Ajalooline Ajakiri, 2014, 2/3 (148/149), 139–172

# Infant mortality in the Lutheran population of Tartu at the end of the nineteenth century

Hannaliis Jaadla, Martin Klesment

ABSTRACT

Using parish registers (1897–1900), linked to the first Russian Imperial census of 1897, this study investigates infant mortality among the Lutheran population in Tartu at the end of the nineteenth century. The results reveal considerable variation in infant mortality according to parents' demographic, cultural and socio-economic characteristics, and sanitary conditions. Even after controlling for the influence of socio-economic status, infants born to Baltic-German families had higher survival rates than those born to Estonian families. This lends support to the view of the Baltic-Germans as the forerunners of demographic modernization in Estonia. Paternal socio-economic characteristics appeared stronger predictors of infant deaths than mother's level of education and employment. Lower infant mortality was characteristic of infants whose fathers were employed in professional and sales occupations. Being born out-of-wedlock, into large families and belonging to households that acquired drinking water from the river exerted a strong negative effect on infant survival.

*Keywords*: infant mortality, Lutherans, parish registers, 1897 census, linked-record study, urban population, Estonia

A secular decline in infant and child mortality[1] contributed significantly to overall mortality decline in Europe during the late eighteenth and nineteenth centuries. The reduction in mortality was an essential part of the transition to modern demographic regime that (with only a few exceptions) preceded the decline in fertility in the nineteenth century. Declines in child

This project has received support from the Estonian Ministry of Education and Science under the research theme SF0130018s11 and grant no. 8904 of the Estonian Science Foundation. We would like to thank Allan Puur and Ridhi Kashyap for valuable comments and feedback on the research.

[1] Infant mortality refers to deaths of children during the first year of life while child mortality refers to deaths between the ages of one and five years. This study focuses only on infant mortality.

http://dx.doi.org/10.12697/AA.2014.2-3.01

mortality occurred earliest in this transition process, usually a couple of decades before the onset of infant mortality declines; geographically the reduction in infant mortality began in the 1860s in Northern and Western Europe.[2] These gains in the initial stages of the mortality transition were mostly achieved by "means of rudimentary and inexpensive technologies" but made an important contribution to the demographic modernization in Europe over the course of the nineteenth century, by directly contributing to the rise in life-expectancy and having indirect, although to some extent debatable implications on fertility decline.[3]

Previous studies suggest that the demographic transition in Estonia followed the model, according to which mortality and fertility declined to a large extent simultaneously.[4] 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.[5]

Mortality patterns in Estonia during the demographic transition have received comparatively less scholarly attention. Kalev Katus and Allan

[2] John Cleland, "The effects of improved survival on fertility: a reassessment", *Population and Development Review*, 27 (2001), 60–92.

[3] David S. Reher, "The demographic transition revisited as a global process", *Population, Space and Place*, 10:1 (2004), 19–41; Samuel H. Preston, "Introduction", *The effects of infant and child mortality on fertility*, ed. by Samuel H. Preston (New York: Academic Press, 1978); Robert I. Woods, Patricia A. Watterson and John H. Woodward, "The causes of rapid infant mortality decline in England and Wales, 1861–1921, part I", *Population Studies*, 42:3 (1988), 343–366; Robert I. Woods, Patricia A. Watterson and John H. Woodward, "The causes of rapid infant mortality decline in England and Wales, 1861–1921, part II", *Population Studies*, 43:1 (1989), 113–132.

[4] Kalev Katus *et al.*, "Demographic development of Estonian population: recent changes in the context of the long-term trends", *New demographic faces of Europe* (Springer, 2000), 125–140. More about the demographic transition in Estonia: Kalev Katus, Allan Puur and Asta Põldma, *Eesti põlvkondlik rahvastikuareng* (Tallinn: Eesti Kõrgkoolidevaheline Demouuringute Keskus, 2002), 22–50; Kalev Katus and Allan Puur, "Eesti rahvastiku suremusest elutabelite analüüsi põhjal", *Akadeemia*, 12 (1991), 2516–2549; Kalev Katus, "Sündimus ja selle piirkondlikud erisused Eestis demograafilise ülemineku jooksul," *Akadeemia*, 1 and 2 (1992), 134–149, 365–585; Kalev Katus, "Fertility transition in Estonia, Latvia and Lithuania", *Demographic trends and patterns in the Soviet Union before 1991*, ed. by Wolfgang Lutz *et al.* (London and New York: Routledge, 1994), 89–111.

[5] Ansley J. Coale, Barbara A. Anderson and Erna Härm, *Human fertility in Russia since the nineteenth century* (Princeton: Princeton University Press, 1979); *The decline of fertility in Europe*, ed. by Susan Cotts Watkins and Ansley J. Coale (Princeton: Princeton University Press, 1986).

Puur[6] have provided a series of crude death rates since the late eighteenth century and life-table estimates for census years from 1897 onwards. As regards infant mortality in the period of demographic modernization, however, the evidence is even more limited. Life-table estimates from 1897 to the 1930s suggest that the decline in infant mortality in Estonia lagged behind that in Northern and Western Europe over the same period.[7] Official statistics of infant mortality are unavailable for the period before the Independence of Estonia in 1918 and the formation of the Central Bureau of Statistics in 1921. Therefore, the official time series of infant mortality rates are only available from 1922.[8] Among the few studies on earlier periods, Herbert Ligi has investigated the regional mortality patterns in Estonia in the eighteenth and nineteenth centuries using aggregated data on infant and child mortality (between age 1–15 years) from a sample of parish registers for every county of Estonia.[9] While Ligi's study highlights geographical variation in infant and child mortality, it does not provide insight into the micro-level factors of infant and child mortality in Estonia.

The present study complements the existing research by analyzing infant mortality in urban population of Tartu at the end of the nineteenth century (the peak period of the demographic transition). The aim of the study is to estimate the overall level of infant mortality among the Lutheran population of Tartu and examine its variation related to demographic, socioeconomic and cultural characteristics. The data sources used in the study are the Lutheran parish baptism and burial registers (1897–1900) and the records of the first Russian Imperial census of 1897 for Tartu. The data from the two sources are linked on the individual level and analyzed employing multivariate logistic and Cox proportion hazards models.

The article consists of seven sections. Following the introduction, the second section provides a concise overview of Tartu in the late nineteenth century. The third section presents findings pertaining to mortality development in Estonia and Tartu, based on earlier studies. The fourth section discusses the main factors which are reported to influence infant mortality

6 Katus and Puur, "Eesti rahvastiku suremusest"; Kalev Katus and Allan Puur, *Life tables: Estonia 1923–1938 and 1950–2000* (Tallinn: Eesti Kõrgkoolidevaheline Demouuringute Keskus, 2004).

7 Katus and Puur, "Eesti rahvastiku suremusest"; Katus and Puur, *Life tables.*

8 *Sündivus, surevus, abielluvus ja rahvaliikumine: 1921–1923*, Eesti Demograafia, vihk II (Tallinn: Riigi Statistika Keskbüroo, 1925), 36–37.

9 Herbert Ligi, *Infant and child mortality geography in Estonia in the 18th–19th centuries* [article manuscript, 1990(?)], University of Tartu Library, Manuscripts collection, f. 146, s. 56.

in the context of demographic transition. The fifth section briefly introduces the data sources and analytical methods. The sixth section presents the results and the concluding section includes a summary and introduction of the findings.

## *The context: Tartu – a university town in the late nineteenth century*

At the end of the nineteenth century the University of Tartu was an important driver of the modernization process and the overall social and cultural development of the town. Unlike other larger towns in the Baltic Governorates, industrialization in Tartu was relatively modest. Tartu did not develop into a major industrial centre with a substantial part of the population being factory workers; rather the town was influenced by the high concentration of scholars and intellectuals connected to the university. Economically Tartu found itself still dependent on merchants and artisans.[10]

In the second half of the nineteenth century modernization brought along widespread and rather rapid urbanization in the Baltic Governorates. The urban proportion of the total population in Estonia increased to 19.2% in 1897 from 8.7% at the beginning of the 1860s.[11] Reflecting these trends, the population of Tartu increased from 20,494 in 1867 to 40,636 at the end of the century (1897 census). The rapid growth is reflected in the composition of the population with 3/4 of the residents being first-generation urban inhabitants.[12] The size of Tartu and its position in the region placed the town as a regional centre for the rural population of South Estonia and further, the surrounding smaller towns formed a closely integrated urban settlement system around Tartu.[13]

The principal source of urbanization was the in-migration of rural population from the surrounding countryside. An important catalyst of migration was the passport law introduced in 1863 that granted the population of the Baltic Governorates the freedom of movement, which permitted unrestricted settlement not only within the Governorates but also to any

---

[10] Hillar Palamets, "19. sajand", *Tartu: ajalugu ja kultuurilugu*, ed. by Heivi Pullerits (Ilmamaa, 2005), 65–72 (69).

[11] Toivo U. Raun, *Estonia and the Estonians* (Hoover Press, 2001), 73.

[12] Veiko Berendsen and Margus Maiste, *Esimene ülevenemaaline rahvaloendus Tartus: 28. jaanuaril 1897* (Tartu: Eesti Ajalooarhiiv, 1999).

[13] Edgar Kant, *Bevölkerung und Lebensraum Estlands* (Tartu: Akadeemiline kooperatiiv, 1935), 171.

part of the Russian Empire.[14] In the process of modernization, geographical mobility enabled social mobility for rural to urban migrants through change of occupation and rise in their social status.[15]

As a result of large-scale in-migration from rural areas, the ethnic composition of Tartu, and similarly in other Estonian towns, underwent significant changes during the second half of the nineteenth century. The proportion of Baltic Germans declined from 35.2% in 1881[16] to 15.9% in 1897; while at the same time both the Estonian and Russian urban populations were increasing both in relative and absolute numbers.[17] Nevertheless, the Baltic Germans retained their position at top of the society in Tartu, even after the urbanization and Estonianization of the urban environment. The strong majority of the urban elite – nobility, literati, industrialists, and large merchants – continued to be Baltic German, leading the work in municipal government, university and in the economic sector.[18]

Compared to magistrates of other larger towns in the Baltic area, in particular Riga and Tallinn, the Tartu municipal government was rather slow to carry out technical and sanitary improvements in the urban environment. The initiative for reforms and re-development often arose from the University, which built a modern water supply system in 1889 and installed electricity in 1894. In contrast, in the town the modern water supply and sewer system was installed only in the 1930s, whereas electricity was set up earlier in 1911.[19]

[14] Raun, *Estonia and the Estonians*, 71–74.

