UiT The Arctic University of Norway

A long shadow of mild shocks on health:

The intergenerational perspective on the fetal origins hypothesis

Evidence from the 18th- and 19th-century Southern Norway

Emre Sari
UiT The Arctic University of Norway, ***School of Business & Economics***

Mikko Moilanen
UiT The Arctic University of Norway, ***School of Business & Economics***

Hilde Leikny Sommerseth
UiT The Arctic University of Norway, ***Department of Archaeology, History, Religious Studies and Theology***

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01	INTRODUCTION	•What is the problem we analyzed in this study? •Where is Rendalen?
02	LITERATURE REVIEW	•What insight is offered into intergenerational health persistence phenomena?
03	DATA	•How do we combine historical data and create the dataset for the study?
04	METHODOLOGY	•What method did we use to analyze?
05	RESULTS	•What are the results and explanations of key findings?
06	CONCLUSION	•Summarizing our thoughts and conveying the broader significance of the study
07	Q&A	•Please feel free to share your comments & questions on this study.
08	APPENDIX	

- In this paper, we examine
  - whether the effects of *in utero* exposure to **mild maternal economic shocks** have a negative influence on a child's later-life health,
  - and whether these adverse impacts persist across multiple generations.

- Our findings indicate that the health effects of *in utero* exposure to **mild maternal shocks can be transferred through generations.**

- **As a contribution to the current literature,**

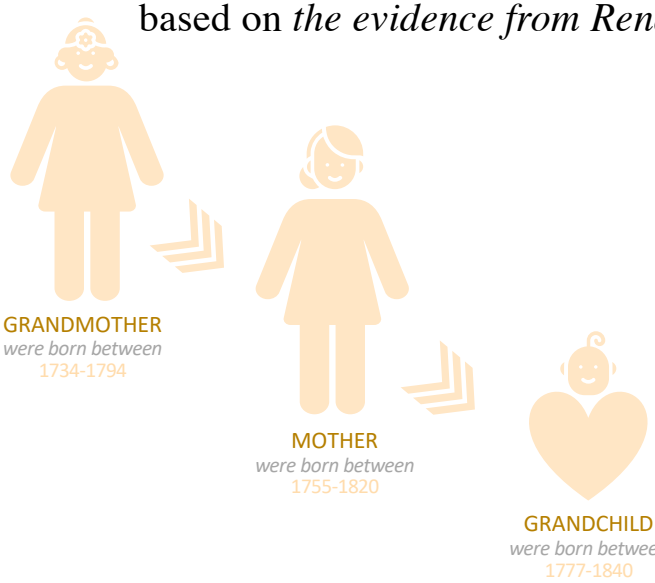
  - these findings have important implications in the intergenerational perspective of the fetal origins hypothesis to *understand how mild shocks can be influential for health in later life*.

- *We have used individual-level three-generation microdata on people born between 1734 and 1840, in the municipality of Rendalen in Southeast Norway.*

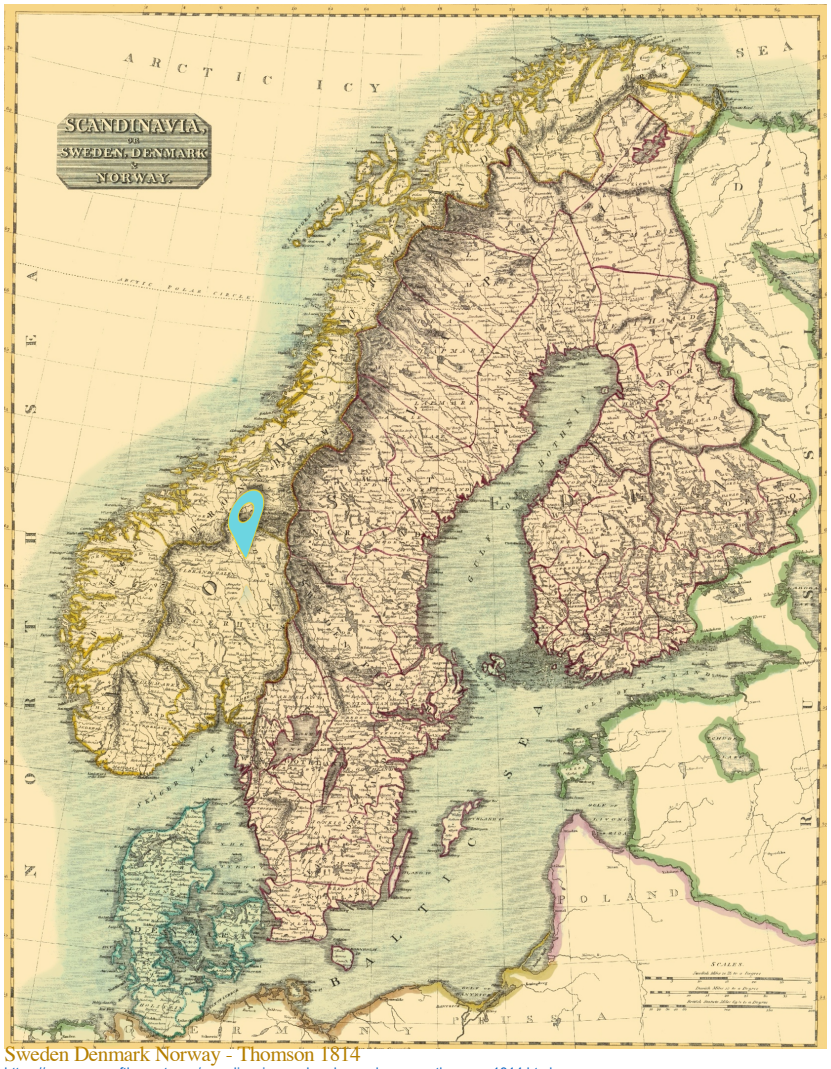
What are the underlying mechanisms behind the multigenerational persistence in health?

