DEMOGRAPHIC RESEARCH
A peer-reviewed, open-access journal of population sciences

DEMOGRAPHIC RESEARCH

VOLUME 36, ARTICLE 1, PAGES 1–40
PUBLISHED 3 JANUARY 2017
http://www.demographic-research.org/Volumes/Vol36/1/
DOI: 10.4054/DemRes.2017.36.1

Research Article

Socioeconomic and cultural differentials in mortality in a late 19th century urban setting: A linked records study from Tartu, Estonia, 1897–1900

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Abstract

BACKGROUND
An expanding literature documents historical linkages between socioeconomic and cultural disparities and survival. The evidence originates mainly from studies of Western Europe and North America, but we know less about the history of mortality differentials in other regions.

OBJECTIVE
This study estimates the mortality level among the Lutheran population of Tartu (1897–1900) and examines its associations with socioeconomic status and ethnicity/language.

METHODS
The analysis draws on parish registers, which have been linked to data from the first Russian Imperial census in 1897. In order to investigate the association between the characteristics of the population and mortality risks, Poisson regression models are estimated.

RESULTS
The results show significant inequalities in mortality associated with socioeconomic status. In addition to upper-level non-manual workers, domestic servants were found to have reduced death risks, while small entrepreneurs displayed elevated risks. Surprisingly, the adult mortality advantage associated with upper-level non-manual jobs and advanced education was driven by women. Men in the upper strata of society exhibited no substantial advantage, but a lack of elementary education implied a mortality disadvantage for working-age men. The effect of education did not disappear

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with the inclusion of occupation and other controls in the models. The analysis revealed no significant difference between ethnic/language groups.

CONCLUSIONS
The observed differentials can be seen as manifestations of a divide between forerunners of and laggards in the secular trend towards longer life expectancy. The study makes a case for a comprehensive approach to examining mortality differentials that pays equal attention to the effects of the individual characteristics of men and women.

CONTRIBUTION
The study contributes to the literature by focusing on an Eastern European context and examining mortality differences associated with occupational group as well as education, which has seldom been done in 19th century settings.

1. Introduction

Scholarly interest in social inequality and its effect on health dates back to the 19th century with contemporary observations of urban working-class living conditions, which in many cases appeared to be associated with elevated death rates among disadvantaged groups. For several reasons, in recent years there has been a considerable increase in interest in the study of socioeconomic mortality differentials in historical populations.

Contrary to expectations, remarkable improvements in life expectancy during the post-war decades did not bring about the disappearance of socioeconomic health inequality. Instead, demographic and epidemiological studies have documented widening mortality differences between social strata in a number of countries in Europe since the 1960s (Mackenbach et al. 1997, 2003, 2008; Kunst et al. 2004). These findings made the contemporary dynamics of social health inequality an important policy issue. In order to judge the extent to which inequality had increased or diminished over the longer term, evidence pertaining to past mortality differentials acquired essential importance (Whitehead 1998). Historical evidence is also important for testing arguments related to the continuity of socioeconomic differentials in mortality, which has attracted considerable attention in recent decades (Link and Phelan 1995; 2002; Phelan et al. 2004). Furthermore, with regard to historical research, mortality rates have proven to be useful proxies for living standards and economic well-being, possessing several advantages over other alternatives (Allen, Bengtsson, and Dribe 2005). As factors such as poverty, inadequate food, and unsafe water supply influence susceptibility to disease and death, variation in survival rates reveals important information about the experience of different social strata and changes over time. This evidence appears to be central to solving the long-running debate over the impact of the Industrial Revolution on social inequality and living standards (Kuznets 1955; Williamson 1997; Piketty 2014).

Research on mortality differentials among historical populations has been stimulated by the development of large-scale demographic databases based on individual records (Hall, McCaa, and Thorvaldsen 2000). The analyses based on these databases have markedly advanced our knowledge of how the social mortality gradient has evolved over time and varied across different contexts (for an overview, see Bengtsson and van Poppel 2011). However, the existing research has some important limitations. With regard to geographical coverage, most European studies on historical mortality differentials have focused on countries in the western, northern, and southern parts of the continent (Belgium, Germany, Italy, France, the Netherlands, Norway, Spain, Sweden, and the United Kingdom). By contrast, only a few studies have examined socioeconomic and cultural differentials in mortality in the 19^{th} century Eastern European context (Liczbińska 2009, 2011; Drozd-Lipińska, Klugier, and Kamińska-Czakłosz 2015; Bonneuil and Fursa 2016). A major reason for this gap is the scarcity of databases in the region that combine detailed individual-level death records and the population at risk.