[15] Ea Jansen, *Eestlane muutuvas ajas: seisusühiskonnast kodanikuühiskonda* (Tartu: Eesti Ajalooarhiiv, 2007), 116.

[16] At the end of the eighteenth century the number of Baltic-Germans and Estonians in Tartu was at similar levels. This balance was still prevailing in 1867 when the first census in the cities of the Governorate of Livland was conducted. At that time 42% of the total population were Baltic-Germans and 46% Estonians.

[17] Veiko Berendsen and Margus Maiste, "Rahvastik", *Tartu: ajalugu ja kultuurilugu*, ed. by Heivi Pullerits (Ilmamaa, 2005), 107–144 (128).

[18] Raun, *Estonia and the Estonians*, 73.

[19] Lea Leppik, *Tartu Ülikooli teenistujate sotsiaalne mobiilsus 1802–1918*, Dissertationes historiae Universitatis Tartuensis, 11 (Tartu: Tartu Ülikool, 2006), 86; Ken Kalling, "Kolehärra ja Tartu teadlased: joogivee mikrobioloogilistest uuringutest Tartus 19. sajandi lõpul", *Tartu Ülikooli ajaloo küsimusi*, 41 (2013), 163–180; Lea Leppik, "Jaama pudrett ehk miks Tartu sai veevärgi nii hilja", *Tartu Ülikooli ajaloo küsimusi*, 41 (2013), 181–203.

## *Previous studies on mortality in Estonia and in Tartu in the nineteenth century*

The onset of demographic modernization is one of the fundamental issues in historical demography. Katus and Puur have assessed that the persistent mortality decline in the Baltic region started around the mid-nineteenth century, with crude death rates (CDR) decreasing from around 30‰ to 20‰ in the period from the 1860s to 1900.[20] The estimates for Tartu by Veiko Berendsen and Margus Maiste demonstrated a similar trend but somewhat higher levels. The fairly high CDR of over 40‰ in 1848–55 (influenced by several cholera epidemics) decreased continuously from the 1860s onwards to less than 25‰ in 1897.[21]

At large, previous studies in historical demography in Estonia have mainly relied on aggregate data from soul revisions, parish registers or early censuses.[22] The few exceptions have been Heldur Palli's family reconstitution studies carried out in three parishes in Estonia (Rõuge, Karuse, Otepää) but these studies focus on the period before the nineteenth century.[23] The demographic transition in Estonia, in particular the early phases of it, has been analyzed in two studies applying similar methodology. First, in his pioneering study, Swedish demographer and statistician Hannes Hyrenius employed the family reconstitution technique, which made an important methodological contribution to the development of historical demography.[24] Hyrenius investigated the Swedish minority population in six local parishes in Estonia (1840–1937); the demographic processes addressed by Hyrenius included child mortality.[25]

20 Katus and Puur, *Life tables*, 33–35.
21 Berendsen and Maiste, *Esimene ülevenemaaline rahvaloendus Tartus*, 227.
22 Mats Nõges, *Rahwamuutused Wiljandi maakonnas 1801.–1923. a.= Bevölkerungsbewegung im Kreise Fellin in Jahren 1801–1923: demograafiline töö* (Tartu ülikool, 1925); Raimo Pullat, *Eesti linnad ja linlased: XVIII sajandi lõpust 1917. aastani* (Eesti Raamat, 1972); Sulev Vahtre, *Eestimaa talurahvas hingeloenduste andmeil (1782–1858): ajaloolis-demograafiline uurimus* (Eesti Raamat, 1973); Lemming Rootsmäe, *Nakkushaigused surma põhjustena Eestis 1711–1850* (Tallinn, 1987); Ligi, *Infant and child mortality geography;* Raimo Pullat, *Eesti linnarahvastik 18. sajandil* (Tallinn: Olion, 1992); Anto Laarmaa, *Rahvastiku loomulik liikumine Tartumaal 1800–1899 (luteri ja õigeusu kirikumeetrikate andmetel)*, MA thesis (Tartu ülikool, 2009).
23 Heldur Palli, "Rõuge rahvas XVII sajandi teisel poolel", *Ajaloolise demograafia probleeme Eestis*, ed. by Heldur Palli (Tallinn: Valgus, 1973), 63–127; Heldur Palli, *Lääne-Eesti rahvastiku struktuur ja taastootmine: Karuse 1685–1799* (Eesti Raamat, 1984); Heldur Palli, *Otepää rahvastik aastail 1716–1799* (Eesti Raamat, 1988).
24 Etienne Gautier and Louis Henry, *La population de Crulai, paroisse normande: étude historique* (Paris: Presses universitaires de France, 1958).
25 Hannes Hyrenius, *Estlands svenskarna: demografiska studier* (CWK Gleerup: [C. Bloms boktryk.], 1942).

In a more recent study, Alexey Shpenev[26] performed family reconstitution and analyzed demographic development, including infant and child mortality, in the Orthodox and Lutheran parishes on the island of Muhu (1762–1900) taking advantage of state-of-the-art statistical techniques and survival analysis. Shpenev's findings indicate a certain reduction in infant mortality in the second half of the nineteenth century.[27]

*Table 1.* Infant mortality rates (per 1000 live births) during the nineteenth century in Tartu and Estonia

| | 1834–59 | 1860–81 |
|---|---|---|
| Tartu*: | | |
| German parishes | 141 | 140 |
| Estonian parishes (urban) | 228 | 225 |
| Estonian parishes (rural) | 202 | 179 |
| Estonia** | 170 | — |

* Infant mortality rates for Tartu are calculated from data available from two medical dissertations by Felix Huebner (1861) and Otto Grosset (1883). The main data sources for their study were parish registers for Tartu. The records for German congregations came from St. John's, St. Mary's, University's and from the Catholic parish; for Estonian urban congregations from St. Mary's and St. Peter's (after 1860) and for the Estonian rural congregation from St. Mary's. In broad terms, the distinction between Estonian urban and rural parishes allows to compare demographic patterns among urban and rural residents.
** Herbert Ligi's manuscript on infant and child mortality in Estonia in the eighteenth and nineteenth century presents infant mortality estimates for various parishes in Estonia covering all counties in both Estland and Livland. Ligi's material allows the calculation of the average IMR for Estonia for the period 1820–49.

Another important source of information on mortality dynamics before the twentieth century in the Governorates of Estland and Livland are the studies by the so-called Tartu School of Biostatistics in Tartu University (1860–86), under the supervision of medical professor Bernhard Körber (1837–1917). The research of biostatisticians drew on the parish registers' data on baptisms, burials and marriages for various cities and rural communities. The biostatisticians focused on medical statistics of hygiene, sanitation, seasonality and causes of death, with less interest in overall population dynamics and structure. The work of Felix Huebner and Otto

26 Alekseĭ Shpenev, *Vliyanie sotsial'nȳkh seteĭ na demograficheskie protsessȳ v doperekhodnom naselenii* (Moskva: Natsional'nȳĭ issledovatel'skiĭ universitet "Vȳsshaya shkola ěkonomiki", 2013).
27 Shpenev, *Vliyanie sotsial'nȳkh seteĭ*, 73–74.

Grosset reported infant mortality rates (IMR) in Tartu from 1834 to 1859 and 1860 to 1881 (see Table 1).[28]

The results by Huebner and Grosset indicate that Estonian urban parishes in Tartu had a higher and rather stable IMR in 1834–59 and 1860–81, while the IMR for the Estonian rural parishes declined in the latter period. The parish register data for Tartu indicated substantially lower IMRs for Baltic Germans than for Estonians. Ligi highlighted significant regional differences in IMRs in Estonia, with lower IMRs in Western Estonia and higher IMRs in Eastern Estonia.[29] According to Ligi, Tartu and the rural counties surrounding it had one of the highest IMRs in Estonia in the first half of the nineteenth century.

The parish register data for Tartu, gathered by Herbert Ligi,[30] allows us to construct the trend of IMR in St. Mary's parish in Tartu from the 1830s onwards until the beginning of the twentieth century (Figure 1). The data reveal a rather similar, high level of IMR in the beginning of the observation period; the IMRs being even around 250. The comparison of Ligi's data on rural and urban congregations in St. Mary's parish indicates higher infant mortality for the urban population. In the 1830s–50s, the IMR for the urban congregation was on average 11% higher than the rural IMR; in the 1860s–80s, the urban disadvantage increased to 25% on average. This is evidence of a strengthening urban disadvantage in infant mortality that corroborates the results by Huebner and Grosset.

The estimates for the late nineteenth century by Katus and Puur suggest that the national average IMR for Estonia was close to 190‰ for boys and above 150‰ for girls (1897).[31] By the early 1920s the levels had declined to 150‰ and 130‰ respectively. Figure 2 places the estimates for Estonia in the context a selection of European countries during the period of demographic transition.[32] The comparison reveals that among the selected

28 Felix Huebner, *Biostatik der Stadt Dorpat und ihrer Landgemeinde in den Jahren 1834–1859* (Dorpat, 1861); Otto Grosset, *Biostatik der Stadt Dorpat und ihrer Landgemeinde in den Jahren 1860–1881* (Dorpat, 1883).

29 Ligi, *Infant and child mortality geography in Estonia*.

30 Herbert Ligi, *Statistilised andmed Tartumaa elanike abielude, sündide ja surmade kohta; laste suremuse algandmed 18.–19. sajandil*. Arhiiviväljakirjutuste põhjal koostatud tabelid (1990), University of Tartu Library, Manuscripts collection, f. 146, s. 56.

