in Finland (e.g. Rickard, Lumaa, and Russell 2009; Nitsch 2014), Sweden (e.g. Öberg 2015), Germany (e.g. Beise and Voland 2008; Voland and Dunbar 1995), and Holland (e.g. Suanet and Bras 2014), to contemporary horticulture societies in Ethiopia (e.g. Gibson and Gurmu 2011), Kenya (Borgerhoff-Mulder 1998), and Ecuador (e.g. Hagen and Barrett 2009), to contemporary western societies in Britain (e.g. Lawson and Mace 2008; 2009) and Australia (e.g. Milne and Judge 2011). This study compared the historical populations of the Krummhörn and the Quebec regions to gain further insight on the relationship between sibship size and offspring outcomes. For each of the outcomes considered above – infant and child mortality, waiting time to marriage, and childbearing – we found, as did Beise and Voland (2008), Voland and Dunbar (1995), and Nitsch (2014), that sibling competition was channeled between same-sex siblings: having additional sisters was associated with poorer health and reproductive outcomes for girls than for boys, and vice versa. For some outcomes, additional siblings of the opposite sex even seemed to be beneficial. For example, additional brothers (sisters) were associated with decreased probability of death for infant girls (boys), and additional sisters were associated with an increase in the reproductive success of males in the Quebec region. As many of the studies cited above have found, we also find notable differences across the two populations: beyond the higher mortality risks, higher proportion of persons married, and younger ages at marriage in Quebec, we observed some distinct sibship influences on those very outcomes. Within the Krummhörn region, the presence of additional same-sex siblings seemed to wield more detrimental effects on subjects' demographic "success" than in the Quebec region, increasing the mortality of children aged 1 to 15 and delaying the waiting time to marriage.

The inclusion or exclusion of the family fixed effect is important for those models with mortality as the outcome of interest. When focusing on between-family differences in the non-fixed effects models, larger families in both populations tended to have lower levels of mortality for both children aged 1 to 15 and infants. This influence was reversed when we used fixed effect models to focus on within-family differences, with additional siblings associated with higher infant and child mortality. The presence of additional same-sex siblings in Quebec households did not seem to incur the same child mortality penalty that it did in the Krummhörn region, even though Quebec families in general experienced increasing levels of child mortality across the 18th century. Perhaps the presence of multiple same-sex children did not strain household resources to the same extent within Quebec pioneer families, who enjoyed greater access to farm produce, livestock, game, and fish than their European counterparts. In addition, our models control for the survival of the immediately preceding child, a control which may restrain the interdependent link between high fertility and high infant mortality. Consistent with this particular result are the estimates across all of the different outcomes that indicate a less detrimental presence of additional older brothers to younger sons in the Quebec population. We postulate that this is due to the importance of sharing labor by siblings in that society. Most of the sons within the Quebec sample were able to build their own farm, and the costs of an additional brother are partly mitigated by their positive contribution to the family farm development.

Turning to our fertility outcome, the elevated negative impact of same-sex siblings in the Krummhörn region versus Quebec was only apparent in between-family analyses which did not control for family-fixed effects. When the family-fixed effect was not included, additional brothers were significantly associated with higher numbers of births for both women and men in the Quebec region; this result may reflect intergenerational transmission of fecundability as a population characteristic. However, inclusion of the family-fixed effect in the Quebec model attenuated the positive association between additional brothers and children born to women such that it was essentially zero; moreover, the family-fixed effect model estimated that additional brothers had a significant and negative effect on the number of children born to men. In this case, focusing our analysis on within-family variation allows us to glimpse an effect of sibling competition – or rather sibling sacrifice – that the across-family analysis cannot illuminate for the Quebec population as a whole. The number of children born during the life course is related to age at marriage: siblings who married later bore fewer children. Those siblings who married later were not randomly selected: Dillon (2010) has shown, for example, that siblings of high birth rank experienced a longer waiting time to marriage. The use of the fixed effects model to highlight within-family variation in birth outcomes allows this sibling differentiation to emerge. Thus, the negative effect of additional brothers on the number of own children born during the life course in Quebec probably reflected younger brothers' delayed transition to childbearing (via marriage) if they had several older brothers.

Notwithstanding the observed differences between Quebec and Krummhörn, the general consistency and robustness of the sibship effect across the different ecological and economic contexts is our most interesting result. Although there existed some differences in the magnitude of the effect, the presence of older siblings of the same gender was similarly associated with increases in infant and child mortality, a longer waiting time until marriage, and fewer children ever born, particularly when a family-fixed effect model was adopted. In fact, comparing results of models which included family-fixed effects to those which did not has proven an important procedure for guiding our interpretations. In general, the inclusion of the family-fixed effect either attenuated previously positive point estimates for the presence of additional siblings, or intensified those that were previously negative. However, it was only in the case of Quebec and with respect to childbearing that inclusion of the family-fixed effect prompted a switch from a positive and significant relationship to a zero or negative relationship. The association of larger sibships with higher infant and child mortality, longer waiting times until marriage, and lower fertility suggests that having additional siblings creates pressures on survival and delays in life course transitions within families in different ecological contexts. This association holds true whether or not the wealthy land owners are included in the Krummhörn population sample. In fact, contextual historical information on Quebec and Krummhörn suggest that the negative pressure occasioned by additional siblings was not driven primarily by the mechanism of inheritable resources, so the presence of an association between additional siblings and poorer health and reproductive outcomes goes against the argument that sibling competition is a direct result of competition over inheritable resources found in Gibson and Gurmu (2011).