This study investigates historical mortality differentials in Tartu, the second largest city in Estonia, between 1897 and 1900. The aim of the study is to estimate the mortality level among the Lutheran population of the city and examine the variation associated with socioeconomic and cultural characteristics. The analysis draws on parish registers, which have been linked to data from the first Russian Imperial census of 1897 in Tartu. In order to investigate the association between population characteristics and mortality risks we estimated a series of Poisson regression models. We believe that our study contributes to the literature in several important ways. First, by focusing on an Eastern European context, the study contributes to a more comprehensive account of mortality differentials in Europe in the late 19^{th} century. Second, the individual-level data that we use allows us to examine mortality differences associated with both occupational group and education, which has seldom been analysed in 19^{th} century settings. During that period the overwhelming majority of the population had only primary schooling. However, the presence of a university makes analysis of educational differentials feasible in the case of late 19^{th} century Tartu. Relative to occupation, education has an important advantage, in that it can be applied to all individuals irrespective of the status of their economic activity. It enables the unemployed and economically inactive to be included in the analysis: excluding such groups might lead to underestimating the size of mortality differences (Martikainen and Valkonen 1998). The study also offers an opportunity to ascertain whether the social position of different ethnic/language groups was reflected in mortality risks. Third, the availability of a local supplement to the census questionnaire permits us to take into account the potentially confounding influence of varying sanitary conditions, and to distinguish it from the effects of socioeconomic and cultural factors. Finally, we investigate both men and women, which allows us to explore the sex-specific pattern of mortality differentials.

The article is structured in seven sections. Following the introduction is a brief overview of the literature on mortality differentials and the historical setting of Tartu at the end of the 19th century. Next is an explanation of the research questions, data, and analytical methods. The last sections report the empirical results and present the conclusions of the study.

2. Socioeconomic and cultural differentials in mortality in 19th century populations

Over the past few decades, several competing views have been advanced on socioeconomic health differentials in historical populations.

The theory of fundamental social causes (sometimes also referred to as the constancy hypothesis), developed by Link and Phelan (1995; 1996; 2002), suggests that socioeconomic differences in mortality have persisted over a long historical period and a wide variety of contexts. This theory builds on the fact that in most societies – contemporary as well as historical – higher socioeconomic status grants individuals better access to essential resources, including money, information, and beneficial social connections. Furthermore, it is assumed that thanks to greater resources, socially advantaged groups have always been more successful in both avoiding exposure to risk factors and overcoming the sequelae of the diseases they contract, thus producing a health gradient. The proponents of the theory maintain that the general association between mortality and socioeconomic status endures, despite the secular trend towards higher life expectancy and a profound transformation in the profile of risk factors (Phelan et al. 2004). Whereas inadequate nutrition, lack of sanitation, poor housing, and the like were previously considered primarily responsible for high mortality due to various infectious diseases among less advantaged groups, in more recent times smoking and excessive alcohol consumption, lack of exercise, and an unhealthy diet have become the main risk factors that lead to similar outcomes from injuries and cardiovascular diseases. Cassel (1976) and Marmot (2004) have expressed largely similar views.

Another prominent perspective – often referred to as the divergence-convergence hypothesis – was introduced by Antonovsky (1967) and is based on evidence from a variety of studies of historical demography in Western Europe. Contrary to the fundamental social causes theory, this approach suggests that there has been a long-term change in the association between socioeconomic status and mortality, driven by the transformation in disease patterns. According to Antonovsky, there was no substantial difference in life expectancy between the upper and lower social strata until the mid-17th century. The absence of a gap is attributed to the epidemiological environment, which was then dominated by highly virulent communicable diseases, with no treatment available. In such circumstances, the foremost cause of mortality was exposure to infectious agents. Over time, highly virulent diseases receded and nutrition- and sanitation-dependent diseases gained importance as causes of death. In tandem with an increase in economic inequality brought about by industrialisation, the shift in disease patterns is assumed to have produced large differentials in mortality between socioeconomic strata. In Antonovsky's view (1967; 1980), social differentials peaked sometime during the 19th century, probably in the second half. The trend subsequently reversed and the class gap started to gradually diminish, reaching relatively low levels in the post-war decades.

Antonovsky's approach resembles health transition theory, which has become the main conceptual framework for describing both historical and contemporary trends in health and mortality (Vallin and Meslé 2004; 2005; Vallin 2013). Health transition theory separates the entire transition process from high to low mortality into successive stages, each including a specific divergence-convergence sub-process. The theory posits that each major improvement is likely to begin with a divergence phase, since advantaged sub-groups tend to benefit most from the improvement due to better resources. When the rest of the population gains access to the improvement (through rising living standards, behavioural changes, improved access to medical techniques, etc.) a convergence phase begins, which can lead to a reduction in mortality differentials until another major advance occurs. According to the health transition perspective, the end of the 19th century – the period this article focuses on – can be considered a stage characterised by substantial mortality differences between social strata.