- Our primary motivation is to shed light on a better understanding of the causal mechanisms of intergenerational health transfer.

- This paper aims to provide a historical overview of health transfer through three consecutive generations, based on *the evidence from Rendalen over 1734-1840*.



Health Outcome ←→ Age of death



Sweden Denmark Norway - Thomson 1814
https://www.mapsofthepast.com/scandinavia-sweden-denmark-norway-thomson-1814.html

A brief history of Rendalen and Norway - *18th and 19th centuries*

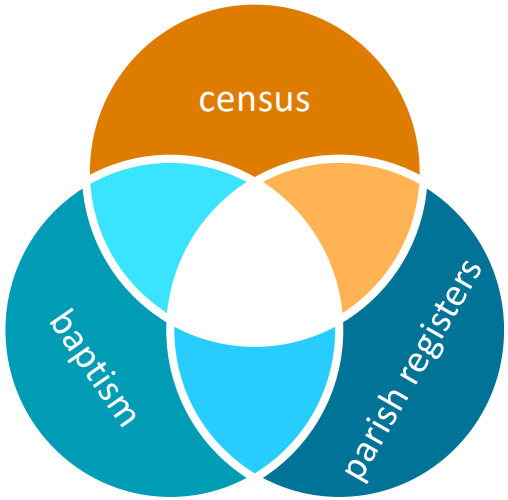
- Rendalen is a municipality in the county of Innlandet, near Sweden's southern border (Norway).
- The primary sources of income for the residents of the parish are agriculture and logging.
- Rendalen has a favorable geographical position and adequate resources (Sogner et al., 2002).
- One of the advantages of the Rendalen historical data is the simplicity of the exogenous conditions within the time frame.

Barker, (1990) believed that socioeconomic status in early childhood may be the basis of serious health problems in later years.

Case et al. (2002) draw attention to *the positive correlation between* the fetal-origins hypothesis and adult health and economic conditions.

Quaranta et al. (2017) underline that families with high infant mortality among siblings in one generation were more likely to experience **a higher risk of infant death in the next generation**, and this phenomenon has remarkable similarities irrespective of different environments, such as *geography*, *climate*, *mortality levels and religion*.

Almond et al. (2018) have probably the most comprehensive systematic analysis of the fetal-origins hypothesis to define human capital and shows how it was produced in early childhood under a comprehensive conceptual framework.