In both historical populations, inheritable resources were of relatively small concern for the majority of the population – but for different reasons. Quebec families within the sample were able to settle their sons within existing parishes or move to newly-opened parishes along the St. Lawrence River, thereby keeping adult sons often in close proximity to other family members. For boys in the Krummhörn region, the stark inequality meant that for most there was no land to inherit. Nevertheless, having older same-sex siblings, and in some cases opposite-sex siblings, was still associated with higher mortality, longer waiting times to marriage, and lower numbers of children ever born in both populations. Though new farmland in Quebec was relatively available during the French regime, developing new family farms entailed considerable work and occasioned delayed transitions. Thus, while Quebec family life was predicated on family solidarity, achieving this family solidarity required sacrifices by certain members of the family group. Setting across-family and within-family analyses side-by-side, we argue that sibling competition – or sacrifice – is manifested as an internal familial dynamic, but is obscured in non-fixed effects models by a broader trend of family cooperation. Thus, by comparing across-family and within-family models, we can reconcile family solidarity and sibling competition/sacrifice as co-existing phenomena.

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References

Amorevieta-Gentil, M. (2009. *Les niveaux et les facteurs déterminants de la mortalité infantile en Nouvelle-France et au début du Régime Anglais (1621-1779)*. (Unpublished doctoral dissertation). Université de Montréal, Montréal

Bates, R. (1986). Les conceptions prénuptiales dans la vallée du Saint-Laurent avant 1725. *Revue d'histoire de l'Amérique française*, 40(2), 253-272.

Becker, G. (1973). A Theory of Marriage: Part I. *Journal of Political Economy*, 81(4), 813-846.

Beise, J. (2001). *Verhaltensökologie menschlichen Abwanderungsverhaltens – am Beispiel der historischen Bevölkerung der Krummhörn (Ostfriesland, 18. und 19. Jahrhundert)*. (Unpublished doctoral dissertation). Justus-Liebig Universität Gießen, Giessen.

Beise, J. (2005). The helping and helpful grandmother: The Role of maternal and paternal grandmothers in child mortality in the seventeenth and eighteenth century population of French settlers in Quebec, Canada. In E. Voland and Anthanasior Chasiotis (Eds.) *Grandmotherhood: The Evolutionary Significance of the Second Half of Female Life* (pp. 215-238). Piscataway, NJ: Rutgers University Press.

Beise, J. and Voland, E. (2008). Intrafamilial resource competition and mate competition shaped social-group-specific-natal dispersal in the 18th and 19th century Krummhörn population. *American Journal of Human Biology, 20*, 325-336.

Borgerhoff-Mulder, M. (1998). Brothers and sisters - How sibling interactions affect optimal parental allocations. *Human Nature*, 9(2), 119-161.

Bouchard, G. (2000). La sexualité comme pratique et rapport social chez les couples paysans du Saguenay (1860-1930). *Revue d'histoire de l'Amérique française*, 54, 183-217.

Boudreau, C., Courville, S., and Séguin, N. (1997). Atlas historique du Québec: Le territoire. Sainte-Foy: Les Presses de l'Université Laval.

Caron, M. and Dillon, L. (2013). Exchange marriages between sibsets: A sibling connection beyond marriage, Québec 1660-1760," Paper presented at the IUSSP International Conference, Busan, South Korea.

Charbonneau, H., Desjardins B., Légaré, J., and Denis, H. (2000). The population of the St. Lawrence Valley, 1608-1760. In M. Haines & R. Steckel (Eds.) *A population history of North America* (pp. 99-142). Cambridge, UK: Cambridge University Press.

Charbonneau, H., and Légaré, J. (1967). La population du Québec aux recensements de 1666 et 1667. Population, 6, 1031-1054.

Cliche, M.A. (1988). Filles-mères, familles et société sous le Régime français. *Histoire sociale/Social History*, 21(41), 39-69.

Daly, M., and M. I. Wilson.1998. The truth about Cinderella: a Darwinian view of parental love. New Haven, CT: Yale University Press.

Dillon, L., Gentil-Amorevieta, M., Caron, M., Lewis, C., Guay-Giroux, A., Desjardins, B., Gagnon, A., (2015). The Registre de la population du Quebec ancien: Past, Present and Future Developments in a Family Reconstitution Database. Manuscript submitted for publication.

Dillon, L. (2010). Parental and sibling Influences on the timing of marriage, 17th and 18th-century Quebec. *Annales de démographie historique*, 1(119), 139-180.

Fisher, R.A. (1930). *The genetic theory of natural selection.* New York, NY: Dover Publications Inc.

Gagnon A., Heyer E. (2001). Intergenerational correlation of effective family size in early Quebec 1608-1800. *American Journal of Human Biology*, 13(5), 645–659.

Gagnon, A., and Mazan R. (2009). Does exposure to infectious diseases in infancy affect old age mortality? Evidence from a pre-industrial population. *Social Science & Medicine* 68, 1609–1616.