Verification of these theoretical views is a serious task that requires empirical data on mortality among social strata that extends far back into the past and spans a long period of time. Perhaps the most recent evidence that enables these hypotheses to be tested comes from a series of coordinated studies in multiple locations in Northern, Western, and Southern Europe, and North America (Bengtsson and van Poppel 2011). The empirical findings do not support the hypothesis that some fundamental mechanisms have always and everywhere provided materially advantaged groups with a greater life expectancy, as anticipated by Link and Phelan (1995; 1996; 2002). However, neither do the findings provide unequivocal support for the divergence-convergence perspective. For the second half of the 19th century the expected mortality gradient, featuring elevated death risks among the lower social strata, is reported in Alghero, Sardinia (Breschi et al. 2011), Geneva (Schumacher and Oris 2011), and the Netherlands (Schenk and van Poppel 2011). By contrast, in Sweden, both in the rural parishes of Scania in the southern part of the country and in the northern sawmill town of Sundsvall, no social differences are found in adult mortality during the period of industrialisation (Bengtsson and Dribe 2011; Edvinsson and Lindkvist 2011). Likewise, in Saguenay, Canada, no substantial social differences in mortality are observed in the latter half of the 19th century, with the exception of farmers having lower mortality than urban residents (Gagnon et al. 2011).

Researchers have offered several explanations for the occasional failure of social health and mortality differentials to exhibit the expected pattern in historical contexts. Edvinsson and Linkvist (2011) suggest that close daily contact between social strata and a shared living environment may explain the absence of pronounced social health contrasts, even if the difference in access to resources was large. In such circumstances, infectious diseases, which accounted for the majority of deaths and lacked effective treatment, could easily spread from the poorest groups to the rest of the population. Molitoris and Dribe (2016) recently cited this mechanism to explain the lack of a class-specific mortality response to economic stress in Stockholm between 1878 and 1926. Another way of explaining the absence of a socioeconomic mortality gradient involves factors that counteracted and nullified the advantages of possessing greater wealth. A review of English historical evidence provides an impressive list of risk factors affecting the higher strata, including an unhealthy diet, excessive consumption of food, alcohol, and tobacco, and lack of physical activity (Razzell and Spence 2006). It has also been argued that the indoor environment of white-collar workers exposed them to a greater risk of tuberculosis (Ferrie 2003).

In addition to socioeconomic differentials, research on historical populations has revealed an association between mortality and cultural factors. For instance, several studies show lower levels of child mortality in Jewish communities as compared with other denominations (Derosas 2003; Van Poppel, Schellekens, and Liefbroer 2002). By contrast, Roman Catholics experienced somewhat higher mortality in the Netherlands and Germany (Haines and Kintner 2000; Wolleswinkel-van den Bosch et al. 2000). These differentials are often driven by intergroup variation in breastfeeding and childrearing practices. Studies of historical contexts also reveal substantial disparities in mortality by language and ethnic origin that may extend from children to adults (Thornton and Olson 2001, 2011; Mercier and Boone 2002). For contexts in which there are cultural divisions, these results underscore the importance of considering non-economic factors. In circumstances where certain ethnic, language, or religious groups hold a more privileged status than the general population, socioeconomic and cultural differentials may overlap.

In conclusion, research into mortality differentials has identified a variety of methodological problems due to which the reported associations between death risks and group affiliation may not fully correspond to reality (Smith, Blane, and Bartley 1994). To mention a few, the use of unlinked data can easily lead to so-called numerator-denominator bias: it has been demonstrated that estimates obtained from unlinked data tend to overstate mortality in disadvantaged groups and understate it among the advantaged (Shkolnikov et al. 2006). Furthermore, in many studies of mortality differences by occupational group the occupation of currently inactive persons, including retirees and disabled persons, is unknown. This creates a risk of underestimating occupational differences because inactive persons not only have elevated mortality risks but also tend to belong to lower occupational groups (Martikainen and Valkonen 1998). There is evidence that even if general tendencies are unaffected, the magnitude of socioeconomic mortality differentials can vary according to the measures and classifications applied (Kunst et al. 2004). These observations highlight the importance of careful attention to methodological choices in the analysis of mortality differentials.

3. The historical context of Tartu

By the end of the 19th century, Tartu was the second largest town in the Russian Imperial Governorate of Livonia after Riga, the provincial capital. Due to rapid urbanisation from the 1860s onwards the population of Tartu doubled in a matter of a few decades, to 40,636 at the time of the 1897 census. However, unlike most rapidly growing urban centres at the time, Tartu experienced relatively modest industrialisation in the 19th century. The presence of the oldest university (established in 1632) in the Baltic provinces of the Russian Empire rendered Tartu an important centre of higher education and science; the university was the largest employer in the town (Leppik 2006).

The population of Tartu was ethnically and linguistically diverse; Estonians and Baltic Germans comprised the two largest ethnic/language groups. Over the course of the 19th century, large-scale in-migration, mainly from the rural areas of southern Estonia, increased the number of Estonians. As a consequence, by 1897 the proportion of Estonian-speakers had reached 71% (from just over 40% in the 1860s), while that of German-speakers had decreased to 17% (Berendsen and Maiste 1999). Russian-speakers accounted for 7% and Jews for 3% of the population in 1897. The major ethnic/language groups had distinct socioeconomic profiles and residential patterns.