31 Kalev Katus and Allan Puur, *Eesti rahvastiku suremustrend elutabelite analüüsi põhjal*, Rahvastiku-uuringud, Series B, no. 14 (Tallinn: Eesti Kõrgkoolidevaheline Demouuringute Keskus, 1992), 18.

32 The estimates from a national average life-table calculated by Katus and Puur (1991 & 1992), using the available data from the First Russian Imperial Census in 1897, are compared to the data from the Human Mortality Database (HMD) covering the period from 1840 to 1920. The 8 countries presented in the figure are four Nordic countries:

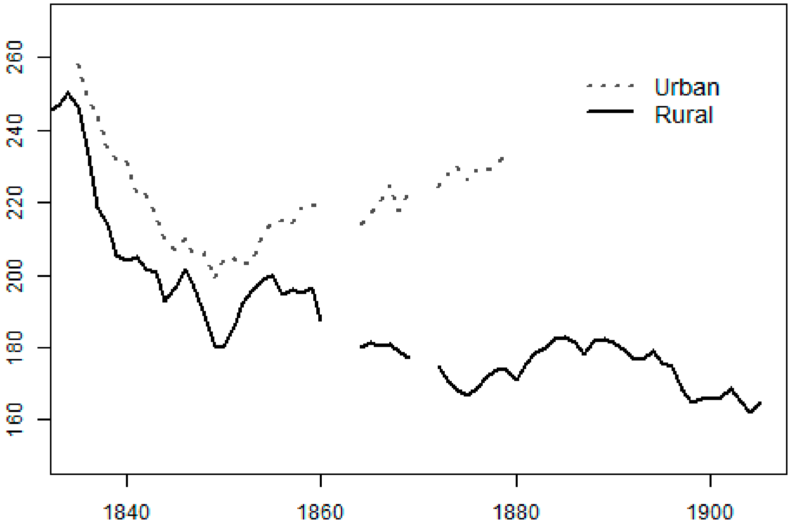


*Figure 1.* 15-year moving average of infant mortality rates for rural and urban congregations in St. Mary's parish in Tartu, 1835–1905. Source: Ligi, *Statistilised andmed Tartumaa elanike abielude, sündide ja surmade kohta*. The data on St. Mary's parish in Tartu is missing in 1861–63 and 1870–71. The material collected for the urban congregation in St. Mary's parish covers the period 1790–1880.

countries only Italy and Netherlands featured infant mortality at levels similar to Estonia at the end of the 1890s. Overall we can say that throughout the mid-nineteenth century Estonia and Tartu demonstrated substantially higher IMRs compared to the levels in selected European countries (see also Table 1). At the turn of the twentieth century, Nordic countries stand out as forerunners in the transition to low infant mortality, with Norway showing remarkably low IMRs already in the 1850s.

## *The factors of infant mortality in historical context*

Scholars investigating mortality change during the demographic transition generally agree that "behind the infant mortality decline is a complex web of causes"[33], which involve socio-economic (strata, education

Sweden (data available from 1835), Denmark (1835), Norway (1846) and Finland (1878) and four other European countries: France (1816), Belgium (1841), Netherlands (1850) and Italy (1872).

[33] Sören Edvinsson, Olöf Gardarsdottir and Gunnar Thorvaldsen, "Infant mortality in the Nordic Countries, 1780–1930", *Continuity and Change*, 23 (2008), 457–485.

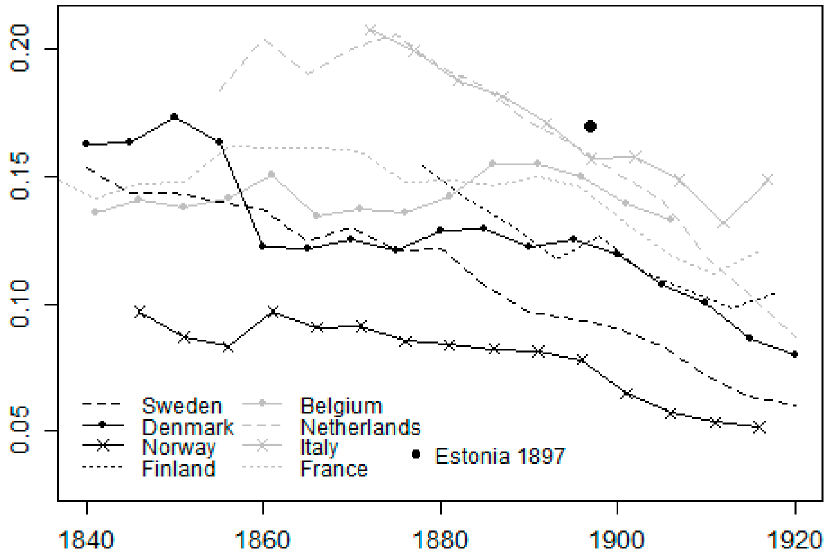


*Figure 2.* The 5-year moving average of probability of infant death ($_1q_0$) in selected European countries (1840–1920) and comparison to the level in Estonia at the end of the nineteenth century. Source: Human Mortality Database 2013; Katus and Puur, *Eesti rahvastiku suremustrend*.

etc.), cultural (ethnicity, religion, traditions, and norms), geographical and environmental factors (urban vs. rural residence, household resources, and sanitary conditions at the household or community level etc.) and public health improvements.

Andrew Hinde[34] refers to three major improvements that influenced the decline of infant mortality in England at the end of the nineteenth century: "environmental and public health improvements, economic improvements", and "changes in child-care practices". The two additional factors highlighted in the demographic transition context are the "decline in fertility"[35] and the improvement in the "education of women"[36]. The role of medical factors is debated in the literature. The traditional view of the

34 Andrew Hinde, *England's population: a history since the Domesday Survey* (Hodder Arnold, 2003).

35 Cleland, "The effects of improved survival on fertility"; David S. Reher, "Back to the basics: mortality and fertility interactions during the demographic transition", *Continuity and Change*, 14 (1999), 9–31; Reher, "The demographic transition".

36 Woods, Watterson and Woodward, "The causes of rapid infant mortality decline, part II", 126–129.

decisive influence of medical innovation on infant mortality decline was first challenged by Thomas McKeown who shifted the emphasis to the importance of standards of living and nutrition.[37]. Recent contributions to this debate propose a joint effect of improvements in medical science, nutrition and standards of living, and public health influencing the outset and course of mortality transition.[38]

Most empirical findings in historical studies of infant mortality reveal higher mortality rates in urban areas. Urban environments in the nineteenth and early twentieth centuries were generally characterized by unhealthy sanitary and living conditions, especially before public health improvements. Consequently, these environments entailed an excess in mortality rates, which is termed in the literature as the "urban penalty".[39] The sanitary reforms taking place in European cities and towns in the late nineteenth century transformed, through the improvement of the public water, sewerage and waste disposal systems, urban areas into more healthy environments. Nevertheless, environmental conditions within cities varied over time and space and previous studies have demonstrated strong association between sanitary conditions and infant mortality.[40] In particular, hot summer months in conjunction with poor sanitary conditions and high population density increased drastically infant mortality in certain areas or districts by the spread of infectious diseases such as diarrhea, dysentery, typhoid fever *etc.*[41]

In contrast to environmental factors, the relationship between infant mortality and economic factors is less straightforward. The evidence from historical studies in different contexts is often contradictory and no systematic variation in infant mortality by family income, parents' occupation and social class has been found, especially before the twentieth century. While

37 Thomas McKeown, *The modern rise of population* (London: Edward Arnold, 1976), XI.

38 Carlo A. Corsini and Pier Paolo Viazzo, *The decline of infant and child mortality: the European experience, 1750–1990* (Martinus Nijhoff Publishers, 1997).

39 Gerry Kearns, "The urban penalty and the population history of England", *Society, health and population during the demographic transition* (Almquist and Wiksell International, 1988).

40 Frans van Poppel and Cor van der Heijden, "The effects of water supply on infant and childhood mortality: a review of historical evidence", *Health Transition Review* (1997), 113–148; Michael E. Mercier and Christopher G. Boone, "Infant mortality in Ottawa, Canada, 1901: assessing cultural, economic and environmental factors", *Journal of Historical Geography*, 28 (2002), 486–507.

41 Woods, Watterson and Woodward, "The causes of rapid infant mortality decline, part I and II"; Naomi Williams and Chris Galley, "Urban-rural differentials in infant mortality in Victorian England", *Population Studies*, 49:3 (1995), 401–420.

findings by Breschi *et al.*[42], Woods *et al.*[43] and Haines[44] report a lower infant mortality among higher social classes, other studies have shown higher infant mortality amongst farmers and in certain wealthier areas in Finland and Iceland.[45] Nonetheless, the overall infant mortality decline seems to have benefited the higher strata to a greater extent, as at the end of the nineteenth century the decline accelerated among higher strata, resulting in diverging mortality levels across social groups.[46]

Several studies have demonstrated the role of cultural determinants in explaining the level of infant mortality but it is often difficult to separate their influence from that of socio-economic or demographic characteristics. For instance, significant effects of differential infant-feeding practices on infant survival have been reported in both historical and contemporary studies.[47] Previous research findings in the United States and Canada in the nineteenth century indicate that ethnicity[48] was an important predictor of infant mortality. Studies also indicate that religious differentials[49]

---

42 Marco Breschi *et al.*, "Socioeconomic conditions, health and mortality from birth to adulthood, Alghero 1866–1925", *Explorations in Economic History*, 48 (2011), 366–375.

43 Woods, Watterson and Woodward, "The causes of rapid infant mortality decline, part I", 363–366.

44 Michael R. Haines, "Socio-economic differentials in infant and child mortality during mortality decline: England and Wales, 1890–1911", *Population Studies*, 49:2 (1995), 297–315.