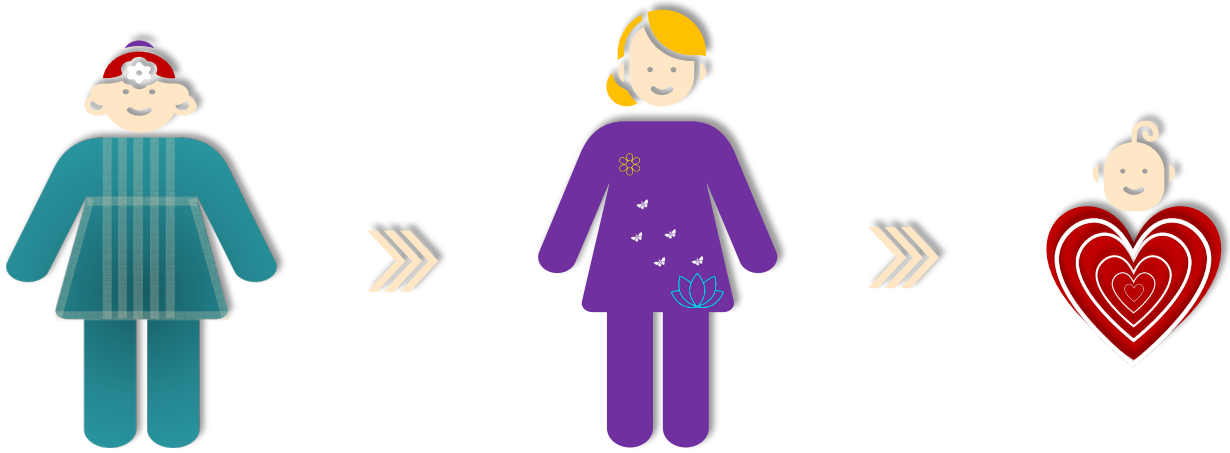


	# of observations	# of dropped observations	% of dropped observations
3 Gen. Linked Data	4,230		
Before cut-off	1,239	2,991	71%
After cut-off	658	581	84%

- The data set for this study was formed from a longitudinal data set created by linking the censuses (1801, 1865, 1875, 1900 and 1910), parish registers, baptism and cadastral records that are covering the period between 1733-1925 in Rendalen; *all those data obtained from the Norwegian Historical Data Center*[1] (NHDC, 2019).

- To study multigenerational persistence in health, we have constructed a three-generation linked dataset that includes 4,230 children with parents and grandparents. And, we proceeded this linkage through the mother's line to merge the three generations together, in order to minimize data loss and keep a comprehensiveness of the data set.

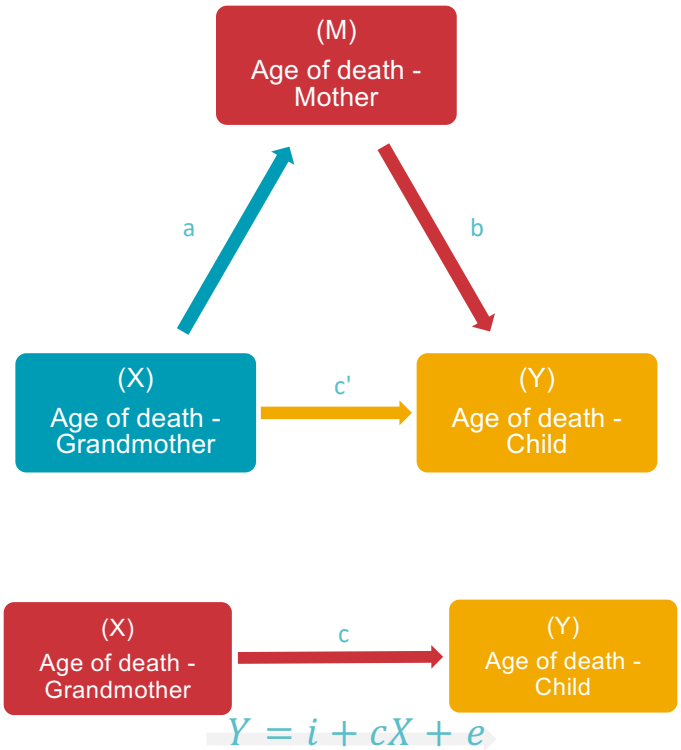
1 https://www.rhd.uit.no/



GRANDMOTHER
were born between
1734-1794

MOTHER
were born between
1755-1820

GRANDCHILD
were born between
1777-1840



Causal Mediation Analysis

- $Y = i_2 + c'X + bM + e_2$
- $M = i_3 + aX + e_3$
- $Y = i_2 + bi_3 + (c' + ab)X + e_2 + e_3$

Variable description and summary statistics.

		Mean	Standard Deviation	Min	Max
Health					
1st generation's health	*Grandchild's age of death - (H1)*	58.938	26.465	1.08	101.51
2nd generation's health	*Mother's age of death - (H2)*	70.890	14.389	18.08	96.09
3rd generation's health	*Grandmother's age of death - (H3)*	72.440	14.106	32.75	97.47
Gender	*Grandchild's gender - (Gen)*	0.453	0.498	0	1
Macro Conditions					
Economic stress & access to nutrition based on the **grandchild's birth year**	*Economic stress - If the general prices go up, it is positive (1), and conversely negative (0) - (Eco1)*	0.643	0.479	0	1
	Access to nutrition - From best (1) to worst condition (7) - (Sum1)	4.319	1.522	1	7
Economic stress & access to nutrition based on the **mother's birth year**	*Economic stress - If the general prices go up, it is positive (1), and conversely negative (0) - (Eco2)*	0.660	0.474	0	1
	Access to nutrition - From best (1) to worst condition (7) - (Sum1)	4.672	1.419	2	7
Socioeconomic Conditions					
Occupation (high (0) / low (1))	*Grandchild - (Occ1)*	0.672	0.470	0	1
	Mother - (Occ2)	0.628	0.484	0	1
	Grandmother - (Occ3)	0.732	0.443	0	1
Illegitimate (0) / legitimate (1)	*Grandchild - (Ill1)*	0.103	0.305	0	1
	Mother - (Ill2)	0.040	0.197	0	1

Note: Described are the mean, standard deviation, minimum and maximum of each variable with detailed descriptions. Changes in general prices between 1736 and 1840 are based on the general consumer price index, which is calculated by the Central Bank of Norway. The access to nutrition covers the period between 1749 – 1835. The occupational classification was made according to HISCLASS. Those whose occupational classification is between 1 and 8 have been included in the higher status.