Baltic Germans prevailed among the higher social strata, including the nobility, university professors, municipal administrators, industrialists, and large merchants (Raun 2001; Leppik 2006). By contrast, Estonians were predominantly employed in manual occupations. The presence of the university and several other educational institutions resulted in the educational attainment of the population being high for the period. According to data provided by Berendsen and Maiste (1999), in Tartu in 1897, 17% of men aged 15 and over had secondary or tertiary education and, 12% of adult women had similar qualifications. The adult literacy rate was 98% for both men and women.

The sanitary conditions in Tartu had several shortcomings in the late 19th century (Körber 1902). The water supply of the town came from artesian and groundwater wells and surface water from the river. Some areas in the centre of the town had a system of wooden street gutters that carried wastewater straight to the river, causing pathogenic contamination (Rammul 1902; Melkert 1904). From the late 1860s, Tartu operated a basket system for waste removal, whereby carriages collected excreta from across the town and transported it to a central facility (Leppik 2013). However, only half of the houses had registered for regular waste removal by the end of the century: residents from the poorer strata preferred to use the waste to fertilise their plots of land. As a result, groundwater wells, the most common source of water in the 19th century, were at risk of contamination from leaking cesspools and surface water (Schmidt 1863; Brasche 1893). It was not until the late 1920s that the development of a modern water supply and sewer system was initiated.

We know relatively little about mortality levels and differentials in Tartu in the second half of the 19th century. Two doctoral dissertations (Huebner 1861; Grosset 1883) analysed vital statistics for Tartu and its surrounding parishes, but unfortunately the authors did not apply detailed mortality measures. More recent studies indicate that the mortality decline was well underway in Tartu during the latter decades of the 19th century (Berendsen and Maiste 1999; Laarmaa 2009). However, the absence of age-specific measures precludes a more precise account of mortality levels among the population of Tartu in the previous studies. Mortality differentials have not been analysed for that period, either for Tartu in particular or for Estonia in general. This study aims to fill these voids in the literature.

4. Research aims and hypotheses

This study has two main objectives. The first aim is to estimate the level of overall mortality among the Lutheran population of late 19th century Tartu. Considering the urban mortality disadvantage that prevailed in Europe at that time (Schofield, Reher, and Bideau 1991; Kearns 1993; Vögele 1998) and the local sanitary conditions, life expectancy in Tartu during this period was expected to be somewhat below the national average. However, the scale of the disadvantage was anticipated to be less pronounced compared to larger cities in the Baltic provinces that had a sizeable industrial workforce.

The second aim was to investigate the variation in mortality risks, thereby providing insight into the factors that affected the health of the population in question. More specifically, the analysis sought answers to the following questions: i) how did the risk of death vary according to socioeconomic status (measured by educational attainment and occupational group)? and ii) what were the differences in mortality related to ethnicity/language? Guided by the divergence-convergence perspective and the findings of previous studies, discussed in the foregoing sections, we anticipated lower mortality among groups with higher socioeconomic status. At the same time we remained undecided as to how systematic and robust the association would be, and the extent to which the effects of education and occupation would be mutually independent. For ethnic/language groups, we hypothesised that Baltic Germans would have a lower mortality rate than Estonians. However, it was not obvious whether the ethnic/language differentials would persist after controlling for socioeconomic status, disparity of sanitary conditions, and other factors.

Finally, we anticipated some variation in socioeconomic and ethnic/language differentials by sex and broad age groups (adults and children), but previous research offered limited clues as to the distinct patterns.

5. Data, variables, and analytical strategy

The main sources of data for this study were the enumeration lists of the First Russian Imperial census in 1897 and the Lutheran parish registers for the population of Tartu. The census records used in this study are based on local copies of the census lists that were prepared by the university and computerised in the 1990s (Berendsen and Maiste 1999). This unique collection of census data provides individual-level information for the entire population of the town on demographic, socioeconomic, and cultural characteristics, housing, and sanitation.[4] The data on vital events was retrieved from the

[4] The programme of the First Russian Imperial census required collection of the following information: name, sex, age, marital status, social estate, occupation, place of birth, usual place of residence, presence at the census, religion, mother tongue, education, literacy, relation to military service, and physical disabilities (Clem 1986). The census programme lacked information on sanitary conditions, but Bernhard Körber, who was a professor of hygiene and involved in the local organisation of the census in Tartu, administered a short supplementary questionnaire on these issues. The information collected in the supplement included water supply, the existence of a privy and cesspit system, paving of the yard, and the materials in which the walls

registers of all the Lutheran parishes in Tartu. The absence of fully survived archived parish registers for non-Lutheran congregations limits our study to Lutherans, who constituted 84% of the total population of Tartu at the end of 19th century.