45 Rolf Engelsen, "Mortalitetsdebatten og sosiale skilnader i mortalitet", *(Norwegian) Historisk Tidsskrift*, 2 (1982), 161–202; Oiva Turpeinen, "Fertility and mortality in Finland since 1750", *Population Studies*, 33:1 (1979), 101–114; Edvinsson, Gardarsdottir and Thorvaldsen, "Infant mortality in the Nordic Countries".

46 Sören Edvinsson *et al.*, "High-risk families: the unequal distribution of infant mortality in nineteenth-century Sweden", *Population Studies*, 59:3 (2005), 321–337.

47 John Knodel and Etienne Van de Walle, "Breast feeding, fertility and infant mortality: an analysis of some early German data", *Population Studies*, 21:2 (1967), 109–131; John E. Knodel, "Two centuries of infant, child and maternal mortality in German village populations", *Society, health and population during the demographic transition* (Almquist and Wiksell International, 1988); Knodel and Van de Walle, "Breast feeding, fertility and infant mortality".

48 Samuel H. Preston and Michael R. Haines, *Fatal years: child mortality in late nineteenth-century America* (Princeton, NJ; Princeton University Press, 1991); Patricia Thornton and Sherry Olson, "Infant vulnerability in three cultural settings in Montreal, 1880", *Infant and child mortality in the past*, ed. by Alain Bideau and Bertrand Desjardins (Oxford: Clarendon Press, 1997), 216; Mercier and Boone, "Infant mortality in Ottawa, Canada".

49 Renzo Derosas, "When culture matters: differential infant and child mortality of Jews and Catholics in 19th-century Venice", Paper presented at the Comité International de Démographie historique, Oslo, 6–13 August 2000; Renzo Derosas, "Watch out for the children! Differential infant mortality of Jews and Catholics in nineteenth-century Venice", *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, 36 (2003), 109–130; Kevin McQuillan, *Culture, religion, and demographic behaviour:*

in infant mortality were apparent in different societies. In the context of Tartu, the cultural determinants might suggest certain differences in the level of infant mortality for German- and Estonian-speaking Lutherans.

Research conducted in developing countries has argued that "maternal characteristics, particularly education" plays a key role in shaping infant and child mortality. John C. Caldwell[50] emphasizes three major shifts that education entails for mothers: adopting new child-care practices in changing society, taking advantage of new opportunities, and changing the traditional family balance and the mother's role in families. While theoretically plausible, empirical findings in historical studies have been less conclusive in detecting differences in infant mortality rates by maternal education.[51] Another strong predictor of infants' chances of survival has been mother's marital status and illegitimate births. Based on previous research infants born to non-married mothers were exposed to substantially higher levels of infant mortality.[52]

## *Research questions, data sources and methodology of the study*

This study has two main objectives. First, it aims to estimate the level of infant mortality among the Lutheran population in Tartu at the end of the nineteenth century. Considering the urban disadvantage demonstrated in several studies, the level of infant mortality is expected to be rather higher than lower in Tartu compared to the national average in the same period.

The second objective is to investigate the variation of infant mortality among sub-groups of the population, defined according to infants and parents' characteristics, and sanitary conditions, thereby providing insight into factors shaping infant mortality in the period of demographic transition. The analysis of variation in infant mortality seeks to answer the following questions: i) how did the risk of infant death vary according

*Catholics and Lutherans in Alsace* (McGill-Queen's Press-MQUP, 1999), xxxvii; Frans van Poppel, Jona Schellekens and Aart C. Liefbroer, "Religious differentials in infant and child mortality in Holland, 1855–1912", *Population Studies*, 56:3 (2002), 277–289.

50 John C. Caldwell, "Education as a factor in mortality decline: an examination of Nigerian data", *Population studies*, 33:3 (1979), 395–413.

51 Preston and Haines, *Fatal years*; Woods, Watterson and Woodward, "The causes of rapid infant mortality decline, part II".

52 Frans van Poppel, "Children in one-parent families: survival as an indicator of the role of the parents", *Journal of Family History*, 25 (2000), 269–290; Anders Brändström, Sören Edvinsson and John Rogers, "Illegitimacy, infant feeding practices and infant survival in Sweden 1750–1950", *Hygiea Internationalis*, 3:1 (2002), 13–52; Edvinsson, Gardarsdottir and Thorvaldsen, "Infant mortality in the Nordic Countries".

to mother's demographic characteristics; ii) what were the differences in infant mortality related to cultural-ethnic affiliation; iii) how were the parents' socio-economic characteristics related to the risk of infant death; iv) how did sanitary conditions influence infant mortality. Based on previous research, it is expected that infants born to non-married mothers have significantly poorer chances of survival. Likewise, having a relatively old and young mother, and having a large number of children in the family is expected to negatively affect the survival of infants. As regards cultural-ethnic affiliation, the Baltic Germans are expected to have lower infant mortality. But it is not clear whether their relative advantage persists after controlling for socio-economic characteristics. Further, the expectation is to find lower infant mortality among groups with higher socio-economic status but it is less clear what is the contribution of the father's and mother's characteristics to the outcome. Finally, better sanitary conditions are expected to exert a significant positive effect on survival chances of infants.

*Table 2.* Data sources for the study of infant mortality in Tartu, 1897–1900

| Data source | Time period | Number of persons/ events |
|---|---|---|
| Census | 1897 | 40,636 |
| Lutheran parish registers: | | |
| Baptisms | 1896–1900 | 4288 |
| Baptisms in the study period | 1897–1899 | 2505 |
| Burials | 1897–1900 | 3159 |
| Infant deaths (0–1 year) | 1897–1900 | 466 |
| Marriages | 1896–1900 | 1281 |

This study draws on two types of archival micro-data: the 1897 census and the Lutheran parish registers (Table 2), both preserved in the Estonian Historical Archives. The first mentioned data source, a collection of individual-level enumeration lists of the First Russian Imperial census in Tartu, was computerized during a research project in the late 1990s.[53] The digitalization of parish register data for Tartu was carried out in the framework of the current study.[54] The analysis of infant mortality in Tartu focuses on the Lutheran population only as the incomplete coverage of parish registers

53 Berendsen and Maiste, *Esimene ülevenemaaline rahvaloendus Tartus.*

54 The vital records from Lutheran parish registers were computerized by the first author in the first phase of the doctoral project "Demographic processes in the Lutheran

for other confessions (Orthodox, Catholic, Jewish) at the end of the nineteenth century did not allow to take them into consideration for the study.

The First Russian Imperial Census was carried out on 28 January 1897. The preserved census lists on Tartu constitute a unique collection that covers the whole population of a town. The computerized micro-data includes 40,636 individual records and provides detailed information on demographic, cultural-ethnic, educational, socio-economic and housing characteristics, enabling insight into a Baltic town at the end of the nineteenth century.

The data on vital events were gathered from the registers of four Tartu Lutheran parishes for the years surrounding the census (1896–1900). The parish registers at the end of century were kept under the regulation and guidance of centralized Russian Church Law (1832), although the implementation of these rules by pastors and parish clerks in local Lutheran parishes varied to some degree.[55] The two biggest Lutheran parishes in Tartu were St. Peter's[56] and St. Mary's[57], the latter one having both urban and rural congregations and also a German-speaking congregation. The two German parishes were St. John's[58] and the University parish[59]. All parishes had registers for baptisms[60], burials[61] and marriages[62]; the amount of information in German-speaking parishes was considerably larger, especially regarding parents' socio-economic background (occupations).

population of Tartu at the end of nineteenth century". The study of infant mortality is the first analytical component in this framework.

55 Heldur Palli, *Eesti rahvastiku ajaloo allikad, 1712–1940* (Tallinn, 1995), 32–34; Laarmaa, *Rahvastiku loomulik liikumine*, 21–27.

56 Estonian Historical Archives [henceforth EAA], f. 3150.

57 EAA, f. 3148.

58 EAA, f. 1253.

59 EAA, f. 1254.

60 EAA, f. 3150, n. 1, s. 87–92; f. 3148, n. 1, s. 66–71, l. 230; f. 1253, n. 1, s. 600; f. 1254, n. 1, s. 58–60, 62–63, 65. The Lutheran baptism registers generally have information about the date of baptism, date of birth, the name of the child, his or her father's and mother's name, his or her mother's maiden name, the parents' religion if differing from Lutheran and at times the father's occupation. In addition baptism registers indicate children born out of wedlock and the stillbirths.

61 EAA, f. 3150, n. 1, s. 87–92; f. 3148, n. 1, s. 66–70, l. 137; f. 1253, n. 1, s. 607; f. 1254, n. 1, s. 58–60, 62–63. The burial registers have information about the date of burial, date of death, the name and age of deceased, at times the occupation of deceased, his or her father's name and occupation (again occasionally), his or her place of birth, his or her marital status and if female and married or widowed her maiden name. Furthermore, at the end of century the burial registers had information about the illness or cause of death.

62 EAA, f. 3150, n. 1, s. 751; f. 3148, n. 1, s. 66–70, l. 141; f. 1253, n. 1, s. 605; f. 1254, n. 1, s. 58, 60, 62–63. The marriage registers have information about the date of marriage, the names, ages and marital status of the spouses, the place of birth for both spouses, their mothers' and fathers' names and sometimes on the husband's and fathers' occupation.

In order to conduct the analysis of infant mortality among the Lutheran population in Tartu, a research dataset was constructed using nominative techniques and linkage of individual records from the census and parish registers. The procedure of record-linkage consisted of two steps and foresaw i) the linkage of infant death records from 1897–1900 (n=466)[63] to corresponding birth records from 1897–99, and ii) the linkage of 1897–99 birth records to the census records. In the first step, 89.5% of infant death records were successfully linked to birth records. In the second step, the success rate was 75.3%. In addition to the mentioned sources, parish marriage registers were used to establish the link between mothers and fathers who were not married at the time of the 1897 census but married after that.

In the last step, 60 stillbirths[64] were excluded from the analysis. As a result, the final dataset for the study of infant mortality has 2445 live births (1897–99) of which 1826 are linked to mothers' records in the 1897 census. The number of infant deaths that occurred in the 1897–99 birth cohort is 357 (total) and 264 (linked to the census).