Results of the regression analysis of mediator and outcome models.

	Dependent variables		
	Mother's health (H2)	Grandchild's health (H1)	Grandchild's health (H1)
	(1)	(2)	(3)
Grandmother's health (H3)	0.152***	0.0001	-0.023
	(0.041)	(0.075)	(0.072)
Mother's health (H2)		0.174**	0.168**
		(0.071)	(0.068)
Economic stress around mother's birth (Eco2)	-3.259***	1.518	2.393
	(1.255)	(2.284)	(2.205)
Economic stress around grandchild's birth (Eco1)		-3.225	-3.659*
		(2.122)	(2.046)
Access to nutrition around mother's birth (Sum2)	0.852**	-0.554	-0.415
	(0.401)	(0.722)	(0.696)
Access to nutrition around grandchild's birth (Sum1)		0.260	0.377
		(0.681)	(0.657)
Occupation of the mother's family (Occ3)	0.009		
	(1.267)		
Occupation of the grandchild's family (Occ2)		-6.904***	1.885
		(2.206)	(2.461)
Grandchild's occupation (Occ1)			-17.371***
			(2.447)
Illegitimacy of mother (Ill2)	1.485	-3.851	-1.629
	(2.845)	(5.095)	(4.920)
Illegitimacy of grandchild (Ill1)		-14.880***	-12.316***
		(3.292)	(3.193)
Gender of a grandchild (Gen)		5.502***	7.056***
		(2.051)	(1.989)
Intercept	59.243***	66.685***	63.052***
	(4.135)	(11.276)	(10.880)
Observations	658	658	658
R^2	0.033	0.073	0.141
Adjusted R^2	0.024	0.058	0.125
Residual Std. Error	14.298 (df = 651)	25.689 (df = 646)	24.760 (df = 645)
F Statistic	3.648*** (df = 6; 651)	4.653*** (df = 11; 646)	8.791*** (df = 12; 645)

Note: Standard errors in parentheses. *p<0.1. **p<0.05. ***p<0.01.

Results of causal mediation analysis.

	Causal Mediation Models					
	Access to Nutrition		Economic Stress		Health	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
ACME [1]	-0.647	0.076*	-0.577	0.024*	0.025	0.024*
ADE [2]	3.600	0.336	2.320	0.264	-0.022	0.788
Total Effect	2.953	0.434	1.743	0.398	0.003	0.946
Prop. Mediated	-0.106	0.474	-0.171	0.422	0.100	0.942

Note: Observations for the access to nutrition is 419 for 0 (best climatic conditions in summertime), and 239 for 1 (worst conditions). Observations for the economic stress is 227 for 0 (decrease in general prices), and 431 for 1 (increase). Sample size used: 658. Simulations: 1000. Quasi-Bayesian confidence intervals. *p<0.1. **p<0.05. ***p<0.01.

1 ACME: *Average Causal Mediation Effect*
2 ADE: *Average Direct Effect*

The present study investigated whether in utero exposure to mild grandmaternal shocks affected the health outcomes of their grandchildren. The significant findings are as follows:

- The fluctuations in the economy in the mother's early childhood may not only affect her health in later life but this is also indirectly transferred to the next generation.
- Poor access to nutrition during the grandmother's pregnancy to the mother has a significant negative impact on the grandchildren's health.

These findings have important implications in the intergenerational perspective of the fetal origins hypothesis to understand how mild shocks can be influential for health in later life. Furthermore, a greater focus on illegitimacy could produce interesting findings that account more for understanding mechanisms of transferring health outcomes through generations. Besides, broader and more modern data on intergenerational transmission would help us establish a higher degree of accuracy on this matter.

Highlights

- *In utero* exposure to mild economic shocks have intergenerational impacts on health
- Mild grandmaternal nutritional stress has a negative impact on grandchild's health
- Fetal origins hypothesis has been extended in terms of intergenerational effects

THANKS!