Gagnon A., Toupance B., Tremblay M., Beise J., Heyer E. (2006). Transmission of migration propensity increases genetic divergence between populations. *American Journal of Physical Anthropology*, 129, 630–636.

Gibson, M.A. and Gurmu E. (2011). Land inheritance establishes sibling competition for marriage and reproduction in rural Ethiopia. PNAS, 108(6), 2200–2204.

Hagen, E.H. and Barret H.C. (2009). Cooperative breeding and adolescent siblings: Evidence for the ecological constraints model? *Current Anthropology*, 50, 727-737.

Hareven, T.K. (2000). *Families, History and Social Change: Life-Course and Cross-Cultural Perspectives*. Boulder, Colorado: Westview Press.

Helfrecht, C. and Meehan, C. L. (2015). Sibling effects on nutritional status: Intersections of cooperation and competition across development. *American Journal of Human Biology*, 10.1002/ajhb.22763.

Kok, J. (2007). Principles and prospects of the life course paradigm. *Annales de démographie historique*, 1(113), 203-230.

Kramer K. L. (2005) Children's Help and the Pace of Reproduction: Cooperative Breeding in Humans. Evolutionary Anthropology 14(6), 224-237.

Laberge, A., Gouger, L., and Boisvert, M. (1996). L'expansion de l'écoumène. In S. Courville (Ed.) *Atlas historique du Québec: Population et territoire* (pp. 58-59). Sainte-Foy: Les Presses de l'Université Laval.

Laberge, A. and Mathieu, J. (1996). L'expansion de l'écoumène. In S. Courville (Ed.) *Atlas historique du Québec: Population et territoire* (pp. 45-54). Sainte-Foy: Les Presses de l'Université Laval.

Lawson, D.W. and Mace, R. (2008). Sibling configuration and childhood growth in contemporary British families. *International Journal of Epidemiology, 37*, 1408-1421.

Lawson, D. W. and Mace, R. (2009). Trade-offs in modern parenting: a longitudinal study of sibling competition for parental care. *Evolution and Human Behavior, 30*, 170-183.

Lawson, D. W. and Mace, R. (2011). Parental investment and the optimization of human family size. *Philosophical Transactions of the Royal Society,* 366, 333-343.

Lukas, D., Clutton-Brock, T. (2012). Life histories and the evolution of cooperative breeding in mammals. *Proceedings of the Royal Society B: Biological sciences*, 279, 2151-2156.

Milne, F.H. and Judge, D.S. (2011). Brothers delay menarche and the onset of sexual activity in their sisters. P*roceedings of the Royal Society B: Biological Sciences*, 278, 417-423.

Nitsch, A., Faurie, C., and Lummaa V. (2014) Alloparenting in humans: fitness consequences of aunts and uncles on survival in historical Finland. *Behavioral Ecology*, 25(2), 424–433.

Öberg, S. (2015). Sibship size and height before, during, and after the fertility decline: A test of the resource dilution hypothesis. *Demographic Research,* 32(2)*,* 29-74.

Ohling, G. D. (1963). Kulturgeschichte des Krummh6rn. In J. Siele & G.D. Ohling (Eds.) *Die Acht und Ihre Sieben* (pp. 17-288). Pewsum: Erster Entw/isserungsverband Emden.

Pollet T.V., and Hoben A.D. (2011). An evolutionary perspective on siblings: Rivals and resources. In: C. Salman & T.K. Shackleford (Eds.) *The Oxford handbook of evolutionary family psychology* (pp. 128-148). New York, NY: Oxford University Press.

Rickard, I.J., Lumma V., Russel A.F. (2009). Elder brothers affect the life history of younger siblings in preindustrial humans: social consequence or biological cost? *Evolution and Human Behavior* 30, 49–57.

Steelman, L. C., Powell B. Werum, R., and Carter, S. (2002). Reconsidering the effects of sibling configuration. *Annual Review of Sociology,* 28, 243-269.

Suanet B., Bras H. (2014). Sibling Position and Marriage Timing in the Netherlands, 1840-1922: A Comparison across Social Classes, Local Contexts, and Time. *Journal of Family History*, 39(2), 126-139.

Trivers, R. L. (1974). Parent-offspring conflict. *American Zoologist,* 14(1), 249-264.

Voland, E. and Beise, J. (2005). The husband's mother is the devil in the house. In E. Voland and Anthanasior Chasiotis (Eds.) *Grandmotherhood: The Evolutionary Significance of the Second Half of Female Life* (pp. 239-255). Piscataway, NJ: Rutgers University Press.

Voland, E. and Dunbar, R.I.M. (1995). Resource competition and reproduction: The relationship between economic and parental strategies in the Krummhörn population (1720-1874). *Human Nature,* 6(1), 33-49.

Voland, E. (2000). Longevity and the costs of reproduction in a historical human population. *Proceedings of the Royal Society of London,* 267, 31-35.

Willführ, K. and Gagnon, A. (2012). Are stepmothers evil or simply unskilled? Infant death clustering in recomposed families. *Biodemography and Social Biology,* 58, 149-161.

Willführ, K. and Gagnon, A. (2013). Are stepparents always evil? Parental death, remarriage, and child survival in demographically saturated Krummhörn (1720-1859) and expanding Quebec (1670-1750). *Biodemography and Social Biology,* 59, 191-211.