To investigate the effects of demographic, cultural and socio-economic characteristics, and sanitary conditions on infant mortality, new-borns in three single-year birth cohorts (1897, 1898, and 1899) were followed through the first year of life. To examine the association between the covariates and the occurrence of infant deaths, the study applies two statistical techniques; the logistic regression and semi-parametric Cox proportional hazards model.[65]

---

63 Included are only those infant deaths that refer to the 1897–99 birth cohorts.

64 Stillbirths were recorded in the baptism and burial registers. As the number of infant deaths is quite small, possible under- or over-registration has significant impact on the estimated level of infant mortality. To minimise the bias, the number of stillbirths in the two registers was compared. The number turned out somewhat larger in the baptism register than in the burial register. A closer examination showed that in several cases the baptism records documented births as stillbirths even if the linked burial record indicated that the infant had lived a few days. The comparison of records allowed us to identify 60 stillbirths in 1897–1900 for which the data were consistent in both registers.

65 In the case of the Cox regression (David G Kleinbaum and Mitchel Klein, *Survival analysis: a self-learning text* (Springer, 2005)), the instantaneous risk of dying at age *t* is the product of a function *t* and a function of the vector of covariates, while logistic regression estimates the level of infant mortality without considering how mortality varies as a function of time (infants' age). The outcome variable in the Cox proportional hazards model is "time to an event", in logistic regression the dependent variable is dichotomous. Although the exponentiated coefficients, the hazard ratio (Cox regression) and odds ratio (logistic regression) are different measures, they have a similar interpretation with regard to the strength of the effect in the models. From the methodological point of view, survival analysis enables to account for the fact that mortality risks are not constant during the first year of life: the risk of dying typically decreases with age, stabilizing

Both methods have been used in previous studies of infant mortality in historical contexts.[66]

In this study, the dependent variable is dying or surviving during the first year of life. To ensure comparability, the same set of independent or explanatory variables was used in the logistic and Cox regression models. The explanatory variables are divided into four groups indicating mothers' demographic characteristics (marital status, age group, number of children), cultural (ethnic affiliation), and socio-economic (the mother's education and labour force participation, the father's education and occupational group) characteristics and sanitary conditions (type of water supply). Information on the sex of the new-born and the mother's marital status (the legitimacy of the child) is available for all births from the parish registers. The age of the mother at the time of birth is available only for infants who were successfully linked to their mother's record in the 1897 census. Similarly, the number of children for a mother can only take into account the number of co-resident children living in the same households with mothers at the time of the census and additional children born during the time period of 1897–99.[67]

Lutherans in Tartu were Estonian-speaking or German-speaking, so the variable of ethnic affiliation is based on the spoken language (available from the census records). To distinguish the contribution of mothers' and fathers' socio-economic status, both maternal and paternal characteristics are included in the analysis (variables are obtained from the census). Education is grouped into primary and secondary education. As the employment rate was relatively low among mothers, the maternal employment variable differentiates only between mothers having gainful employment (occupation) and those not having one. More complete information on the father's occupation enables to analyse the effect of socio-economic differences on infant mortality in somewhat greater detail. The variable of

at the end of infancy (Mattijs Vandezande, *Born to die: intergenerational clustering of infant mortality, the Antwerp District, 1846–1905* (Leuven, 2010), 101).

66 Frans van Poppel, Marianne Jonker and Kees Mandemakers, "Differential infant and child mortality in three Dutch regions, 1812–1909", *The Economic History Review*, 58:2 (2005), 272–309; Derosas, "Watch out for the Children!".

67 It would have been preferable to derive the number of children from childbearing histories of women enumerated at the census. However, data limitations constrain this study to somewhat underestimate the measure (high infant and child mortality). In principle, this information can be attained from so-called books on persons ("personaalraamat") but these source materials are not yet computerized and linked to the census. The computerization is in progress and is expected to be completed in 2014 for three parishes.

"father's occupation" distinguishes five categories by grouping the HISCO[68] major groups and adding the category "non-employed" (includes unemployed and economically non-active men).

Availability and source of water supply was used as a proxy for sanitary conditions. The variable constructed for water supply is derived from the census. The source of water in the mother's (parents') house distinguishes three categories: households acquiring water from wells, households acquiring water from the river and households with the type of water source not reported. As the latter category is quite large, it likely includes households that did not have a private well and received water from public pump wells operated by the municipality.

*Table 3.* Number of live births and infant deaths by explanatory variables in Tartu, 1897–1900 (by explanatory variables)

| | Number of live births | Proportion of live births (%) | Number of infant deaths |
|---|---|---|---|
| Sex of infant | | | |
| Male | 1243 | 50.8 | 197 |
| Female | 1202 | 49.2 | 160 |
| Mother's characteristics | | | |
| *Marital status* | | | |
| Married | 2203 | 90.1 | 181 |
| Non-married | 242 | 9.9 | 61 |
| *Age at birth* | | | |
| 15–24 | 304 | 16.6 | 44 |
| 25–34 | 993 | 54.4 | 129 |
| 35+ | 529 | 29.0 | 91 |
| *Number of children* | | | |
| 1 | 532 | 29.0 | 68 |
| 2 | 462 | 25.2 | 64 |
| 3 | 363 | 19.8 | 50 |
| 4 | 228 | 12.5 | 37 |
| 5+ | 247 | 13.5 | 45 |
| Cultural characteristics | | | |
| *Ethnic affiliation* | | | |
| Estonian | 2108 | 86.2 | 321 |
| Baltic-German | 337 | 13.8 | 36 |
| Socio-economic characteristics | | | |
| *Maternal education* | | | |
| Primary | 1690 | 93.3 | 243 |
| Secondary/higher | 122 | 6.7 | 15 |

[68] Marco H. D. Van Leeuwen, Ineke Maas and Andrew Miles, *HISCO: Historical international standard classification of occupations* (Leuven: Leuven University Press, 2002).

| | Number of live births | Proportion of live births (%) | Number of infant deaths |
|---|---|---|---|
| *Maternal employment* | | | |
| Non-employed | 1861 | 76.1 | 273 |
| Employed | 584 | 23.9 | 84 |
| *Paternal education* | | | |
| Primary | 1342 | 92.0 | 201 |
| Secondary/higher | 117 | 8.0 | 8 |
| *Paternal occupation* | | | |
| Professional | 105 | 6.5 | 12 |
| Sales | 250 | 15.4 | 26 |
| Production | 492 | 30.3 | 72 |
| Day laborers | 726 | 44.7 | 107 |
| Non-employed | 51 | 3.1 | 8 |
| Sanitary conditions | | | |
| *Water supply* | | | |
| Well | 753 | 50.8 | 116 |
| River | 34 | 2.3 | 12 |
| Not stated | 696 | 46.9 | 82 |

Table 3 presents the number of live births and infant deaths for all explanatory variables included in the study. With the exception of the sex of infant and mother's marital status, the number of events reported in the table is based on the sub-set of linked parish register/census records.

## *Results: Infant mortality rate and differentials in the Lutheran population of Tartu*

Table 4 presents the infant mortality rate, neonatal and post-neonatal mortality rates estimated from the final dataset that consisted of live births in Lutheran parishes of Tartu 1897–99 (n=2445) and infant deaths that occurred amongst these new-borns. One quarter of infant deaths occurred in the neonatal period and three quarters in the post-neonatal period. The estimation based on a sub-set of 1897–99 birth records that were successfully linked to the census (n=1826) yield a closely similar result (IMR 144‰).

Table 5 summarizes descriptive and multivariate results pertaining to differentials between sub-groups of the population. Descriptive results are presented by means of infant mortality rate (per 1000 live births) with 95% confidence intervals. Multivariate results are presented by means of odds ratios from logistic regression models and hazard ratios from Cox models. To estimate the effect of covariates on survival chances of infants, two sets of logistic regression and Cox models are fitted. The first set

(Model 1) produces estimates for the non-adjusted effects of independent variables, including one subset of variables at a time. Estimates adjusted for the effects of all control variables are obtained from the second subset of models (Model 2). When moving from non-adjusted to adjusted models, a stepwise procedure was applied to ascertain which control variables bring about changes in the effects of independent variables.[69]

*Table 4.* Infant mortality by age intervals in Tartu, 1897–1900

| Age interval | No. of deaths | Prop. of infant deaths | Mortality rate (per 1000 live births) | 95% confidence intervals |
|---|---|---|---|---|
| Neonatal (0–30 days) | 86 | 0.24 | 35 | (28–43) |
| Post-neonatal (31–365 days) | 271 | 0.76 | 111 | (98–124) |
| Total | 357 | 1.00 | 146 | (131–161) |

Studies of infant mortality emphasize the change in the type of risk factors of mortality in successive stages of infancy, and therefore, neonatal (first month) and post-neonatal (months 1–12) mortality are often analyzed separately.[70] This approach allows researchers to distinguish between endogenous risk factors, that usually prevail in the neonatal period, and the exogenous factors that become central after weaning when infants are more exposed to their surroundings and living conditions. In this study, however, the results of separate regressions for neonatal mortality did not yield statistically significant results and the estimates for post-neonatal mortality followed the overall pattern reported in Table 5. For that reason, the results for neonatal and post-neonatal mortality are not presented separately.

Sex difference in infant mortality reveals an expected pattern: the IMR for girls was 133 and for boys 158 per 1000 live births. Likewise, the logistic regression model shows that the odds of dying during the first year of life for new-born girls were almost 20.6% lower than for males in the adjusted model. Hazard regression models demonstrate a similar pattern but the

[69] The statistical analysis was performed using the R programming language. Given the relatively small number of observations, statistical significance is measured at the 90% level.

[70] Derosas, "Watch out for the Children!"; Tommy Bengtsson, Cameron Campbell and James Z. Lee, *Life under pressure: mortality and living standards in Europe and Asia, 1700–1900* (Cambridge, MA: MIT Press, 2009).

difference between boys and girls fails to reach the level of statistical significance in Model 2.