For further **questions** & **comments**

emre.sari@uit.no

inequal.org/home

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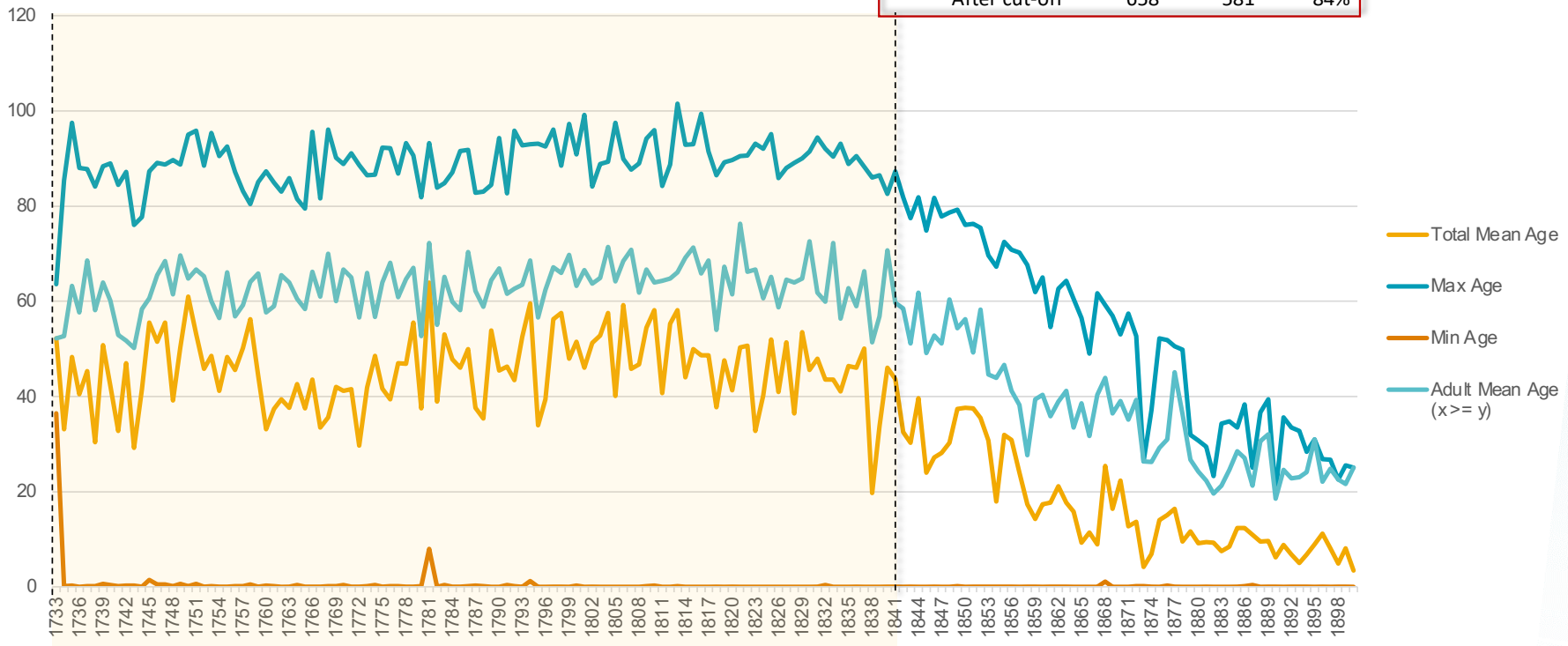
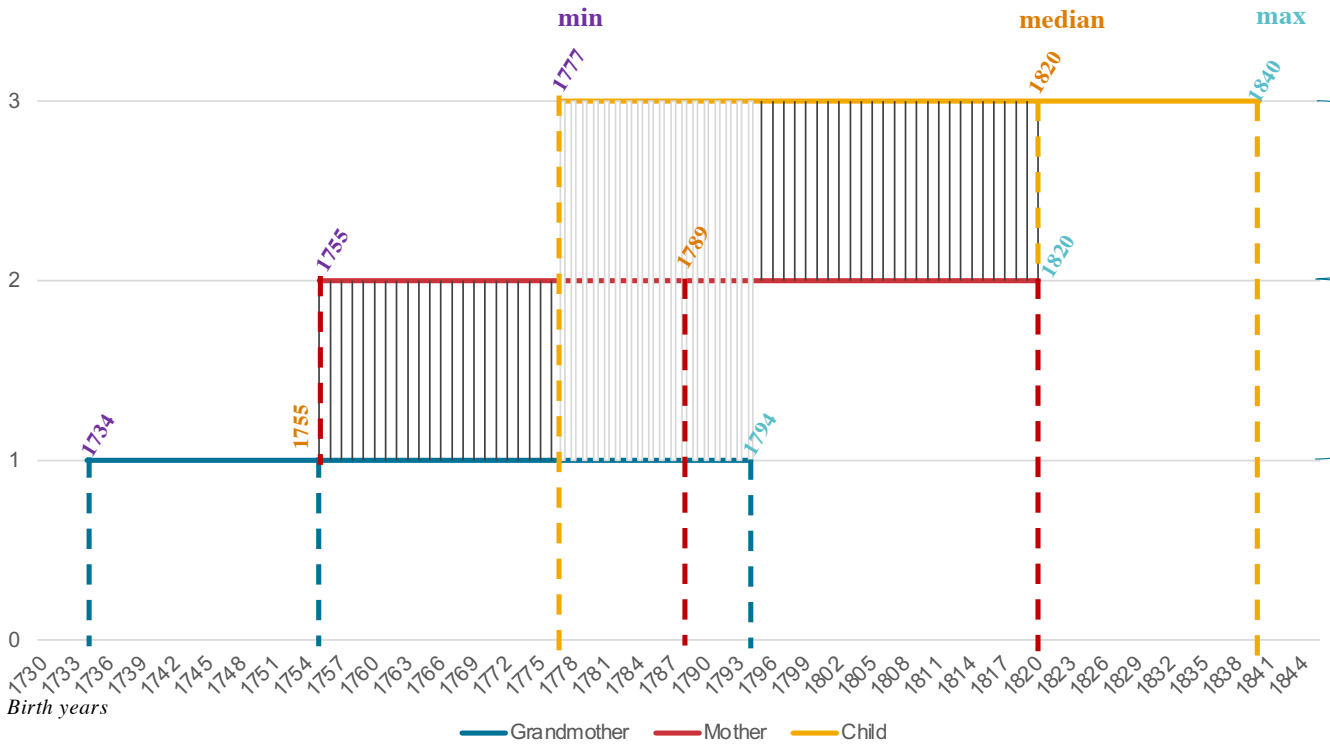




