Infant Mortality Differentials in Tartu (Estonia): Social and Environmental factors, 1897-1900

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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 & Chen, 1986; Wolleswinkel-van den Bosch, 2000; Edvinsson, Gardardsdottir & Thorvaldsen, 2008).

Previous studies suggest that the demographic transition in Estonia followed the model according to which mortality and fertility declined, to a large extent, simultaneously (Katus & Puur, 1991, 1992; Katus, Sakkeus, Puur, & Põldma, 2000; Katus, 1994). The existing studies on the demographic transition period in Estonia have mainly focused on fertility decline and the timing of the modernization process. The Princeton European Fertility Project identified Estonia among the forerunners in the fertility transition in Europe, exhibiting an early emergence of parity-specific family limitation.(Coale, Anderson, & Härm, 1979; Watkins & Coale, 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 & 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 (see below) 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 40 636 in 1897.

The aim of the paper is to assess the effect of differences between various social and ethnic groups, environmental factors 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 & van der Heijden, 1997; Mercier & Boone, 2002), we expect to find higher levels of infant mortality in districts with the worst sanitary (access to water) 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. The computerised micro-data of the census provides rich information on demographic, cultural-ethnic, educational, socio-economic and housing characteristics, enabling insight into a Baltic city at the end of the 19th century. To allow for comparisons with other settings, occupations are recoded into international historical classification of occupations – HISCO.[2]

[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.

Table 1. Data Sources

Data source	Time period	Number of persons/events
Census	1897	40 636
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 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%). The linkage procedure was followed by linking individual records by names and all additional information available (year of birth or age, information about the spouse or parents etc.). This enables the combining of the characteristics of new-born and parents' characteristics irrespective of the data source in which they were originally recorded. In addition to the mentioned sources, parish marriage registers were used to establish the link between mothers and fathers who were not married at time of the 1897 census but married after the census.

To investigate the effects of demographic, socio-economic, cultural and environmental 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 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).

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 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 (see below) reports overall descriptive statistics and the infant mortality rates by demographic, socio-economic and cultural characteristics and presents model estimates.

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 labourers.

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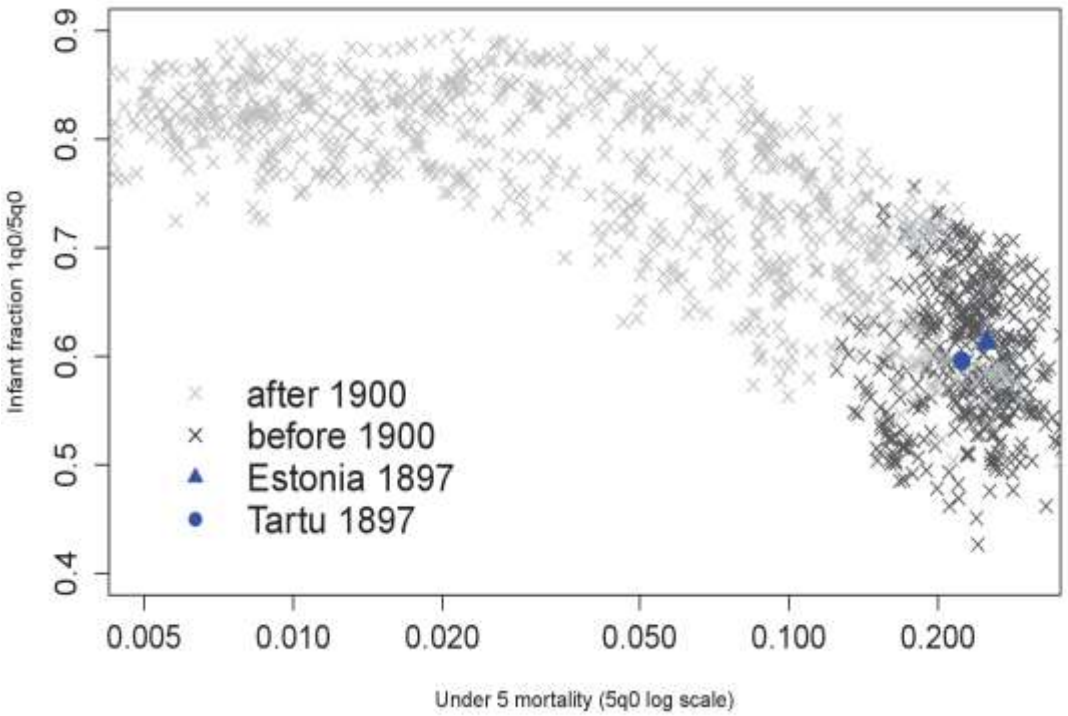
University of Tartu parish. EHA, F. 1254
Tartu St. Peter's (Peetri) parish. EHA, F. 3150

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.

	No. of live births	No. of infant deaths	IMR (per 1000 live births)	IMR 95% confidence interval	Cox regression, hazard ratios			
					Model 1		Model 2	
Sex of infant								
Male	1243	197	158	(136-181)	1.00		1.00	
Female	1202	160	133	(112-154)	0.82	*	0.81	
Mother's characteristics								
Marital status								
Married	2203	181	134	(119-150)	1.00		1.00	
Non-married	242	61	252	(189-315)	3.11	***	3.26	***
Age at birth								
15-24	304	44	145	(102-187)	1.07		1.07	
25-34	993	129	130	(107-152)	1.00		1.00	
35+	529	91	172	(137-207)	1.27		1.18	
Parity								
1	532	68	125	(97-158)	1.00		1.00	
2	462	64	138	(105-172)	1.42	*	1.28	
3	363	50	138	(100-176)	1.43	*	1.23	
4	228	37	162	(110-215)	1.49	*	1.34	
5+	247	45	182	(129-235)	1.79	***	1.73	**
Cultural characteristics								
Ethnic affiliation								
Estonian	2108	321	152	(136-169)	1.00		1.00	
Baltic-German	337	36	107	(72-142)	0.69	**	0.73	
Socio-economic characteristics								
Maternal education								
Primary	1690	243	144	(126-162)	1.00		1.00	
Secondary/higher	122	15	123	(61-185)	1.76		1.93	’
Maternal employment								
Non-employed	1861	273	147	(129-164)	1.00		1.00	
Employed	584	84	144	(113-175)	1.00		0.81	
Paternal education								
Primary	1342	201	150	(129-170)	1.00		1.00	
Secondary/higher	117	8	68	(21-116)	0.38	**	0.42	*
Paternal occupation								
Professional	105	12	114	(49-179)	0.72		0.78	
Sales	250	26	104	(64-144)	0.61	*	0.64	*
Production	492	72	147	(112-180)	1.05		0.98	
Day laborers	726	107	147	(119-175)	1.00		1.00	
Non-employed	51	8	157	(48-265)	1.38		1.46	
Sanitary conditions								
Water supply								
Well	753	116	154	(126-182)	1.00		1.00	
River	34	12	353	(153-553)	2.44	***	2.32	***
Not stated	696	82	118	(92-143)	0.76	**	0.74	**
No of observations					1826		1826	
No of infant deaths					264		264	
Log-likelihood							-1923.82	
Degrees of freedom							21	
AIC of p-value							0.000	

* Model 1 is not adjusted for control variables; model 2 is adjusted for same set of control (control variables include all covariates listed in the table). Statistical significance levels: *** at p<0.001; ** at p<0.01; * p<0.05; ‘ p<0.1