The mother's demographic characteristics addressed in this study include the mother's marital status, age at childbearing and the number of children. The results presented in Table 5 reveal variation in the level of infant mortality associated with all these variables, although not all differences are statistically significant. Among the characteristics included in the analysis, the mother's marital status has a very strong effect on the child's survival chances. The IMR for illegitimate children is nearly two times higher than for children born to married mothers. The regression models show that while controlling for other characteristics, illegitimate children have a more than 3 times higher risk of dying during the first year of life. Given the relatively high proportion of illegitimate births in Tartu at the end of the nineteenth century (9.9%, 1897–99), this large excess risk tends to shift the overall level of infant mortality upwards among the town population.

*Table 5.* Infant mortality rate and model estimates in Tartu, 1897–1900

| | IMR (per 1000 live births) | IMR 95% confidence interval | Logistic regression, odds ratios | | | | Cox regression, hazard ratios | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Model 1 | | Model 2 | | Model 1 | | Model 2 | |
| Sex of infant | | | | | | | | | | |
| Male | 158 | (136–181) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Female | 133 | (112–154) | 0.81 | * | 0.79 | * | 0.82 | * | 0.81 | |
| Mother's characteristics | | | | | | | | | | |
| *Marital status* | | | | | | | | | | |
| Married | 134 | (119–150) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Non-married | 252 | (189–315) | 3.44 | *** | 3.60 | *** | 3.11 | *** | 3.26 | *** |
| *Age at birth* | | | | | | | | | | |
| 15–24 | 145 | (102–187) | 1.11 | | 1.12 | | 1.07 | | 1.07 | |
| 25–34 | 130 | (107–152) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| 35+ | 172 | (137–207) | 1.30 | | 1.21 | | 1.27 | | 1.18 | |
| *Number of children* | | | | | | | | | | |
| 1 | 125 | (97–158) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| 2 | 138 | (105–172) | 1.45 | * | 1.27 | | 1.42 | * | 1.28 | |
| 3 | 138 | (100–176) | 1.49 | * | 1.25 | | 1.43 | * | 1.23 | |
| 4 | 162 | (110–215) | 1.60 | * | 1.40 | | 1.49 | * | 1.34 | |
| 5+ | 182 | (129–235) | 1.93 | *** | 1.85 | ** | 1.79 | *** | 1.73 | ** |
| Cultural characteristics | | | | | | | | | | |
| *Ethnic affiliation* | | | | | | | | | | |
| Estonian | 152 | (136–169) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Baltic-German | 107 | (72–142) | 0.67 | ** | 0.70 | | 0.69 | ** | 0.73 | |

| | IMR (per 1000 live births) | IMR 95% confidence interval | Logistic regression, odds ratios | | | | Cox regression, hazard ratios | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Model 1 | | Model 2 | | Model 1 | | Model 2 | |
| Socio-economic characteristics | | | | | | | | | | |
| *Maternal education* | | | | | | | | | | |
| Primary | 144 | (126–162) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Secondary/higher | 123 | (61–185) | 1.80 | | 2.08 | * | 1.76 | | 1.93 | * |
| *Maternal employment* | | | | | | | | | | |
| Non-employed | 147 | (129–164) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Employed | 144 | (113–175) | 0.99 | | 0.78 | | 1.00 | | 0.81 | |
| *Paternal education* | | | | | | | | | | |
| Primary | 150 | (129–170) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Secondary/higher | 68 | (21–116) | 0.36 | ** | 0.38 | * | 0.38 | ** | 0.42 | * |
| *Paternal occupation* | | | | | | | | | | |
| Professional | 114 | (49–179) | 0.72 | | 0.81 | | 0.72 | | 0.78 | |
| Sales | 104 | (64–144) | 0.60 | * | 0.62 | * | 0.61 | * | 0.64 | * |
| Production | 147 | (112–180) | 1.08 | | 0.99 | | 1.05 | | 0.98 | |
| Day laborers | 147 | (119–175) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Non-employed | 157 | (48–265) | 1.41 | | 1.55 | | 1.38 | | 1.46 | |
| Sanitary conditions | | | | | | | | | | |
| *Water supply* | | | | | | | | | | |
| Well | 154 | (126–182) | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| River | 353 | (153–553) | 3.01 | *** | 3.00 | *** | 2.44 | *** | 2.32 | *** |
| Not stated | 118 | (92–143) | 0.74 | ** | 0.73 | ** | 0.76 | ** | 0.74 | ** |
| No of observations | 1826 | | 1826 | | 1826 | | 1826 | | 1826 | |
| No of infant deaths | 264 | | 264 | | 264 | | 264 | | 264 | |
| Log-likelihood | | | | | -714.82 | | | | -1923.82 | |
| Degrees of freedom | | | | | 21 | | | | 21 | |
| AIC of p-value | | | | | 1475.6 | | | | 0.000 | |

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

The IMR for children born to older mothers (aged 35 or older) was 172‰, compared to 130‰ for mothers in the prime childbearing age-group (25–34). In the adjusted models, older mothers exhibit an 18–20% higher risk of infant death, but both the adjusted nor in the non-adjusted models, the limited number of observations (see Table 3) does not allow the difference from the reference group to reach the level of statistical significance. Slightly elevated risk of infant deaths is also characteristic of younger mothers (aged 15–24), but like for older mothers, the difference from the reference group is not significant.

As regards the number of children, the IMR increases from the lowest rate around 125‰ for the mothers of firstborns to the highest IMR of 182‰ among mothers with five or more children. Similarly, in the adjusted models the number of children exhibits a positive association with infant mortality. Relative to the reference group (first child), women with two or three children have a 23–28% higher likelihood of infant death (depending on model), while the mothers of 4 and 5+ children feature a 34–40% and 72–85% higher risk of infant death respectively, the latter difference being statistically significant. These results imply that being born into a large family reduces the infants' chances of survival independent of mother's age and other characteristics.

Cultural characteristics reveal large contrast in the levels of infant mortality between the Estonian-speaking and German-speaking sub-population. The IMR for Baltic-Germans was rather low 107‰ while the rate for Estonians living in the town amounted to 152‰. The results from the multivariate analysis underline the importance of ethnic affiliation for infant survival, with the risk of dying being more than 30% lower for Baltic-German children in the non-adjusted models (Model 1).

In a stepwise inclusion of control variables, the effect of ethnic affiliation is only slightly reduced. The risk of infant death for the children of Baltic-German mothers stays at the level of around 60% compared to Estonian mothers.[71] In the final adjusted model (Model 2), the inclusion of a complete set of control variables and the ensuing increase in the degrees of freedom prevents ethnic affiliation from retaining a statistically significant effect.

Differentials associated with socio-economic characteristics appear less pronounced in our results. For the two maternal characteristics included in the analysis – mother's education and employment – the estimated IMRs show modest variation. In contrast, paternal characteristics make a significant difference in the levels of infant mortality. In particular, much

[71] These intermediate models are not reported in Table 5.

lower IMRs are observed among children whose fathers had attained secondary or higher education. The estimates for fathers' occupational group also show noticeable differences with IMRs being lower for professionals and sales workers and higher for children born to day labourers, production workers and non-employed fathers.

Multivariate results reveal a rather unexpected relationship between maternal education and infant mortality. All models show strong disadvantage for new-borns whose mothers have secondary or higher education. A stepwise estimation procedure indicated that the inclusion of ethnicity and paternal socio-economic characteristics (father's education and occupation) made a strong contribution to the emergence of the unexpected relationship between maternal education and infant survival. The disadvantaged position of children born to women with secondary education emerges only when simultaneously controlling for these three variables. The results concerning maternal secondary education obviously suffer from the relatively small number of observations (107 births and 15 infant deaths in this group). Given these facts and the mismatch between descriptive and multivariate results, the positive association between women's secondary or higher education and infant mortality revealed by the models should be interpreted with considerable caution. The mother's employment makes minor difference in survival of infants that is statistically non-significant in all models.

Modelling results on paternal education corroborate the descriptive findings. The advantage of the father's secondary or higher education is evident in all models with significant positive effect on the survival chances of new-borns. For infants born to fathers with secondary or higher education, the relative hazard of dying is approximately 40% of that of less educated fathers. The socio-economic differentials in infant mortality are also clearly visible by fathers' occupation, a classical measure of social stratification. Children of fathers who were employed as professionals or worked in sales occupations had a relative advantage in survival compared to day labourers' children. It can be underlined that fathers with higher education were mostly employed as professionals or in sales but sales as an occupational category still reveals an advantage, after controlling for education.

The effect of sanitary conditions on infant mortality, proxied in this study by the source of water supply, is evident in the Lutheran population in Tartu. In the exploratory analysis, we experimented with various characteristics of sanitary conditions, including the sanitary assessment of town districts by Bernhard Körber, based on population density, water supply, building material of houses and paving of yards or streets etc.[72] Among these variables, only the source of water supply gave statistically significant results. Therefore, the individual-level information from the census on water supply was used in the analysis instead of district-level assessments by Körber. Not surprisingly, children in households which reported the river as the main source of water supply show excess mortality during the first year of life. Among households which acquired their drinking water from the river, the IMR amounts to 353‰. In the models, infants feature a three times higher risk of death in these households. Households not stating their water supply include households mainly from the central boroughs. It can be assumed that these households took their water mainly from public pump wells that possibly explain the relative advantage in terms of lower infant mortality.

The comparison of estimates based on logistic regression and Cox proportional hazards models allowed us to illuminate the role of age pattern of infant mortality in generating the differences between sub-groups of infants. The overall consistency of estimates based on different models suggests that the role of age pattern is limited. The observed gradients of odds ratios and hazards ratios run in the same direction in both types of models and do not reveal large contrasts in the effects of covariates. In general, the consistency of estimates suggests that the reported empirical results are robust and reliable.