Willführ, K. and Myrskylä, M. (2013). Phenotype-environment mismatch due to epigenetic inheritance? Programming the offspring's epigenome and the consequences of migration. *American Journal of Human Biology,* 25, 318-328.

Willführ, K. and Myrskylä, M. (2014). Disease load at conception predicts survival in later epidemics in a historical French-Canadian cohort, suggesting functional trans-generational effects in humans. *PLOS One,* 9(4), e93868.

Willführ, K. and Störmer, C. (2015). Social Strata Differentials in Reproductive Behavior among Agricultural Families in the Krummhörn Region (East Frisia, 1720-1874). Historical Life Course Studies, 2, 58-85.

Table 1: Sample cohorts, Krummhörn region(1720-1824) and Quebec (1670-1799)

Cohort	Krummhorn		Quebec	
	Female	Male	Female	Male
	1	2	3	4
1670			234	195
1680			1,012	859
1690			1,862	1,763
1700			3,320	3,168
1710			3,984	3,888
1720	39	46	5,354	5,155
1730	420	407	7,816	7,590
1740	746	755	9,864	9,398
1750	817	821	11,564	11,351
1760	933	954	5,613	5,609
1770	1,086	1,169	1,192	1,178
1780	971	1,059	25	33
1790	997	967		
1800	1,140	1,201		
1810	1,101	1,185		
1820	1,325	1,273		
1830	1,347	1,284		
1840	1,275	1,241		
1850	488	510		
Total	12,685	12,872	51,840	50,187

Table 2: Summary statistics, infant and child mortality, proportions marrying and age at marriage, Krummhörn region(1720-1824) and Quebec (1670-1799)

Number	# born between 1720 and 1849	# died in infancy	# died between ages 1 and 15	# married once	# never married	Age at first marriage		
						Average	Min	Max
Krummhorn								
Female	12,685	1,532	2,062	4,266	2,723	26.6	15.4	65.4
Male	12,872	1,737	2,147	3,839	3,164	28.8	18.3	68.0
Total	25,557	3,269	4,209	8,105	5,887			
Quebec								
Female	51,840	10,739	6,142	30,671	3,954	22.8	15.0	65.5
Male	50,187	12,096	5,992	27,498	4,600	26.6	15.1	69.2
Total	102,027	22,835	12,134	58,169	8,554			

Proportion	# born between 1720 and 1849	# died in infancy	# died between ages 1 and 15	# married once	# never married	Age at first marriage		
						Average	Min	Max
Krummhorn								
Female	49.63%	12.08%	16.26%	46.93%	29.95%			
Male	50.37%	13.49%	16.68%	42.71%	35.20%			
Total	100.00%	12.79%	16.47%	44.83%	32.56%			
Quebec								
Female	50.81%	20.72%	11.85%	87.73%	11.31%			
Male	49.19%	24.10%	11.94%	85.67%	14.33%			
Total	100.00%	22.38%	11.89%	86.74%	12.76%			

Notes: For adults in the Krummhoern region, 2,102 female and 1,985 males likely outmigrated and as such their marital status is unknown. For the Quebec population, marital status is unknown for 334 males and 1 female.

Table 3: Risk of infant mortality, Persons born in the Krummhörn region(1720-1824) and Quebec (1670-1799), Cox Proportional Hazard Model (with and without fixed effects)

Sex	Girls	Girls	Girls	Girls	Boys	Boys	Boys	Boys
Model	1	2	3	4	5	6	7	8
Age	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Variables								
N elder brothers (alive)	0.793**	0.874**	1.129	1.015	0.777**	0.885**	3.330**	1.983**
	(0.029)	(0.008)	(0.094)	(0.020)	(0.027)	(0.008)	(0.253)	(0.037)
N elder sisters (alive)	0.791**	0.895**	2.949**	2.139**	0.793**	0.864**	1.202*	1.002
	(0.030)	(0.008)	(0.233)	(0.042)	(0.028)	(0.008)	(0.089)	(0.018)
Born in urban environment (Yes)		1.659**		1.588**		1.847**		1.417**
		(0.037)		(0.110)		(0.039)		(0.087)
Paternal Loss	1.399	1.654**	1.397	1.309+	1.443+	1.420**	1.000	1.263+
	(0.353)	(0.148)	(0.642)	(0.187)	(0.311)	(0.125)	(0.407)	(0.175)
Maternal Loss	5.138**	3.895**	3.089**	3.302**	5.033**	3.960**	2.916**	2.834**
	(0.617)	(0.253)	(0.913)	(0.429)	(0.628)	(0.256)	(0.964)	(0.362)
Paternal Age (Ref: 20-30)								
<20	0.591	0.902	0.746	1.240	0.623	1.082	0.542	1.222
	(0.592)	(0.251)	(1.059)	(0.480)	(0.624)	(0.281)	(0.618)	(0.432)
30-40	0.865+	0.899**	0.716*	0.954	0.978	0.926**	0.941	0.900*
	(0.069)	(0.026)	(0.101)	(0.045)	(0.073)	(0.025)	(0.122)	(0.040)
40-50	0.892	0.828**	0.731	0.992	0.824+	0.866**	0.942	0.907
	(0.102)	(0.032)	(0.161)	(0.076)	(0.093)	(0.031)	(0.196)	(0.066)
50-60	1.136	0.700**	1.095	1.048	0.791	0.842**	0.999	0.930
	(0.246)	(0.042)	(0.447)	(0.125)	(0.197)	(0.047)	(0.432)	(0.107)
>60	0.000	0.787	0.000	1.211	1.449	0.747+	1.379	0.925
	(0.000)	(0.118)	(0.000)	(0.299)	(1.453)	(0.111)	(2.047)	(0.234)
unknown	0.902	0.884	0.380	1.000	0.957	1.017	2.134	1.000
	(0.069)	(0.075)	(0.250)	(0.000)	(0.070)	(0.079)	(1.483)	(0.000)