Our research data set was based on 34,135 individuals who identified themselves as Lutherans in the 1897 census. To analyse the mortality differentials, individual death records were linked to corresponding census records for a three-year period starting from the date of the census (January 28, 1897 to January 27, 1900). The linkage was performed by applying nominative techniques. Out of 1,773 deaths recorded during the observation period, 73.5% were successfully linked to the corresponding census record. The linkage rate is similar to that reported in many linked-records studies of the period (Edvinsson 1995; Hautaniemi, Anderton, and Swedlund 2000; Thornton and Olson 2011). The length of time between the census and the death of an individual seems to have slightly reduced the chances of a secure match. For deaths that occurred during the first two years following the census the linkage rate was 75% and for the final year it was approximately 70%. The linkage rates were somewhat higher for females, children, and older persons, which may reflect differences in mobility. To evaluate the bias resulting from incomplete linkage, a comparison between all death records and those that were successfully linked was undertaken for a number of characteristics (sex, age group, ethnicity/language, marital status, and aggregated cause of death). Although the comparison revealed some discrepancies, the magnitude of the bias (typically 1–2 percentage points) was not large enough to invalidate our main results. The working dataset we used in the analysis consisted of 34,081 individuals who were observed for 99,710 person-years, and included 1,249 deaths.

The main independent variables in the analysis of mortality differentials were occupation, educational attainment, and ethnicity/language. There is a long-established approach in social history studies to base socioeconomic status categorisations on occupation. In the context of mortality studies the assumption is that occupational groups differ in access to various resources and social power relevant to health; in addition, occupation relates to the sphere of work itself in ways that can affect health through several mechanisms (safety of the work environment, control over work intensity, work-related stress, etc.). The categorisation applied in the study distinguishes between five occupational groups: upper-level non-manual workers, lower-level non-manual workers, small entrepreneurs, manual workers, and domestic servants.[5] Upper-level non-manual workers are those who were engaged in higher managerial and

and roof were built (Berendsen and Maiste 1999). The availability of this additional information renders the collection of 1897 census materials for Tartu particularly well suited to the analysis of mortality differentials.

[5] At the preparatory stage we also experimented with more refined occupation groupings ,based on HISCO (Van Leeuwen, Maas, and Miles 2002) and ISCO-88 (ILO 1990) classifications. However, a more detailed breakdown did not provide much additional insight into mortality differentials, partly because of the decreased number of observations resulting from expanding the number of occupational groups.

professional occupations (university lecturers, medical doctors, lawyers, engineers, teachers, etc.). The category of lower-level non-manual workers includes technicians, clerks, and persons working in sales and service occupations. Small entrepreneurs are mainly shopkeepers and artisans: those included in this category can be assumed to have been in charge of their own business. Manual occupations comprise both skilled and unskilled workers: we attempted to distinguish between sub-groups of manual workers according to skill level, but, as no systematic pattern emerged, the sub-categorisation was not implemented in the final version of the study. However, a separate category was deemed necessary for domestic servants as this group made up a significant proportion of the Tartu workforce and exhibited a distinct mortality pattern.

Descriptive statistics reveal that the occupational structure of the Tartu population was dominated by manual workers, who accounted for over three-fifths of the gainfully employed; the second largest group was comprised of domestic servants, who made up another fifth (Table 1). The remaining three groups accounted for a much smaller share of the labour force. The descriptive statistics also indicate a considerable difference in the occupational structure and labour market attachment of men and women. A markedly higher proportion of men among the gainfully employed shows the predominance of the male breadwinner–female homemaker family model (Pott-Buter 1993; Janssens 1998). More detailed evidence pertaining to age-specific employment rates suggests that most Tartu women left their paid employment upon marriage, while it was quite common for unmarried women to participate in the labour force.[6] In order to account for this situation, for women, the individual-level variable for occupational group (the main specification) was supplemented by an additional variable that combined individual and family-level information. For non-employed women aged 15 and older the further variable refers to the occupational group of their husband or father if they resided in the household at the time of the census. For children under age 15 only the family-level information for occupational group was used; the variable is based on the father’s occupation (or the mother’s occupation if the father was not present).

[6] In the 25–39-year age group, employment rates were 81% and 21% among unmarried and married women respectively.

Table 1: Descriptive statistics of main independent variables, children aged 1–14 and adults, Lutheran parishes of Tartu, Estonia, 1897–1900

Variable	Men	Women	Total	Men (%)	Women (%)	Total (%)	Deaths
Occupational group							
Upper non-manual	526	444	970	4.7	5.1	4.9	23
Lower non-manual	692	355	1,047	6.2	4.0	5.2	30
Small entrepreneurs	1,089	407	1,496	9.7	4.6	7.5	56
Manual	8,076	4,746	12,822	71.9	54.1	64.1	435
Domestic servants	842	2,823	3,665	7.5	32.2	18.3	84
Subtotal: employed	11,225	8,775	20,000	100.0	100.0	100.0	628
Non-employed	4,154	9,927	14,081				621
Total	15,379	18,702	34,081				1,249
Education							
No education	1,021	1,179	2,200	6.6	6.3	6.5	76
Primary	12,133	15,597	27,730	78.9	83.4	81.3	1,056
Secondary or tertiary	2,225	1,926	4,151	14.5	10.3	12.2	117
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249
Ethnic/language group							
Estonians	12,433	14,957	27,390	80.8	79.9	80.4	989
Baltic Germans	2,946	3,745	6,691	19.2	20.1	19.6	260
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249

Note: Occupational group refers to individuals' own occupation or parents' occupation.
Source: Based on the linked records data set of Lutheran parish registers and the 1897 census; source materials are preserved in Estonian National Archives, Tartu, Estonia.