## *Summary and discussion*

This article investigated infant mortality at the end of the nineteenth century among the Lutheran population in Tartu, based on the linked micro-level data from the 1897 census and parish registers. According to the results, IMR was 144‰ in 1897–99. This estimate is 15% lower than concurrent estimates at the national level (about 170‰ in 1896/1897).[73] Several measurement problems may account for the observed difference.[74] However, considering these

---

[72] Bernhard Körber, *Die Stadt Dorpat (Jurjew) in statistischer und hygienischer Beziehung* (Jurjew (Dorpat): C. Mattiesen, 1902), 219–269.

[73] Ligi, *Statistilised andmed Tartumaa elanike abielude, sündide ja surmade kohta*; Katus and Puur, *Eesti rahvastiku suremusest*, 18; Katus and Puur, *Life tables*.

[74] Given the fact that not all records (infant deaths to births and birth records to mothers) were successfully linked in our study, the imperfect linkage may have biased the estimate of infant mortality downward. To examine whether this may have occurred, the IMR was estimated based on all live births and infant deaths recorded in parish registers in 1897–99, regardless of the result of record-linkage. This alternative estimation of IMR yielded a closely similar result (146‰) suggesting that imperfection of record-linkage is relative harmless to the results. Further, one could suspect that the IMR may be low due

arguments, we think that the lower IMR appears to be plausible. Compared to other large towns in the Baltic area, Tartu was best characterized as a university town with a concentration of intellectuals and relatively few larger enterprises and industrial proletariat. Another part of the explanation might be that in Estonia in general the urban disadvantage in infant mortality had started to weaken in the 1890s since in the early 1920s the urban-rural gradient in infant mortality was already in favour of the urban population.[75] In sum, this suggests that the relatively low level of infant mortality compared to the national average may not result from measurement problems but describe the circumstances in Tartu quite realistically.

Further the study sought answers to four questions, regarding the effects of the mother's demographic characteristics, parents' cultural-ethnic affiliation, socio-economic status and sanitary conditions on infant survival. With regard to the mother's characteristics, the study found a sizable difference in infant survival between legitimate and illegitimate births.[76] This finding is in agreement with previous historical studies that have emphasized the importance of illegitimacy, mainly an urban phenomenon, for mortality levels among infants and children. The explanations of this pattern include the necessity of unwed mothers to work and therefore to stop breast-feeding earlier than married mothers and also the greater risk of poverty among single mothers.[77] The results lend support to the former mechanism by showing that in our dataset, the labour force participation rate of single mothers was twice higher (50%) than that of married mothers (26%). Women outnumbered men in Tartu at the end of the century, with a substantial number of young female migrants moving to the town to find employment. These female

---

to under-registration of infant deaths but several facts speak against this possibility. First, as shown in earlier sections, the national IMR estimates for Estonia are relatively high compared to forerunners of mortality decline in Europe. If one considers the national level estimates plausible, underreporting of infant deaths must have occurred at the local level. One potential cause of local underreporting could be migration but the rapid inflow of new inhabitants to Tartu makes this explanation relatively unlikely (underreporting would require that a significant number of people registered the birth in Tartu but then left, leaving the infant death unregistered or registered in some other parish beyond the town). Underreporting of infant deaths also seems quite unlikely if one considers neonatal and post-neonatal mortality. The proportion between infant deaths occurring in these two periods is consistent with that reported in literature (Vandezande, "Born to die", 100).

75 *Sündivus, surevus, abielluvus ja rahvaliikumine 1921–1923*, 36–37.

76 The illegitimacy ratio in Tartu amounted to 99‰ and there was quite a large difference between the Estonian- (106‰) and German-speaking (53‰) population.

77 Van Poppel, "Children in one-parent families", 279–283; Brändström, Edvinsson and Rogers, "Illegitimacy, infant feeding practices", 29–50; Edvinsson, Gardarsdottir and Thorvaldsen, "Infant mortality in the Nordic Countries", 474–475.

workers were mostly from the lower strata of society: 43% of all women who stated their occupation in the census were domestic servants, working for wealthier households.[78] The latter fact indirectly supports the poverty argument mentioned above. The results concerning mother's age (infants born to "young" and "older" mothers have elevated risk of dying) and the number of children (infants born to large families have poorer chances of survival) are also in line with the expectation based on previous literature.[79]

The study found a distinct cultural-ethnic divide in infant mortality. In accordance with our expectation, Baltic-Germans showed considerably lower infant mortality than Estonians in 1897–1900 in Tartu. Interestingly, these cultural differences were not explained away after investigating for the effects of socio-economic variables.[80] The salience of ethnic difference is also revealed by the fact that the introduction of ethnicity to models systematically moderated the effects of other covariates. Several mechanisms may have contributed to the observed pattern. Preston and Haines[81] have argued the varying customs in child-raising and breast-feeding to be central in cultural-ethnic differences. To denote similar mechanisms, Reid[82] used the term "individual behaviour" dictated by culture. Furthermore, Mercier and Boone[83] attribute strong cultural differences in infant mortality between the French and non-French populations in Ottawa (Canada) to differing practices in child-rearing, hygiene or "healthy" behaviour and reproduction. The ethnic differences observed in Tartu might have similar explanations related, for instance, to child-care practices and prolonged breast-feeding among Baltic-Germans that enhanced the survival chances of their children. Compared to Estonians, the German-speaking population had closer contacts with the university and thereby likely better knowledge of modern hygiene practices. Finally, considering the rather early onset of fertility transition in Estonia and the Baltic-Germans as likely

78 Berendsen and Maiste, *Esimene ülevenemaaline rahvaloendus Tartus*, 238–258.

79 Katherine A. Lynch and Joel B. Greenhouse, "Risk factors for infant mortality in nineteenth-century Sweden", *Population Studies*, 48:1 (1994), 117–133; Derosas, "Watch out for the children!".

80 Although adding socio-economic variables reduced statistical significance to borderline values due to increase in the degrees of freedom in the models.

81 Preston and Haines, *Fatal years*.

82 Alice Reid, "Locality or class? Spatial and social differentials in infant and child mortality in England and Wales, 1895–1911", *The decline of infant and child mortality*, 129–154 (140).

83 Mercier and Boone, "Infant mortality in Ottawa, Canada", 502.

trendsetters in this development[84], lower infant mortality among the latter may be at least in part due to mortality-fertility interaction during the demographic transition.[85]

Somewhat unexpectedly, the study failed to reveal a systematically positive association between maternal education and new-born survival that is considered an important factor in the transition from high to low infant and child mortality in Europe[86] Rather, the multivariate analysis demonstrated higher risk of infant deaths among the more educated women. At the end of the nineteenth century most women in Tartu had primary education from parish or town schools with only a fraction of them having secondary education. The latter constituted of a socially and ethnically very homogenous group, with 90% of them being German-speaking. In addition, the number of infant deaths experienced by the German-speaking mothers became fairly small once distributed across different levels of education. Considering the small number of observations and multicollinearity (effects of education, ethnic affiliation and social status are inter-related), the multivariate results for women's education should be interpreted with caution.[87] In contrast, the analysis demonstrated substantial differences in infant mortality by paternal education, in accordance with the expected direction of the relationship. This suggests that at the end of the nineteenth century, the husbands' level of education was central in determining the socio-economic status and living conditions of the household, and through these factors, affecting the survival chances of new-borns.

The evidence from previous research has been contradictory with regard to occupational differences in child survival. Some studies have reported quite large differences[88] while others[89] have failed to do so. In line with

---

[84] Kalev Katus, Allan Puur and Luule Sakkeus, "The demographic characteristics of national minorities in Estonia", *The demographic characteristics of national minorities in certain European states*, ed. by Werner Haug, Youssef Courbage, and Paul Compton (Council of Europe, 2000), II, 29–92 (43–50).

[85] Reher, "Back to the basics"; Reher, "The demographic transition".

[86] David S. Reher, "In search of the 'urban penalty': exploring urban and rural mortality patterns in Spain during the demographic transition', *International Journal of Population Geography*, 7:2 (2001), 105–127 (120–121).

[87] Consistent with general expectations, the descriptive measures (IMRs) showed somewhat lower infant mortality among highly educated women. However, due to their small number, the difference between the groups was not statistically significant.

[88] Woods, Watterson and Woodward, "The causes of rapid infant mortality decline, part I"; Haines, "Socio-economic differentials in infant and child mortality during mortality decline, 297–315; Breschi *et al.*, "Socioeconomic conditions, health and mortality", 366–375.

[89] Edvinsson, Gardarsdottir and Thorvaldsen, "Infant mortality in the Nordic Countries".

expectation, this analysis demonstrated moderate differences in infant mortality associated with the father's occupation. Lower infant mortality is characteristic of higher strata, with the father employed in professional and sales occupations. Edvinsson *et al.*[90] have explained occupational differences in infant mortality in the late nineteenth century by more rapid improvement in living conditions, the implementation new child-care practices and hygienic measures among the higher occupational groups. Also in Tartu, the quality of housing, living conditions and health-care practices may have accounted for the advantage in infant survival among professional and sales workers.

Consistent with our expectations, the analysis showed clear disadvantage for households that used the river as their main source of drinking water. It can be assumed that these households, generally residing on the waterside and on lower ground, had poorer sanitary conditions and difficulties in applying adequate hygiene measures and practices. This finding is in accord with contemporaneous research by Körber who assessed the sanitation and hygiene conditions of the boroughs of Tartu. In his most influential work, based on the 1897 census, he claimed that the worst conditions with poor water supplies prevailed in the boroughs next to the Emajõgi River, where seasonal flooding frequently caused contamination of wells, and hence, contributed to the onset of epidemics.[91] Our findings on water supply deserve attention in the context of historical studies focusing on the effect of sanitary improvements (such as the instalment of piped water in the cities) on infant and child mortality. Frequently, such studies have encountered difficulty in demonstrating the immediate connection between sanitary improvements and health outcomes.[92]

At the same time we have to acknowledge several limitations of this study. The research was conducted on a relatively small number of infant deaths with a large proportion of Estonians in our research dataset (consistent with the structure of the population). This limited our ability to obtain statistically significant results for several characteristics and analyse the ethnic minority (Baltic Germans) in greater detail. Another limitation is the absence of non-Lutheran population (mainly Russians and Jews in terms of ethnic groups), the presence of which would have broadened the scope of our analysis, in particular with regard to cultural differences.