Table 3 cont.: Risk of infant mortality, Persons born in the Krummhörn region(1720-1824) and Quebec (1670-1799), Cox Proportional Hazard Model (with and without fixed effects)

Sex	Girls	Girls	Girls	Girls	Boys	Boys	Boys	Boys
Model	1	2	3	4	5	6	7	8
Age	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1	0 to 1
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Maternal Age (Ref: 20-30)								
<20	1.712*	1.256**	0.956	1.273**	2.075**	1.335**	1.673	1.549**
	(0.403)	(0.060)	(0.387)	(0.089)	(0.454)	(0.058)	(0.617)	(0.098)
30-35	1.066	0.945+	1.040	1.022	1.030	0.914**	1.060	0.951
	(0.090)	(0.027)	(0.139)	(0.045)	(0.081)	(0.025)	(0.132)	(0.040)
35-45	1.071	0.902**	1.002	1.166*	1.009	0.887**	1.015	1.078
	(0.104)	(0.033)	(0.170)	(0.077)	(0.092)	(0.030)	(0.166)	(0.068)
>45	0.867	0.844	1.335	1.666**	1.032	0.847	1.822	1.498**
	(0.319)	(0.097)	(0.770)	(0.272)	(0.409)	(0.090)	(1.009)	(0.229)
unknown	1.057	1.041	1.857	1.000	0.935	1.078	0.241*	1.000
	(0.074)	(0.158)	(1.682)	(0.000)	(0.062)	(0.143)	(0.155)	(0.000)
Birth cohort (decades)	0.958**	1.126**	1.217+	0.925*	0.947**	1.112**	1.285*	0.963
	(0.008)	(0.006)	(0.139)	(0.035)	(0.008)	(0.006)	(0.132)	(0.034)
Birth Rank (ascending order)	1.156**	1.139**	0.705**	0.899**	1.185**	1.137**	0.658**	0.937**
	(0.023)	(0.006)	(0.032)	(0.010)	(0.022)	(0.006)	(0.027)	(0.010)
Next elder sibling has died	0.797**	1.165**	0.543**	0.802**	0.996	1.131**	0.630**	0.762**
	(0.065)	(0.027)	(0.055)	(0.022)	(0.071)	(0.025)	(0.057)	(0.020)
Family fixed effects	N	N	Y	Y	N	N	Y	Y
N IDs (aged 0 or 1)	12,685	51,840	12,685	51,840	12,872	50,187	12,872	50,187
N deaths	1,532	10,739	1,532	10,739	1,737	12,096	1,737	12,096
Observations	26,177	105,304	26,177	105,304	26,420	101,161	26,420	101,161

Standard errors in parentheses

** p<0.01, * p<0.05, + p<0.1

Table 4: Risk of child mortality (age 1 to 15), Persons born in the Krummhörn region(1720-1824) and Quebec (1670-1799), Cox Proportional Hazard Model (with and without fixed effects)

