Infant mortality in the Lutheran population of Tartu (Estonia) at the end of 19th century

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Abstract. Using Lutheran parish registers (1897-1900) linked to the micro-data of the 1st Russian census of 1897 in Tartu, this study compares the level of infant mortality among social and ethnic groups in the Lutheran population at the end of 19th century.. Previous studies based on aggregate data have shown rather early onset of demographic transition, in particular with regard to parity-specific fertility limitation in Estonia, however the national average IMR at the end of 19th century appears considerably higher than in other European countries with early demographic with early demographic transition. The findings of micro-level analysis indicate that ethnicity had a strong effect on child's survival prospects; children from the Baltic-German families having higher survival rates. In addition, paternal socio-economic characteristics were stronger predictors of infant deaths than mother's level of education or participation in the labor force. Furthermore, being born out-of-wedlock and poor water supplies had a negative effect.

1. Background

A secular decline in infant and child mortality has been acknowledged to have contributed significantly to the overall mortality decline in Western countries in the 18th-19th century. In a broader framework, the reduction of mortality is usually regarded as an essential starting point for the demographic transition (Cleland 2001; Reher 2004). Historical studies and evidence on developing countries have shown that a wide range of interrelated direct and indirect determinants shape the survival chances of children and furthermore, indicate that the levels of infant mortality and the web of causes behind its decline are complex, involving geographical and socio-economic factors, ethnic and cultural traditions, literacy and education,

the relative empowerment of women, public health policies and individual efforts (Masuy-Stroobant, 2006; Mosley and Chen, 1986; Wolleswinkel-van den Bosch, 2000; Edvinsson, Gardardsdottir and Thorvaldsen, 2008).

Previous studies on the topic have found that infant mortality is clustered within families, both for historical (European) populations and in contemporary less developed regions; most infant deaths tend to occur in a relatively small number of families (Lynch and Greenhouse, 1994; Edvinsson et al, 2005). Viewing this phenomenon of "death clustering" on a familial level and considering mother as "medium of infant mortality" her characteristics, including education, socio-economic position, income and childcare practices are all part of infants overall survival chances in their first year of life (Vandezande et al., 2010).

In the context of Princeton European Fertility Study, Estonia has been identified as one of the forerunners of demographic modernisation in Eastern Europe (Coale and Watkins, 1986) It has been estimated that the decline of marital fertility passed the 10% threshold in 1888, before any other country in the region (Coale, 1992). The mortality decline in the Baltic provinces of Estland and Livland (modern Estonia) started in the mid-19th century, with crude death rates declining from around 30‰ to 20‰ in the period from the 1860s to 1900 (Katus and Puur, 2004).

Estimates by Katus and Puur (1991, 2004) suggest that the national average infant mortality rate (IMR) for Estonia was close to 190‰ for boys and above 150‰ for girls in 1897 and by the early 1920s the levels had declined to 150‰ and 130‰ respectively. Figure 1 places the estimates for Estonia in context of other European countries during the demographic transition period, demonstrating the relationship between infant mortality ($_1q_0$) and child mortality ($_5q_0$), termed as the infant fraction (Robinson et al., 2010), and describing the changes in mortality over time. In comparison to European countries with early onset of demographic transition, the IMR at the end of century for Estonia was higher and the decline in infant and child mortality somewhat slower, while on the contrary Estonia had substantially lower IMR than other provinces in the Russian Empire and other Eastern European countries in the same period.

2. Focus of the Study and Research Questions

This study focuses on infant mortality among the Lutheran population of Tartu (Estonia) at the end of 19th century. Tartu — an old university town with ethnically and culturally mixed population — was rapidly increasing in the late 19th century, with the population doubling from around 20 000 in 1867 to 40 639 in 1897.

