THE EFFECT OF INBREEDING ON LONGEVITY, FERTILITY AND DISABILITY

Erling Häggström Lundevaller & Lotta Vikström

Department of Historical, Philosophical and Religious Studies | Centre for Demographic and Ageing Research (CEDAR) | Umeå University, Sweden

Background

In the Skellefteå region in northern Sweden, cousin marriages were common. In 1750 the national prevalence of marriages between first cousins was estimated at 0.2% while in Skellefteå it was 0.34%. In early 19th century the national prevalence was 1% and in Skellefteå around 1.3%, and from the mid 19th century it had reached 1.5% for Sweden while Skellefteå had 2.65%. This makes Skellefteå an interesting case to study if there are any effects of inbreeding. This study aims at assessing these effects on mortality, fertility and disability.

Laws and rules against marriage between relatives have existed in Sweden since at least the Middle ages. During the 1170's all marriages between individuals who were related at sixth cousins or closer were forbidden. This changed in 1215 when up to fourth cousins could marry. In 1680 the law was changed so that up to second cousins were allowed to marry. The king could however give an exemption and then cousins could also marry. In 1845 marriages between cousins were legalized.

Data and sample

Digitized parish registers stored at the Demographic Data Base (DDB) at Umeå University, Sweden, based on original records of birth and baptism, marriage, migration, death and burial, and annual catechetical examination records from the 18th to 20th century. Everybody born in the Skellefteå region 1890-1910 is followed until death or censoring. For the fertility and disability study they have to be observable until the age of 45. Life length (birth date to death date), fertility (number of children) and disability (impairment notes in the registers) are the outcome variables. Inbreeding coefficient is calculated using parish registers back to the 18th century. The inbreeding is classified in the groups shown in Table 1 and used as explanatory variable:

Table 1. Inbreeding groups with number of people.

Inbreeding	Men	Women	
0	6606	6192	Inbreeding coefficient is 0, there is no relation between parents.
1	2175	2061	Inbreeding coefficient is in the interval 0 < F < 1/256, parents are related but not third cousins or closer.
2	765	726	Inbreeding coefficient is in the interval 1/256 ≤ F < 1/64, parents are third cousins up to second cousins.
3	590	501	Inbreeding coefficient is in the interval 1/64 ≤ F < 1/16. Parents are second cousins up to first cousins.
4	386	328	Inbreeding coefficient is in the interval 1/16 ≤ F, parents are cousins or more closely related.

Methods

- Life length is analyzed with Kaplan-Meier curves and Cox regression (not shown).
- Stillbirths are analyzed with logistic regression.
- Number of children is analyzed with Poisson regression.
- Disability is analyzed with logistic regression.

Results

- Life length is significantly lower for men of inbreeding class 3 and 4 and for the women of inbreeding class 4 (Figures 2-3). It is significant in a Cox regression (not shown).
- Inbreeding increases the risk of stillbirths (Figure 4).
- Second cousins have more children (Figure 5), inbreed fathers (Figure 6) have less children in group 4 and women show a decreasing number of children as inbreeding increases (Figure 7).
- There is a tendency, although insignificant, that higher inbreeding causes increased risk of disability (Figure 8).

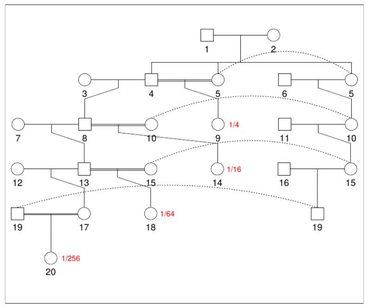

Figure 1: In this pedigree individuals 9, 14, 18 and 20 are inbred on different levels: 9's parents are siblings, 14's parents are first cousins, 18's parents are second cousins and 20's parents are third cousins. All other children have unrelated parents. Dotted lines connect the same individual, i.e. the individual is present in two places in the figure. Squares are men while circles are women.

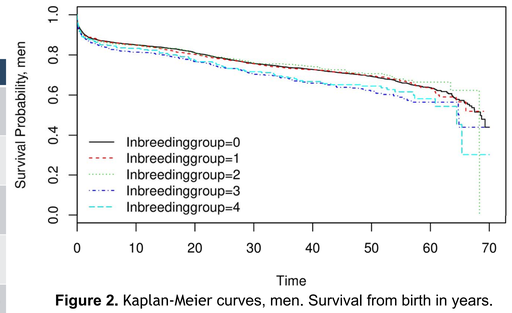

Figure 2. Kaplan-Meier curves, men. Survival from birth in years.

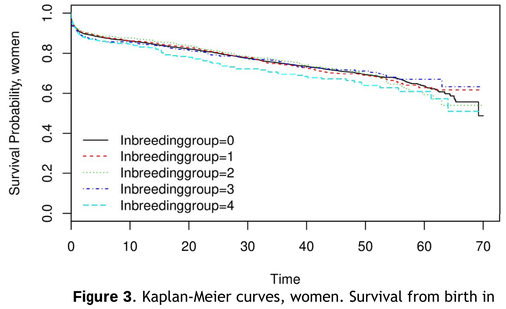

Figure 3. Kaplan-Meier curves, women. Survival from birth in years.