Modern studies have shown that educational attainment improves the likelihood of survival through various mechanisms, but education has seldom been addressed in historical settings. As an educational qualification is related to the kinds of work that people can do (it precedes occupation on the causal pathway), part of the mortality differential associated with occupational group may, in fact, be driven by education (Martikainen, Blomgren, and Valkonen 2007). An important advantage of education over occupational group is that it can easily be applied to the entire adult population, irrespective of whether or not individuals are currently employed; also, educational qualifications are usually obtained in early adulthood and remain stable over most of the life course. For these reasons, this study uses occupation and education as complementary measures of socioeconomic status. The independent variable for education distinguishes between three categories: secondary or tertiary education, primary education, and no primary education. Table 1 shows that more than three-fifths of the town's population had attended or completed primary education, and roughly a tenth had attended or completed secondary or tertiary education. The remainder of the population had not received primary education.[7] Among persons aged 15 and over, the proportion of the latter group was very small (3%); two-thirds of the adults who lacked primary education were illiterate. Compared to occupational group, the sex difference in education appears smaller. For the analysis of mortality differentials among children we constructed an education variable based on the father's education (or mother's education if the father was not present).

Ethnic/language group was defined according to the language question in the census (mother tongue) and differentiated between Estonians and Baltic Germans.[8] The majority of the Lutheran population included in the study were Estonians (more than four-fifths of the population studied), while Baltic Germans formed the minority (one-fifth). The latter also includes a small number of Lutherans (430 persons) belonging to other language groups (mostly Latvians). Apart from the small size of these groups, the merging was motivated by their similarity to Baltic Germans in terms of occupational structure. For all the main independent variables there were virtually no cases of missing values, which attests to the quality of the data.

In addition, six control variables were considered in the study. Previous historical research has demonstrated that the local sanitary environment can be an important confounding factor influencing mortality differentials in historical contexts (Woods and Williams 1995; Molitoris and Dribe 2016). Due to spatial segregation, whether based on socioeconomic status or ethnicity (both types of segregation were present in Tartu in the 1890s), the observed socioeconomic and ethnic differentials in mortality may be partially mediated by disparities in the sanitary conditions between districts and neighbourhoods. To account for this we used water supply, type of privy, and the presence of carters as controls. The two former measures were found to be significant in an earlier study on the impact of sanitation on infant mortality in the same setting (Jaadla and Puur 2016) and the effect of horses in near proximity to the residence has been demonstrated in other contexts (Morgan 2002; Thornton and Olson 2011). Previous research has also indicated the importance of individuals' geographical mobility to their subsequent chances of survival (Hautaniemi, Swedlund, and Anderton 1999; Kesztenbaum and Rosenthal 2011). Because the urban environment exposed individuals to greater risks, migrants arriving from the countryside can be assumed to have been healthier than urban dwellers on average. To control for the influence of mobility, migrant status was included among the controls. It was assumed to be of particular importance to the measurement of ethnic/language differentials, because

[7] The formulation of the education question in the 1897 census did not allow us to clearly identify completed education.

[8] We use the term ethnic/language groups in this study because ethnicity and language closely coincided in Estonia. For instance, the 1922 census, which contained both ethnic and language questions, indicated that only 0.8% of ethnic Estonians did not report Estonian as their mother tongue (Riigi Statistika Keskbüroo 1924: 31).

Estonians formed the bulk of migrants to Tartu during the period of our study. Where appropriate, age group and sex were also included among the controls.[9] Descriptive statistics for the control variables are presented in Table A-3 of the Appendix.

In order to analyse socioeconomic and cultural differentials the study applied Poisson regression models, as a panel comprising a three-year observation window can be considered too short for rigorous longitudinal analysis. Poisson models are widely used in epidemiology to model rate data that consists of the number of events (in this study, the number of deaths) divided by the exposure time (person-years at risk) during which the events occurred (Preston 2005). Poisson regression models have been employed in a number of studies of mortality in historical populations (Leonard, Beemer, and Anderton 2012; Leonard et al. 2015; Molitoris and Dribe 2016). The Poisson model can be expressed by the following formula (Dalgaard 2008: 262):

$$\log \rho = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots \beta_k x_k + \log T$$

in which $\log \rho$ represents the log rate of the event (death); β_0 represents the constant; $x_1, x_2 \ldots x_k$ represent the covariates (occupational group, educational level, ethnic/language group, etc.) included in the model; $\beta_1, \beta_2 \ldots \beta_k$ represent a vector of parameters to measure their effects, and log T is an offset of exposure measured in days. Our strategy foresaw the estimation of separate models for adults and children. To ascertain whether the mortality differentials were more pronounced among those of working age, additional models were fitted for the age group 15–59. Because socioeconomic status may not necessarily have the same consequences by sex, pooled models for adults of both sexes were complemented with separate models for men and women. In estimating the models the observation time was split into three episodes, from January 28, 1897 to January 27, 1898, from January 28, 1898 to January 27, 1899, and from January 28, 1899 to January 27, 1900, respectively. Age of individuals was fixed at the beginning of each episode.