Sex	Girls	Girls	Girls	Girls	Boys	Boys	Boys	Boys
Model	1	2	3	4	5	6	7	8
Age	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Variables								
Variables	0.866**	0.916**	**1.464****	**1.110****	0.874**	0.911**	**7.808****	**3.853****
N elder brothers (alive)	(0.028)	(0.012)	**(0.124)**	**(0.036)**	(0.028)	(0.012)	**(0.700)**	**(0.138)**
	0.894**	0.924**	**6.669****	**3.843****	0.869**	0.906**	**1.483****	**1.140****
N younger brothers (alive)	(0.029)	(0.012)	**(0.576)**	**(0.132)**	(0.028)	(0.012)	**(0.128)**	**(0.038)**
	0.980	1.040*	0.883	0.910**	0.956	0.990	1.532**	1.471**
N elder sisters (alive)	(0.040)	(0.021)	(0.075)	(0.032)	(0.038)	(0.021)	(0.112)	(0.048)
	1.003	1.017	1.267**	1.451**	0.991	0.984	0.858+	0.840**
N younger sisters (alive)	(0.041)	(0.020)	(0.090)	(0.043)	(0.039)	(0.020)	(0.074)	(0.030)
Born in urban environment (Yes)		1.948**		1.776**		2.163**		1.555**
		(0.059)		(0.166)		(0.066)		(0.155)
Maternal Loss	1.483**	1.481**	1.274	1.388**	1.507**	1.498**	1.697**	1.875**
	(0.120)	(0.077)	(0.261)	(0.150)	(0.119)	(0.081)	(0.342)	(0.214)
Paternal Loss	1.179+	1.217**	1.205	1.272*	1.069	1.159*	1.255	1.118
	(0.103)	(0.068)	(0.237)	(0.133)	(0.091)	(0.068)	(0.235)	(0.127)
Paternal Age (Ref: 20-30)								
<20	1.019	0.447	0.475	0.320	0.000	0.946	0.000	0.745
	(0.723)	(0.224)	(0.611)	(0.254)	(0.000)	(0.359)	(0.000)	(0.464)
30-40	1.158*	1.034	1.184	0.937	1.012	1.069+	0.854	0.904
	(0.082)	(0.038)	(0.156)	(0.062)	(0.069)	(0.040)	(0.111)	(0.062)
40-50	1.134	1.028	1.188	0.956	0.994	1.010	0.846	0.798*
	(0.112)	(0.052)	(0.245)	(0.106)	(0.097)	(0.051)	(0.177)	(0.090)
50-60	1.003	0.923	0.614	0.700*	0.750	1.078	1.115	0.859
	(0.227)	(0.074)	(0.266)	(0.120)	(0.175)	(0.087)	(0.491)	(0.154)
>60	0.000	0.928	0.000	0.386*	0.978	1.081	5.192e+15	0.912
	(0.000)	(0.208)	(0.000)	(0.144)	(0.981)	(0.220)	(4.928e+23)	(0.340)
unknown	1.066	1.235*	0.956	1.000	1.011	1.426**	0.933	1.000
	(0.075)	(0.121)	(0.424)	(0.000)	(0.067)	(0.141)	(0.541)	(0.000)

Table 4 cont.: Risk of child mortality (age 1 to 15), Persons born in the Krummhörn region(1720-1824) and Quebec (1670-1799), Cox Proportional Hazard Model (with and without fixed effects)

Sex	Girls	Girls	Girls	Girls	Boys	Boys	Boys	Boys
Model	1	2	3	4	5	6	7	8
Age	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15	1 to 15
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Maternal Age (Ref: 20-30)								
<20	1.473+	0.977	0.952	1.136	1.040	0.967	0.898	1.080
	(0.345)	(0.063)	(0.410)	(0.117)	(0.304)	(0.063)	(0.482)	(0.116)
30-35	1.014	1.053	1.057	0.907	1.133+	1.040	0.992	0.846**
	(0.074)	(0.039)	(0.130)	(0.056)	(0.080)	(0.039)	(0.123)	(0.053)
35-45	1.085	0.992	1.035	0.811*	1.124	1.009	0.941	0.762**
	(0.091)	(0.048)	(0.162)	(0.077)	(0.093)	(0.049)	(0.154)	(0.074)
>45	0.775	0.916	0.774	0.774	0.976	1.098	0.467	0.790
	(0.282)	(0.153)	(0.413)	(0.181)	(0.382)	(0.175)	(0.278)	(0.195)
unknown	1.097	1.634**	2.151+	1.000	1.082	1.496*	1.622	1.000
	(0.067)	(0.250)	(0.998)	(0.000)	(0.065)	(0.237)	(1.006)	(0.000)
Child's birth cohort	0.961**	1.131**	1.054	1.026	0.961**	1.112**	0.948	0.952
	(0.007)	(0.008)	(0.112)	(0.054)	(0.007)	(0.008)	(0.102)	(0.053)
Birth Rank (ascending order)	1.099**	1.057**	0.564**	0.774**	1.100**	1.059**	0.592**	0.800**
	(0.020)	(0.008)	(0.028)	(0.014)	(0.019)	(0.008)	(0.030)	(0.016)
Next elder sibling has died	0.938	1.004	0.836+	0.992	0.956	1.006	0.977	0.956
	(0.064)	(0.033)	(0.084)	(0.044)	(0.065)	(0.034)	(0.101)	(0.044)
Family fixed effects	N	N	Y	Y	N	N	Y	Y
N IDs (aged 0 or 1)	11,153	41,101	11,153	41,101	11,135	38,091	11,135	38,091
N deaths	2,062	6,142	2,062	6,142	2,147	5,992	2,147	5,992
Observations	69,946	348,904	69,946	348,904	69,606	321,832	69,606	321,832

Standard errors in parentheses

** p<0.01, * p<0.05, + p<0.1

Table 5: Waiting time to marriage, Persons born and married in the Krummhörn region(1720-1824) and Quebec (1670-1799), Cox Proportional Hazard Model (with and without fixed effects)