# of Observations

658 Grandchild

Mother / Grandchild
127 / 340

247 Mother

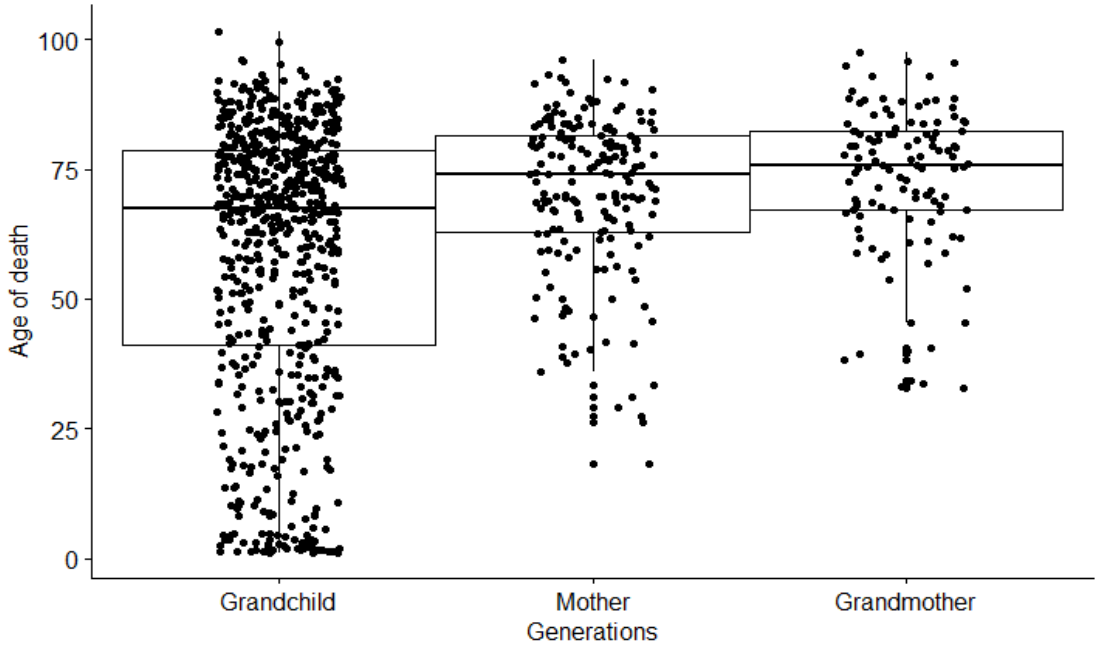
Grandchild / Mother
95 / 143

161 Grandmother

1066 Total

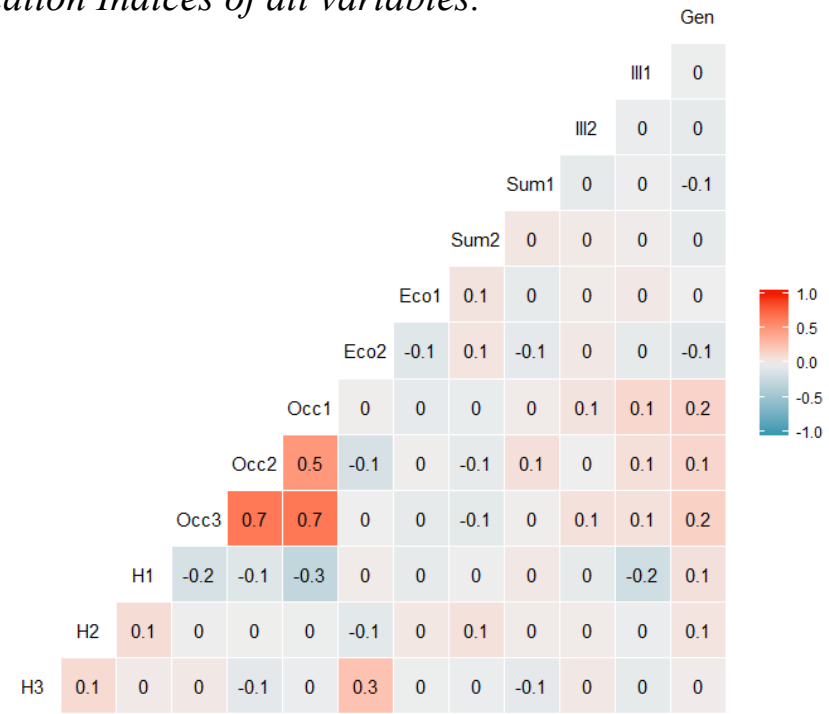
We did not include infants who died before the age of one year in order to eliminate the effect of deaths due to possible complications during delivery. As a result, we exclude the 84% observation in the three generation linked data set from our study.

The age of death distribution for three generations.