The paper has two objectives. First, to estimate the level of infant mortality among the population of Tartu at the 1897 census. Previous studies on aggregate data have shown rather early timing of demographic transition and thereby the mortality decline in Estonia, however the IMR at the end of 19th century is considerably higher than in countries with similar timing of transition. The second aim is to assess the effect of differences between various social and ethnic groups and the districts of the city, thereby providing an insight into factors shaping infant mortality:

- Parents' socio-economic status. Based on previous research, it is expected that higher social strata had a significant lowering effect on the level of infant mortality (Woods, 1988/89; Haines, 1995).
- Cultural-ethnic affiliation. Previous studies have reported significant variation in infant mortality across ethnic and cultural groups (Preston and Haines, 1991; Thornton and Olson, 1997). In the context of Tartu, it is expected that Baltic-Germans had significantly

lower level of infant mortality. However, it is not clear whether the difference persist, when controlling for socio-demographic characteristics.

- Mother's characteristics. Recent studies emphasize the role of women's education on infant survival (Masuy-Stroobant, 2006). Based on these findings, we expect a positive association between mother's education and new-born's survival chances.
- Sanitary conditions and water supply. Based on research on other settings (e.g. van Poppel and van der Heijden, 1997; Mercier and Boone, 2002), we expect to find higher levels of infant mortality in district with the bad sanitary conditions.

3. Data and Methods

This study draws on two types of archival data (Table 1), preserved in the Estonian Historical Archives (EHA). First, the collection of micro-data of the First Russian Imperial census, carried out on 28th of January in 1897, computerised in the late 1990s.[1] As the 1897 census provides this study with individual-level demographic, socio-economic, cultural, and other characteristics for the study population, it delimits the analysis to a relatively brief period of time. Second, the data on vital events were gathered from the parish registers of 4 Tartu's Lutheran parishes for the years surrounding the census (1896-1900). Unfortunately, the incomplete coverage of parish registers for other confessions (Orthodox, Jewish) did not allow to take them into consideration for the study.

In order to conduct the analysis of infant mortality among the Lutheran population in Tartu, a research dataset was constructed using nominative techniques and linking individual records from the census and from the city's parish registers. In addition to parents' demographic, cultural-ethnic, educational and housing characteristics; the 1897 census provides, through the information on primary and secondary occupations, the insight into the socio-economic structure in a Baltic city at the end of 19th century. To allow for comparisons with other settings, occupations are recoded into international historical classification of occupations – HISCO.[2]

Table 1. Data Sources

Data source	**Time period**	**Number of persons/events**
Census	1897	40 639
Lutheran parish registers:		
Baptisms	1897-1899	2 505
Burials:	1897-1900	3 209
❖ Infant deaths (0-1 year)	1897-1900	466
Marriages	1896-1900	1 281

The procedure of record-linkage consisted of two steps and foresaw i) the linkage of infant death records from 1897-1900 (n=466) to birth records from 1896-1899, and ii) the

[1] Berendsen, V., Maiste, M., 1999. Esimene ülevenemaaline rahvaloendus Tartus 28. Jaanuaril 1897. [The First Russian Imperial Census in Tartu on 28th of January, 1897]. Eesti Ajalooarhiiv.

[2] HISCO's compatibility with the International Labour Organisation's ISCO68 scheme will also make it possible to link historical and contemporary datasets.

linkage of 1896-1899 birth records to census records. The first step enabled the linkage of deceased infants to their birth records (successful linkage rate 89.5%) and their parents' information from birth records, whereas the second step enabled access to the characteristics of parents from the census (successful linkage rate 75.3%). In addition to the mentioned sources, parish marriage registers were used to confirm the linkage between mothers and fathers who were not married at time of the 1897 census. Families not found in the census (failure of linkage) are considered residents of surrounding parishes or in-migrants after the census, and are therefore censored from the analysis.

To investigate the effects of demographic, socio-economic and cultural characteristics on infant mortality, three cohorts of births (1897, 1898, and 1899) were followed through the first year of life and their survival chances were assessed individually, and in the family context. The study applied two statistical techniques, logistic regression and semi-parametric Cox proportional hazards model to estimate the association between the covariates and the occurrence of infant deaths (e.g. Kleinbaum and Klein, 1996, van Poppel et al., 2005).

The explanatory variables included sex of the child, mother's age, parity, ethnicity, maternal and paternal social status, education and the availability of drinking water. The same set of variables was used in logistic regression and Cox models. The statistical analysis was performed using the R programming language.