Sex	Women	Women	Women	Women	Men	Men	Men	Men
Model	1	2	3	4	5	6	7	8
Age	15+	15+	15+	15+	15+	15+	15+	15+
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Variables								
N elder brothers (alive)	**0.868****	**0.986***	**0.726****	**0.926****	0.912**	0.953**	**0.744****	**0.989**
	(0.020)	**(0.006)**	**(0.079)**	**(0.022)**	(0.023)	(0.006)	**(0.065)**	**(0.022)**
N younger brothers (alive)	0.932**	0.970**	0.768*	0.921**	**0.953****	**1.009+**	**0.823***	**1.067****
	(0.015)	(0.005)	(0.082)	(0.020)	**(0.016)**	**(0.005)**	**(0.082)**	**(0.024)**
N elder sisters (alive)	**0.863****	**0.961****	0.867+	0.986	0.936*	0.987*	0.782*	0.964
	(0.020)	**(0.006)**	(0.067)	(0.019)	(0.024)	(0.006)	(0.089)	(0.024)
N younger sisters (alive)	0.947**	1.001	1.005	1.081**	**0.932****	**0.977****	0.832	0.943*
	(0.015)	(0.005)	(0.088)	(0.020)	**(0.015)**	**(0.005)**	(0.094)	(0.023)
Born in urban environment (Yes)		0.806**		1.046		0.783**		0.986
		(0.013)		(0.053)		(0.014)		(0.058)
Maternal Loss	0.977	1.077**	1.181	1.290**	1.023	0.994	1.370*	1.025
	(0.033)	(0.015)	(0.158)	(0.058)	(0.036)	(0.014)	(0.174)	(0.048)
Paternal Loss	1.017	1.112**	1.456**	1.283**	0.971	1.031*	1.484**	1.129**
	(0.033)	(0.015)	(0.175)	(0.050)	(0.034)	(0.014)	(0.185)	(0.045)
Paternal Age (Ref: 20-30)								
<20	0.322+	0.856	0.862	0.724	0.522	0.935	0.234	0.531+
	(0.186)	(0.117)	(1.223)	(0.181)	(0.302)	(0.152)	(0.256)	(0.177)
30-40	1.050	0.888**	0.976	1.037	0.930	0.828**	0.915	1.009
	(0.050)	(0.014)	(0.101)	(0.034)	(0.045)	(0.014)	(0.097)	(0.036)
40-50	1.032	0.863**	0.987	1.119*	0.775**	0.768**	0.893	1.138*
	(0.072)	(0.020)	(0.163)	(0.063)	(0.058)	(0.018)	(0.155)	(0.069)
50-60	1.161	0.837**	1.351	1.168+	0.660*	0.732**	0.600	1.284*
	(0.169)	(0.030)	(0.459)	(0.103)	(0.116)	(0.029)	(0.215)	(0.125)
>60	1.425	0.829*	2.072e+12	0.982	1.025	0.673**	2.244e+12	1.480*
	(1.011)	(0.078)	(2.738e+18)	(0.175)	(0.595)	(0.069)	(2.989e+18)	(0.286)
unknown	1.014	0.839**	1.044	1.000	0.949	0.795**	1.828	1.000
	(0.046)	(0.039)	(0.386)	(0.000)	(0.045)	(0.041)	(0.867)	(0.000)

Table 5 cont.: Waiting time to marriage, Persons born and married in the Krummhörn region(1720-1824) and Quebec (1670-1799), Cox Proportional Hazard Model (with and without fixed effects)

Sex	Women	Women	Women	Women	Men	Men	Men	Men
Model	1	2	3	4	5	6	7	8
Age	15+	15+	15+	15+	15+	15+	15+	15+
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Maternal Age (Ref: 20-30)								
<20	0.847	1.193**	0.521+	1.184**	1.267	1.047+	1.060	1.081
	(0.159)	(0.031)	(0.181)	(0.054)	(0.263)	(0.029)	(0.398)	(0.053)
30-35	0.921+	0.933**	1.020	0.981	0.990	0.986	1.013	1.037
	(0.046)	(0.016)	(0.099)	(0.031)	(0.051)	(0.018)	(0.101)	(0.035)
35-45	0.894+	0.954*	0.867	1.031	0.979	1.021	1.003	1.140*
	(0.054)	(0.021)	(0.111)	(0.051)	(0.062)	(0.024)	(0.135)	(0.060)
>45	0.822	0.980	0.820	1.137	1.272	1.090	0.909	1.239
	(0.217)	(0.076)	(0.430)	(0.141)	(0.398)	(0.092)	(0.429)	(0.176)
unknown	0.990	0.972	2.011+	1.000	0.991	0.988	0.709	1.000
	(0.041)	(0.081)	(0.806)	(0.000)	(0.044)	(0.093)	(0.309)	(0.000)
Birth cohort (decades)	1.064**	1.019**	1.117	1.027	1.093**	1.036**	1.031	1.010
	(0.007)	(0.003)	(0.097)	(0.028)	(0.007)	(0.003)	(0.092)	(0.030)
Birth Rank (ascending order)	1.032**	1.019**	1.000	1.002	1.007	1.034**	0.994	1.002
	(0.012)	(0.004)	(0.046)	(0.010)	(0.013)	(0.004)	(0.050)	(0.011)
Family fixed effects	N	N	Y	Y	N	N	Y	Y
N IDs (aged 15 and over)	6,989	34,625	6,989	34,625	7,003	32,098	7,003	32,098
N marriages	4,266	30,671	4,266	30,671	3,839	27,498	3,839	27,498
Observations	21,454	98,802	21,454	98,802	22,770	114,702	22,770	114,702

Standard errors in parentheses

** p<0.01, * p<0.05, + p<0.1

Table 6: Number of children born, Persons born and married in the Krummhörn region(1720-1824) and Quebec (1670-1799), Poisson Regression model (with and without fixed effects)