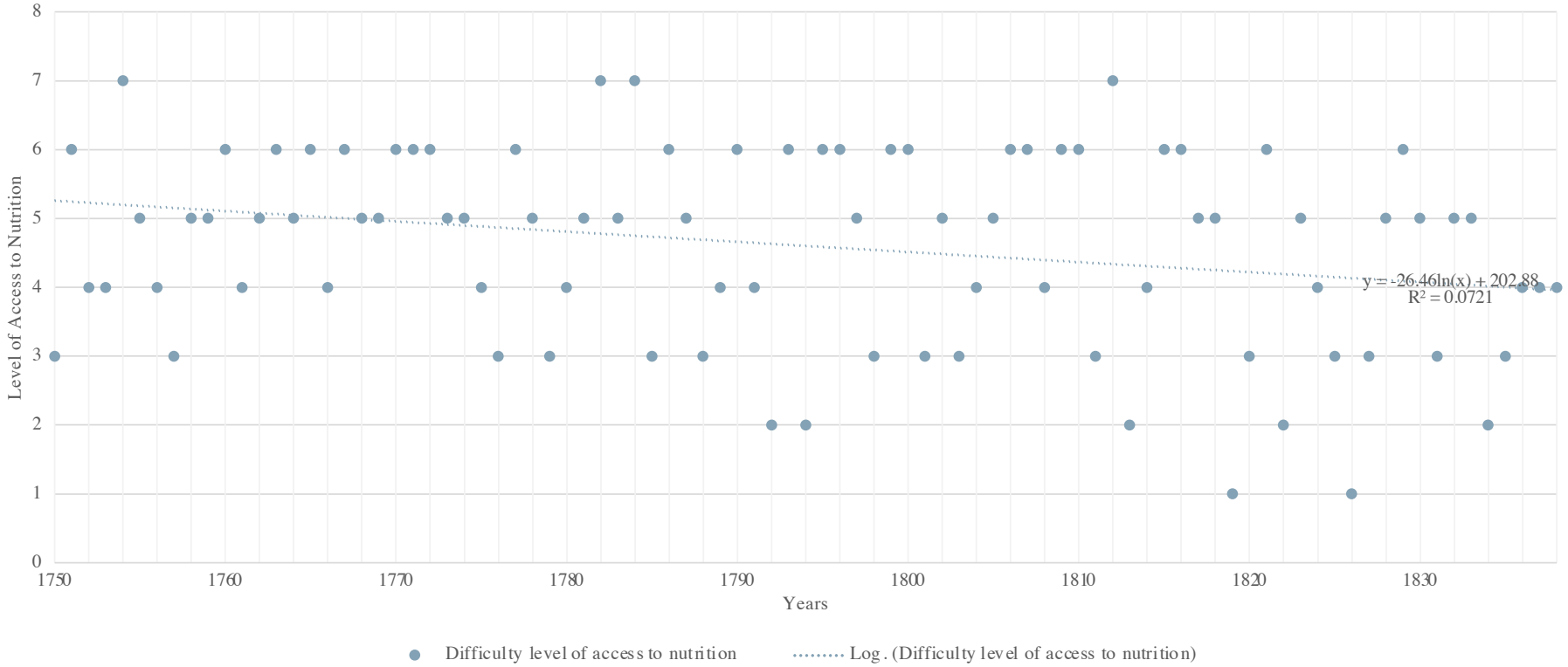
These boxplots show the age of death distributions for three consecutive generations based summaries on maximum, third quartile, median, first quartile and minimum from top to bottom, respectively. The difference in the median weights of the health outcomes of the mother and grandmother seems to be relatively close compared to the grandchildren. The reason for this is our data selection method, which we determine when establishing the family connection.