4. Preliminary results

The preliminary results of the present study suggest that in Tartu at the end of 19th century IMR for boys was close to 158‰ and 133‰ for girls, substantially lower than the national average. Table 2 reports the infant mortality rates by demographic, socio-economic and cultural characteristics and presents model estimates (odds ratios and hazard ratios for logistic and Cox regression respectively).

The findings suggest that ethnicity had a strong effect on new-born's survival prospects; children from the Baltic-German families had significantly higher survival rates than children born to Estonian families. Interestingly, the effect persists even after for controlling for socio-economic status of parents. Evidently, this reflects better living conditions of the Baltic-Germans, residing mainly in the central districts of the city with better sanitary conditions. The availability of water supply was another variable exerting a strong influence on infant mortality. The households which used the river as a main source of drinking water featured substantially lower survival rates. Finally, in line with previous studies, children born out-of-wedlock had considerably lower survival chances in the Lutheran population of Tartu alike.

While previous research on developing countries and historical populations has emphasized the importance of mothers as a "medium of infant mortality", the findings of this study indicate rather the importance of paternal education and social status on the survival chances of child during the first year of life. In line with the expectation, the survival rates were somewhat lower for the children whose father's had higher than primary education. Similarly, children whose fathers were employed in sales sector did much better than the children of day laborers.

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Sources of archival data

The First Russian Imperial Census of 1897 in Tartu

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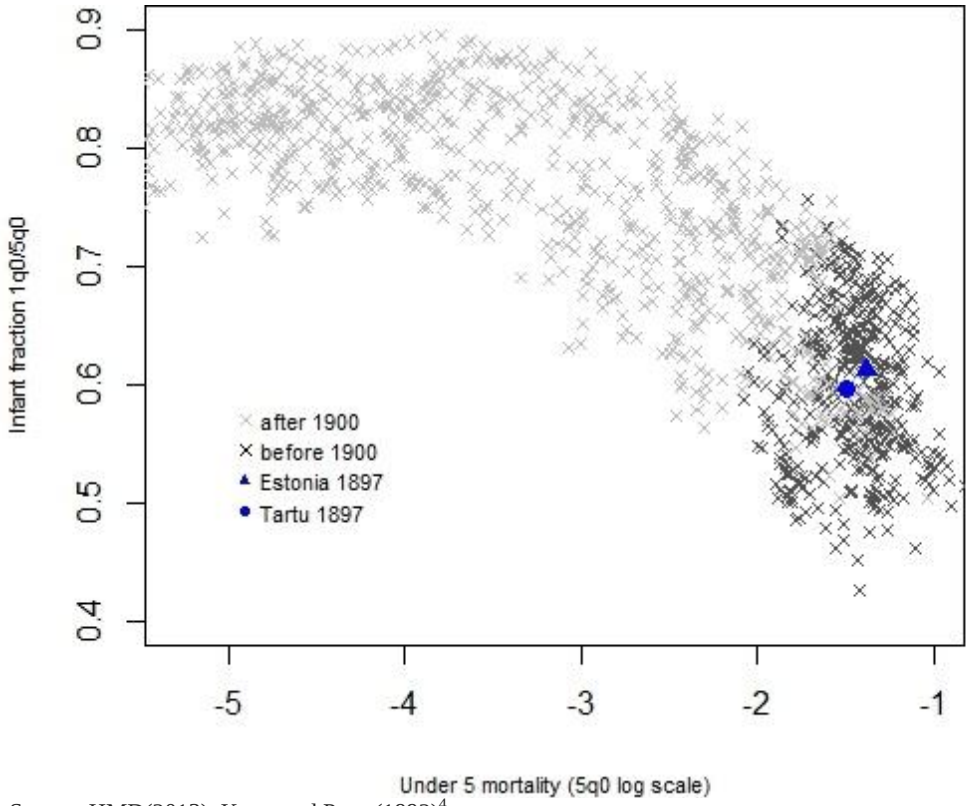
Tartu Maarja parish. EHA, F. 3148