90 Edvinsson *et al.*, "High-risk families".
91 Körber, *Die Stadt Dorpat (Jurjew) in statistischer und hygienischer* Beziehung, 219–269.
92 Van Poppel and van der Heijden, "The effects of water supply on infant and childhood mortality".

Furthermore, we have to admit that the lack of information on factors such as breast-feeding, individual hygiene and child-rearing practices limit the possibility of identifying specific behavioural mechanisms that may have contributed to the observed patterns. Also, we are aware that the process of constructing the research dataset and linking available information may have introduced some bias in our estimates.

Overall, this study provided new evidence on the level and differentials in infant mortality in the Lutheran population of Tartu. It illuminated the effects of several demographic, cultural, socio-economic and sanitary factors related to infant survival. To draw more general conclusions about the demographic behaviour of the Lutheran population in Tartu amidst the period of demographic modernization, it is important to extend the analysis to other demographic processes, and to their interactions. As a next step, the analysis should be extended to child and adult mortality in order to understand ways how the social setting, cultural factors and living conditions affected survival beyond infancy. A further aim is to analyze fertility patterns amongst the Lutheran population based on fertility histories of women enumerated in the 1897 census, derived from the parish books on persons. These intended analyses are expected to contribute to the identification of forerunners of demographic transition in Estonia and enable an in-depth view on mortality-fertility interactions.

Hannaliis Jaadla (b. 1986) is a Ph.D. student at the Estonian Institute for Population Studies, Tallinn University.*

Martin Klesment (b. 1976) is a senior researcher at the Estonian Institute for Population Studies, Tallinn University.

* Correspondence: Tallinn University, Uus-Sadama 5, M-553, 10120, Tallinn, Estonia. E-mail: hjaadla@tlu.ee

## Kokkuvõte: *Imikusuremus Tartu luteriusulises rahvastikus 19. sajandi lõpul*

Käesolev artikkel käsitleb imikusuremust Tartu luteriusulises rahvastikus perioodil 1897–1900 ja analüüsib imikusuremuse erisusi rahvastikurühmades sõltuvalt demograafilistest, sanitaar-keskkondlikest, sotsiaal-majanduslikest ja kultuurilistest teguritest. Varasemad uurimused on näidanud, et pikaaegne imiku- ja lastesuremuse vähenemine Euroopas ja Põhja-Ameerikas 18.–19. sajandil oli üheks oluliseks tingimuseks demograafilise käitumise nüüdisajastumisel. Taolised muutused suremusülemineku algfaasis aitasid otseselt kaasa rahvastiku keskmise eeldatava eluea pikenemisele ja omasid kaudset mõju sündimuse langusele. Põhilisteks imikusuremise vähenemist mõjutavateks teguriteks peetakse ajaloolis-demograafilistes uurimustes hügieeni- ja sanitaarolude paranemist, ühiskonna majanduslikku arengut, elatustaseme tõusu ja muutusi imikute ja väikelaste eest hoolitsemise viisides. Demograafilise ülemineku kontekstis rõhutatakse sageli ka sündimuse vähenemise mõju ja edasiminekut naiste haridustasemes. Üldiselt loetakse imikusuremuskordajaid üheks olulisemaks ühiskonna demograafilise ja sotsiaalse arengu mõõdikuks.

Varasemate uurimuste põhjal võib öelda, et Eesti kuulub demograafilise ülemineku varase ajastusega piirkondade hulka, kus sündimuse ja suremuse vähenemine leidis aset enam-vähem samaaegselt. Ajaloolis-demograafilistest üldkäsitlustest on teada, et suremuse kiire vähenemine algas Eesti- ja Liivimaal 19. sajandi keskpaigas. Samas on teadmised imikusuremuse tasemest sellel perioodil suhteliselt piiratud ja lünklikud; ametlik statistika imikusuremuse kohta on Eestis kättesaadav alates 1922. aastast. 1897. aasta rahvaloenduse andmetele tuginevad elutabeli arvutused demonstreerivad, et 19. sajandi lõpul oli imikusuremuse tase Eestis märgatavalt kõrgem kui teistes sarnase demograafilise arenguga piirkondades. Lisaks on võimalik leida varasemaid imikusuremuse hinnanguid Tartu ülikooli biostaatikute töödest, kus näiteks Tartu linnakoguduste imikusuremuskordajad olid märgatavalt kõrgemad kui maakogudustes.

Käesoleva artikli eesmärgiks on hinnata imikusuremuse taset Tartu luteriusulises elanikkonnas 19. sajandi lõpul ja selgitada selle varieeruvust erinevates rahvastikurühmades. Tuginedes teemakohasele kirjandusele ja teoreetilistele käsitlustele otsiti vastuseid järgmistele küsimustele: i) milline mõju oli ema tunnustel (vanus, abielulisus, laste arv) imikusuremusele; ii) millised olid imikusuremuse erisused sotsiaal-majanduslike rühmade (vanemate haridus, amet) vahel; iii) kuidas sanitaartingimused

mõjutasid imikute ellujäämistõenäosust; iv) millised olid imikusuremuse erisused kultuurilis-etnilise kuuluvuse järgi. Demograafilise ülemineku kontekstis on nende võrdluste sihiks tuvastada rahvastikuarengu nn pioneerrühmi, kelle hulgas imikusuremuse vähenemine oli 19. sajandi lõpuks teistest kaugemale edenenud.

Käesolev uurimus põhineb kahel teineteist täiendaval mikro-andmestikul: Tartu Jaani, Maarja, Peetri ja ülikooli koguduste kirikumeetrikatel (8728 sünni-, surma- ja abielukirjet) ning 1897. aastal läbi viidud esimese ülevenemaalise rahvaloenduse individuaalandmetel (40 636 loenduskirjet). Kuna teiste usutunnistuste koguduste meetrikad ei ole ajavahemiku 1897–1900 kohta täielikult säilinud, keskendub artikkel luteriusulisele rahvastikule. Imikusuremuse analüüsiks vajaliku andmebaasi loomine toimus kahes etapis. Esimese sammuna said 1897.–1900. aasta imikute surmakirjed (n=466) lingitud 1897.–99. aasta sünnikirjetega (n=2505), teise sammuna järgnes sellele sünnikirjete linkimine rahvaloenduse andmetega. Sünnikirjetega õnnestus lapse nime alusel siduda 90% imikute surmakirjetest (n=417). Ema andmetega 1897. aasta rahvaloenduses õnnestus linkida 75% sünnikirjetest (n=1882). Kolme allikat (surmameetrika, sünnimeetrika ja loendus) ühendav imikusuremuse andmebaas võimaldab jälgida kolme sünnikohorti (1897, 1898 ja 1899) läbi esimese eluaasta ja analüüsida kahe statistilise mudeli (logistiline regressioon ja Cox-i regressioon) abil imikute ellujäämistõenäosust individuaalselt ja perekonna (vanemate) kontekstis.

Analüüsi tulemuste kohaselt oli imikusuremuskordaja aastatel 1897–99 Tartu luteriusulises elanikkonnas 144‰. See näitaja on 15% võrra madalam kui Eesti keskmine samal perioodil. Tulemused näitasid, et imikusuremus varieerus oluliselt erinevates rahvastikurühmades. Ootuspäraselt suurendasid vastssündinu riski surra esimese eluaasta jooksul pere suurus ja ema vallalisus; vallaslaste imikusuremus risk oli pea kolm korda suurem kui abielus sündinud lastel. See tulemus on kooskõlas mitmete varasemate ajaloolis-demograafiliste uurimustega, kus rõhutatakse abielulisuse mõju imikute ja laste elulemusele. Lisaks leidis käesolev uurimus positiivse seose isa hariduse ja kaubandussektorisse kuuluva ameti ning imikute elulemuse vahel. Üllatuslikult ilmnes aga vastupidine seos ema hariduse ja imikusuremuse vahel. Samuti näitas analüüs, et eestlaste peredesse sündinud laste ellujäämistõenäosus oli mõnevõrra madalam kui baltisakslastel. Erisuse säilimine ka pärast sotsiaal-majanduslike tunnuste (vanemate haridus ja amet) arvessevõtmist võib tuleneda kahe rahvusrühma erinevatest praktikatest laste eest hoolitsemisel ja nende kasvatamisel. Demograafilise ülemineku kontekstis osutab see imikusuremuse varasemale vähenemisele baltisakslaste hulgas ja vastavalt baltisakslaste pioneerrühma rollile.

Üheks omaette huvipakkuvaks tulemuseks võib pidada tugeva seose leidmist tarbevee allika ja imikusuremuse vahel. Reeglina peetakse elukeskkonna, eriti joogivee puhtuse paranemist üheks oluliseks teguriks imikusuremuse vähenemisel, kuid suhteliselt harva on seda seost õnnestunud statistiliselt veenval kujul näidata. Käesoleva analüüsi tulemused demonstreerivad selgesti, et jõevee tarbimine oli äärmiselt ebasoodus imikute ellujäämistõenäosusele.

Käesoleva artikli näol on tegemist teadaolevalt Eestis esimese demograafilise ülemineku perioodi lingitud loendus-sündmusandmete põhjal analüüsiva uurimusega. Tartu luteriusulise elanikkonna näitel õnnestus näidata keskkondlike, sotsiaal-majanduslike ja kultuuriliste tegurite rolli imikusuremuse taseme kujundamisel 19. sajandi lõpu Eesti linnaühiskonnas. Demograafilise ülemineku kontekstis ulatuslikumate järelduste tegemiseks on kavas laiendada uurimust edaspidi ka teistele rahvastikuprotsessidele. Järgnevaks ülesandeks on laste- ja täiskasvanusuremuse analüüs ning seejärel sündimuse analüüs Tartus 19. sajandi teisel poolel.