Correlation Indices of all variables.

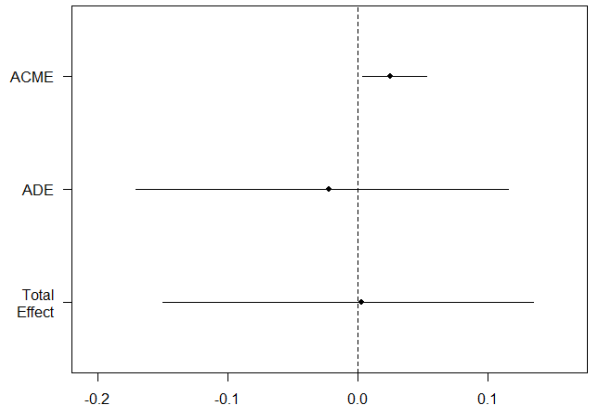


The figure presents the results of the correlation analysis. The darkness of the color indicates degrees of correlation from -1 to 1. The highest correlations are between occupational variables.

Access to nutrition.

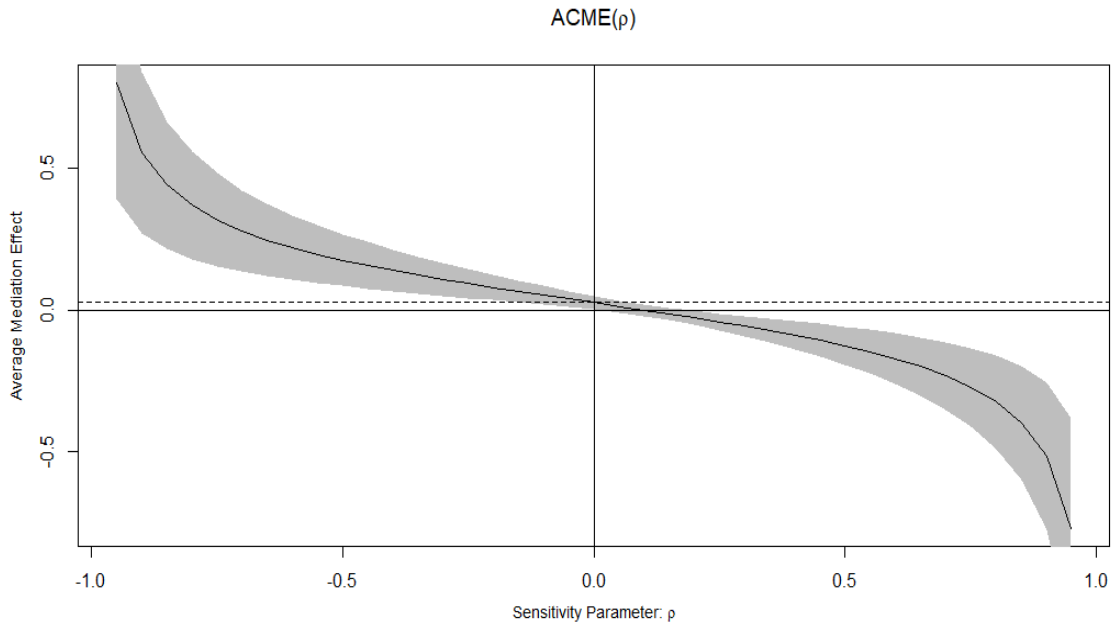


This graph is derived from the summertime climate index in Åker to categorize access to nutrition. The chart is indexed from easy (1) to hard (7) with respect to years. The level of access to nutrition has improved over the years, and this development can be observed in the logarithmic trend line, as well.



Graphical summary of the health outcome model, including grandchild SES. ACME is estimated to be 0.025 (ϱ<0.1), with a 95% confidence interval between 0.003 and 0.05.

Sensitivity analysis for the health outcome model, including grandchild SES



The graph illustrates the point by plotting the estimated ACME and its 95% confidence intervals. The solid line presents the estimated ACME at different values of p. The dashed line is drawn at the point estimate of the mediation effect for p=0. The gray region represents a 95% confidence interval for each value at each value of p (Imai, Keele, & Tingley, 2010).