The R statistical software package was employed for the estimation. The modelling results are presented in terms of adjusted rate ratios, with associated levels of significance. Further details pertaining to specific models are given in the following sections.

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[9] In the preliminary analyses we experimented with a somewhat broader range of control variables, but the inclusion of additional covariates (e.g., marital status, paving of the yard) did not significantly improve the models.

6. Results

6.1 Estimates of life expectancy

In order to estimate overall mortality levels for the Lutheran population of Tartu we constructed abridged life tables. The calculation of age-specific deaths rates was based on the deaths recorded in parish registers during the two years surrounding the census (1896 and 1897) and the Lutheran population enumerated at the census. Because children under one year of age are often under-enumerated in historical censuses, the number of live births registered during the year preceding the census was used for the estimation of infant mortality (Thornton and Olson 2011). The estimation employed the MORTPAK software package (United Nations Population Division 2013), which means that the results are not affected by incomplete linkage of death records to the census.

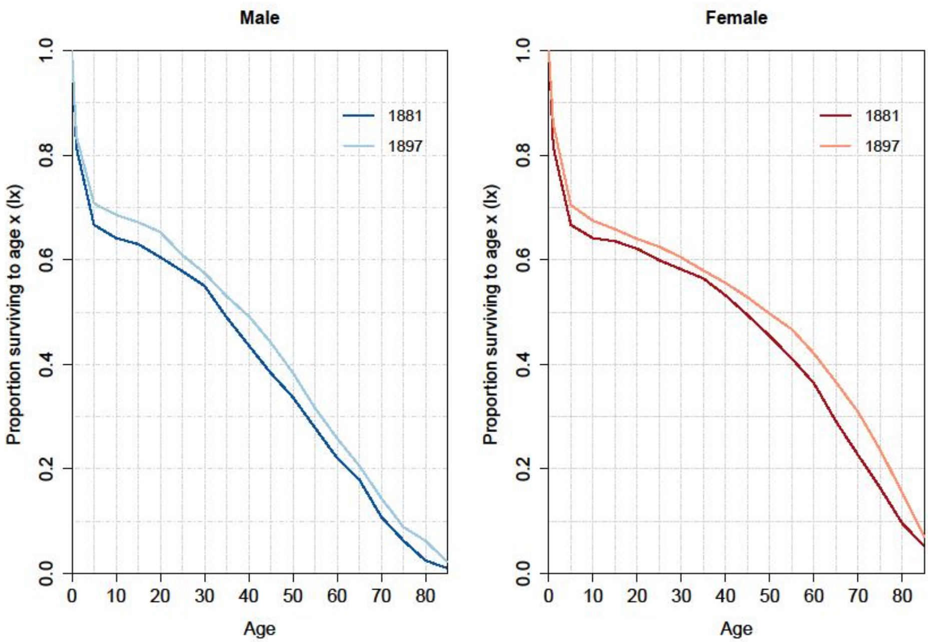
According to the estimates, life expectancy at birth was 42.7 years for Lutheran women in Tartu between 1896 and 1897, and 36.4 years for men (the life tables are presented in Table A-1 of the Appendix). These results indicate that Lutherans in Tartu had a clear longevity disadvantage relative to the national average: the concurrent estimates for the country as a whole were 45.5 years for women and 41.9 years for men (Katus and Puur 1992). Since close to 85% of the population resided in rural areas in Estonia in the late 1890s, the gap can be seen as a manifestation of the urban mortality disadvantage that prevailed all over Europe during that period (Schofield, Reher, and Bideau 1991; Kearns 1993). The results also show that the pattern varies by sex. The gap between local and national life expectancy is particularly evident for men (5.4 years); among women, the difference is almost half that (2.8 years). This suggests that adult men were particularly exposed to the risk factors underlying the urban disadvantage.

To provide some insight into the dynamics of life expectancy in late 19th century Tartu, we compared life table estimates from 1896–1897 and 1881–1882.[10] The results corroborate findings from previous studies based on crude death rates, according to which an urban mortality decline was well underway in the town in the latter decades of the 19th century (Berendsen and Maiste 1999). Between 1881 and 1897, life expectancy at birth increased three years for both men and women (from 39.2 for women and 33.1 for men in 1881–1882). A closer analysis of the change revealed that reductions in child and infant mortality made the largest contribution to the rise in life expectancy (Figure 1). As there are no life table estimates available for Estonia as a whole in the early

[10] The 1881–1882 abridged life table was based on the 1881 census of the three Baltic governorates of the Russian Empire and the Lutheran parish registers surrounding the census year. The procedure applied was similar to those employed in constructing the 1896–1897 life table.