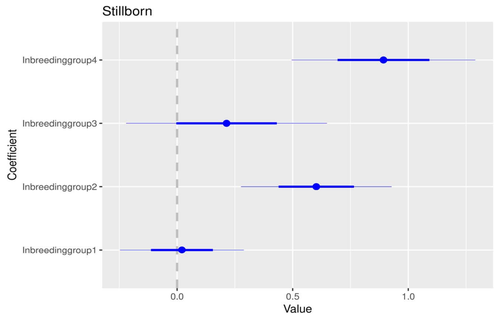

Figure 4. Parameter estimates form a logistic regression of risk of stillbirth based on children's inbreed group. Bandwidth one (thick) and two (thin) standard deviations. Positive values indicate higher risk.

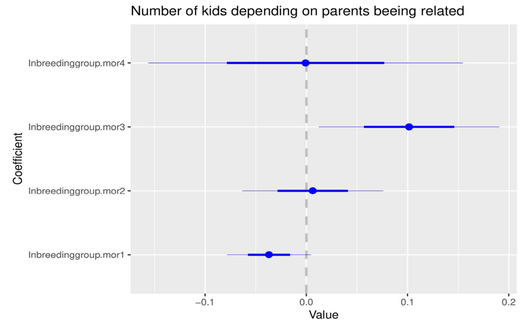

Figure 5. Parameter estimates form a Poisson regression of number of children based on parents being related. Bandwidth one (thick) and two (thin) standard deviations. Positive values indicate more children.

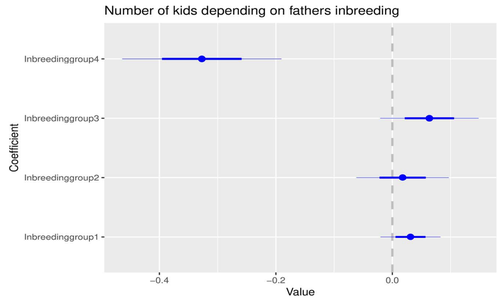

Figure 6. Parameter estimates form a Poisson regression of number of children based on fathers' inbreeding factor. Bandwidth one (thick) and two (thin) standard deviations. Positive values indicate more children.

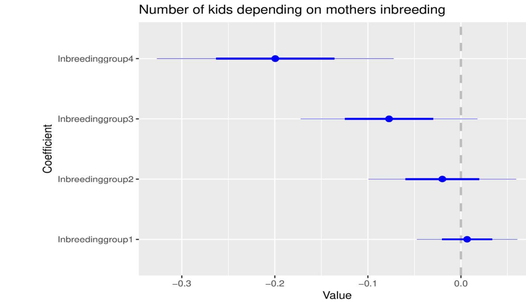

Figure 7. Parameter estimates form a Poisson regression of number of children based on mothers' inbreeding factor. Bandwidth one (thick) and two (thin) standard deviations. Positive values indicate more children.

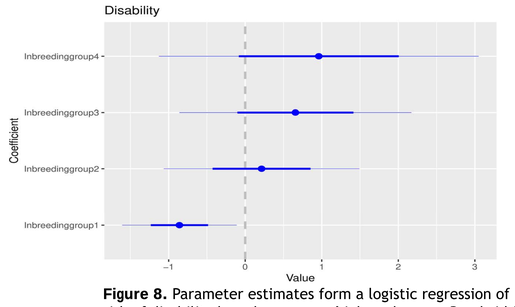

Figure 8. Parameter estimates form a logistic regression of risk of disability based on persons' inbreed group. Bandwidth one (thick) and two (thin) standard deviations. Positive values indicate higher risk.

Selected references

Bittles, A. and I. Egerbladh. The influence of past endogamy and consanguinity on genetic disorders in northern Sweden. *Annals of human genetics* (2005): 69 (5).

Ballou, J. D. "Calculating inbreeding coefficients from pedigrees." *Genetics and Conservation: A Reference for Managing Wild Animal and Plant Populations. Menlo Park, California: Benjamin/Cummings* (1983): 509-520.

Helgason, Agnar, et al. "An association between the kinship and fertility of human couples." *Science* 319.5864 (2008): 813-816.

European Research Council
Established by the European Commission
Supporting top researchers from anywhere in the world

UMEÅ UNIVERSITY

DISLIFE *Liveable disabilities: Life courses and opportunity structures across time*

This study is part of a project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant Agreement No. 647125), ERC Consolidator Grant, Prof. Lotta Vikström, Umeå University.

Contacts:
Erling Häggström Lundevaller, Dr. in Statistics (Erling.Lundevaller@umu.se)
Lotta Vikström, Prof. of History & PI of the DISLIFE project (Lotta.Vikstrom@umu.se)