Sex	Girls	Girls	Girls	Girls	Boys	Boys	Boys	Boys
Model	1	2	3	4	5	6	7	8
Age	15+	15+	15+	15+	15+	15+	15+	15+
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Dependent Variable	N births	N births	N births	N births	N births	N births	N births	N births
Variables								
N brothers at birth (alive)	0.971*	1.010**	0.946+	1.002	0.997	1.006+	0.926**	0.972**
	(0.012)	(0.003)	(0.028)	(0.006)	(0.013)	(0.003)	(0.025)	(0.005)
N sisters at birth (alive)	0.978+	1.001	0.973	0.980**	1.013	1.015**	0.938+	1.017**
	(0.012)	(0.003)	(0.024)	(0.005)	(0.013)	(0.003)	(0.032)	(0.006)
N brothers at 15 (alive)	1.002	1.017**	0.986	0.980+	1.017*	1.013**	0.959	0.889**
	(0.008)	(0.003)	(0.036)	(0.011)	(0.008)	(0.003)	(0.028)	(0.009)
N sisters at 15 (alive)	1.006	1.022**	0.870**	0.834**	1.002	1.021**	0.995	1.028*
	(0.008)	(0.003)	(0.023)	(0.009)	(0.008)	(0.003)	(0.041)	(0.013)
Paternal Age (Ref: 20-30)								
<20	0.829	0.979	1.465	0.989	0.762	0.922	1.161	0.985
	(0.166)	(0.049)	(0.794)	(0.076)	(0.191)	(0.052)	(0.804)	(0.095)
30-40	0.841	0.952**	1.435	1.010	0.829	0.952**	1.230	0.952**
	(0.169)	(0.006)	(0.777)	(0.011)	(0.208)	(0.006)	(0.849)	(0.011)
40-50	0.793	0.935**	1.310	1.023	0.776	0.926**	1.278	0.914**
	(0.161)	(0.008)	(0.715)	(0.019)	(0.196)	(0.008)	(0.888)	(0.018)
50-60	0.950	0.902**	1.318	1.030	0.861	0.939**	1.056	0.899**
	(0.201)	(0.013)	(0.739)	(0.030)	(0.226)	(0.013)	(0.749)	(0.027)
>60	1.000	0.951	5.788	1.054	0.638	0.873**	2609108.432	0.873*
	(0.389)	(0.033)	(7.131)	(0.062)	(0.257)	(0.033)	(1.868e+09)	(0.054)
unknown	0.807	0.917**	1.253	1.000	0.790	0.867**	0.861	1.000
	(0.162)	(0.016)	(0.704)	(0.000)	(0.198)	(0.017)	(0.625)	(0.000)

Table 6 cont.: Number of children born, Persons born and married in the Krummhörn region(1720-1824) and Quebec (1670-1799), Poisson Regression model (with and without fixed effects)

Sex	Girls	Girls	Girls	Girls	Boys	Boys	Boys	Boys
Model	1	2	3	4	5	6	7	8
Age	15+	15+	15+	15+	15+	15+	15+	15+
Population	KH	QUE	KH	QUE	KH	QUE	KH	QUE
Dependent Variable	N births	N births	N births	N births	N births	N births	N births	N births
Maternal Age (Ref: 20-30)								
<20	1.282**	1.042**	1.335*	1.006	1.142	0.999	0.953	0.957**
	(0.118)	(0.010)	(0.193)	(0.014)	(0.125)	(0.010)	(0.181)	(0.014)
30-35	1.275**	0.970**	1.292+	0.992	1.199	0.975**	1.033	1.011
	(0.120)	(0.007)	(0.196)	(0.011)	(0.133)	(0.007)	(0.202)	(0.011)
35-45	1.162	0.954**	1.253	1.007	1.143	0.989	0.968	1.022
	(0.111)	(0.009)	(0.199)	(0.017)	(0.129)	(0.009)	(0.196)	(0.017)
>45	1.397*	0.916*	1.281	0.986	0.839	0.758**	0.647	0.779**
	(0.215)	(0.032)	(0.337)	(0.045)	(0.174)	(0.031)	(0.211)	(0.041)
unknown	1.212*	0.867**	1.379	1.000	1.130	0.902**	0.874	1.000
	(0.112)	(0.029)	(0.299)	(0.000)	(0.125)	(0.032)	(0.249)	(0.000)
Birth cohort (decades)	0.976**	0.998	1.046	1.005	0.980**	0.997**	0.911*	1.007
	(0.003)	(0.001)	(0.039)	(0.009)	(0.003)	(0.001)	(0.034)	(0.009)
Birth Rank (ascending order)	1.010	1.004**	0.972+	0.993*	0.994	1.002	1.042*	1.004
	(0.007)	(0.002)	(0.017)	(0.003)	(0.007)	(0.002)	(0.020)	(0.003)
Constant	295.696**	8.968**			185.320**	12.921**		
	(163.690)	(1.671)			(112.208)	(2.453)		
Family fixed effects	N	N	Y	Y	N	N	Y	Y
Observations	4,704	26,274	2,889	22,321	4,089	22,994	2,393	19,077
Number of families			1,175	6,919			987	6,145

Standard errors in parentheses

** p<0.01, * p<0.05, + p<0.1