University of Tartu parish. EHA, F. 1254

Tartu Peetri parish. EHA, F. 3150

Figure 1. The relationship between infant mortality (probability of dying before age one ($_1q_0$)) and child mortality (probability of dying before age five ($_5q_0$)) - the infant fraction; for some Nordic and Western-European countries (until 2000) and Estonia at the end of 19th century.[3]



Source: HMD(2013), Katus and Puur (1992)[4]

[3] Infant mortality fraction is a ratio of infant mortality ($_1q_0$) to under-five mortality ($_5q_0$), the latter calculated as $5q0 = 1 - [(1 - 1q0) * (1 - 4q1)]$. (Robinson et al. 2010)

[4] The estimates from a national average life-table calculated by Katus and Puur (1991), using the available data from the First Russian Imperial Census in 1897 and the estimates only for Tartu in the same year, are compared to the data from the Human Mortality Database (HMD) covering the period from 19th century until year 2000 and extracting the information from female period life tables. The 8 countries presented in the figure are four Nordic countries: Sweden (from 1835), Denmark (1835), Norway (1846) and Finland (1878) and four other European countries: France (1816), Belgium (1841), Netherlands (1850) and Italy (1872).

Table 2. Infant mortality rate and model estimates, Tartu 1897-1900.

	Infant mortality rate, per 1000 live births	95% confidence interval	Logistic regression, odds ratios		Cox regression, hazard ratio	
			Model 1	Model 2	Model 1	Model 2
Sex						
Male	158	(136-181)	1.000	1.000	1.000	1.000
Female	133	(112-154)	0.815 *	0.792 ’	0.825 ’	0.924
Illegitimacy						
Legitimate child	134	(119-150)	1.000	1.000	1.000	1.000
Illegitimate child	252	(189-315)	2.171***	3.825***	2.002 ***	3.217 ***
Maternal age at birth						
15-24	145	(102-187)	1.133	1.152	1.065	1.058
25-34	130	(107-152)	1.000	1.000	1.000	1.000
35+	172	(137-207)	1.391 *	1.262	1.415*	1.261
Parity						
1	125	(97-158)	1.000	1.000	1.000	1.000
2	138	(105-172)	1.097	1.311	1.230	1.503*
3	138	(100-176)	1.090	1.275	0.999	1.196
4	162	(110-215)	1.322	1.349	1.502*	1.555’
5+	182	(129-235)	1.520*	1.861*	1.618*	1.932’
Ethnic group						
Estonian	152	(136-169)	1.000	1.000	1.000	1.000
Baltic-German	107	(72-142)	0.666*	0.500’	0.686*	0.537’
Maternal education						
Primary	144	(126-162)	1.000	1.000	1.000	1.000
Secondary	123	(61-185)	0.835	1.145	0.846	1.102
Maternal labor force						
No occupation	147	(129-164)	1.000	1.000	1.000	1.000
Occupation	144	(113-175)	0.977	0.757	0.980	0.780
Paternal education						
Primary	150	(129-170)	1.000	1.000	1.000	1.000
Secondary	68	(21-116)	0.417*	0.460	0.438*	0.495
Socio-economic group						
Professional	114	(49-179)	0.746	0.867	0.771	0.856
Sales	104	(64-144)	0.671’	0.607’	0.690’	0.623’
Production	147	(112-180)	0.992	0.978	0.980	0.971
Day laborers	147	(119-175)	1.000	1.000	1.000	1.000
Not active	157	(48-265)	1.076	1.675	1.076	1.583
Water supply						
Well	154	(126-182)	1.000	1.000	1.000	1.000
River	353	(153-553)	2.995**	3.031 **	2.444 **	2.314 **
No mention	118	(92-143)	0.733 *	0.749 ’	0.746 *	0.749 *
No of observations			1882	1882	1882	1882
No of infant deaths			314	314	314	314

Note 1: Model 1 is not adjusted for control variables; model 2 is adjusted for same set of explanatory variables for both logistic and Cox regressioon.
Note 2: *** at p<.000; ** at p<.001; * p<.05; ’ p<.1