1880s it is not possible to judge whether the extent of urban disadvantage had changed between the 1881 census and the next census. However, the comparison of our estimates for Tartu based on life tables for the three Baltic governorates in 1880–1883 suggest that the disadvantage in life expectancy characteristic of the Lutheran population in Tartu did not change substantially during the 1880s and 1890s.[11]

Figure 1: Number of life table survivors, Lutheran parishes of Tartu, Estonia, 1881–1882 and 1896–1897



Source: As for Table 1, authors' calculations.

The Tartu Lutherans exhibit a noticeably higher life expectancy than the populations of the major urban centres of the Russian Empire. Data for Riga, then the capital of the Livonian governorate, show a three-year gap in life expectancy for males and a four-year gap for females. Relative to St. Petersburg and Moscow, the difference appears even more pronounced, ranging from 11 to 16 years (Ptuha 1960). The advantage observed for Tartu seems plausible for several reasons. First, 19th century

[11] According to Besser and Ballod (1897), life expectancy at birth was 39.1 years for males and 42.7 years for females in the Estonian, Livonian, and Curonian Governorates 1880–1883.

Tartu could be characterised as a medium-sized town with only a few large industrial enterprises. In his account of sanitary conditions, Körber (1902) reported better housing standards in Tartu than in the major industrial centres of the time, including Riga and a number of cities in Germany. Less crowding may have entailed lower risks through the transmission of airborne infectious diseases, which were among the leading causes of urban deaths in that period (Bernhardt 1995; Reid 2002). Second, due to the presence of the university, the concentration of medical personnel was remarkably high in Tartu by contemporary standards. This may imply not only improved access to health care but also an elevated public interest in sanitary issues.[12] Finally, the composition of the population may also have exerted a positive influence. As noted earlier, Tartu featured a high concentration of people with advanced educational qualifications. Similarly, the proportion of Baltic Germans in the town, who had markedly lower infant mortality than Estonians (Jaadla and Klesment 2014), exceeded the national average by a factor of more than six.

6.2 Multivariate results

6.2.1 Differentials in adult mortality

Occupation. Table 2 presents the modelling results for occupational groups among adults, controlled for demographic characteristics, education, and sanitary conditions. In all models, the occupation variable refers to individuals' own occupation. The model based on the data for all adults shows fairly small mortality differences associated with occupational group. Contrary to expectations, upper-level non-manual workers – the strata at the top of the social hierarchy – display a rather limited (–9%), statistically insignificant mortality advantage over the reference group (manual workers). Interestingly, the lowest rate ratio (–17%) is found for domestic servants, although the difference does not reach the level of statistical significance. At the other end of the spectrum the mortality risks for small entrepreneurs clearly exceed those of the reference group (+37%). The difference between lower-level non-manual and manual workers is marginal (+2%).

[12] Public interest in sanitary issues is reflected in the activities of the permanent sanitary committee, which was established by the municipal government in 1879. Owing to these activities, in the late 1880s Tartu became one of the first towns in the Russian Empire to institute a specialised unit for monitoring the quality of food products (Kalnin 1980).

Table 2: Rate ratios for occupational differences in adult mortality (Poisson regression models), Lutheran parishes of Tartu, Estonia, 1897–1900

Occupational group	Both sexes		Men		Women	
	15+	15–59	15+	15–59	15+	15–59
Upper non-manual	0.91	0.90	0.96	0.99	0.60	0.23
Lower non-manual	1.02	1.12	0.92	1.05	1.29	1.14
Small entrepreneurs	1.37*	1.17	1.46*	1.31	n.a.	n.a.
Manual (ref)	1	1	1	1	1	1
Domestic servants	0.83	0.81	1.01	1.18	0.70*	0.53*
Non-employed	1.28**	1.32*	1.38**	1.22	1.18	1.19
Number of persons	25,116	21,334	10,839	9,585	14,277	11,749
Number of deaths	1,084	563	526	320	558	243

Note: *p<0.1;**p<0.01; *** p<0.001.
Occupational group refers to individuals' own occupation.
Models are controlled for sex, age, education, ethnicity/language, migrant status and sanitary characteristics. Results for female small entrepreneurs are not available due to small number of events.
Source: As for Table 1, authors' calculations.

At first glance, the high mortality risks among small entrepreneurs may seem surprising. This group can be assumed to have possessed greater economic resources than manual workers or domestic servants. We suspect that two complementary mechanisms may have contributed to the reported outcome. First, it seems plausible that having a shop or small business would entail a stronger attachment to one's job than would be typical of wage earners. We assume that small entrepreneurs would have remained in their jobs despite ill health and advancing age. By contrast, wage earners with failing work capacity would have more limited chances of keeping their jobs, particularly because employers would tend to replace them with healthier workers. As a consequence, wage earners in poor health are assumed to have been more likely to leave the workforce and become non-employed, affecting the mortality differentials between the groups. The comparison of model estimates for all and working-age adults lends some support to this assumption: the significant excess mortality of small entrepreneurs is mainly driven by older age groups.[13] Second, a stronger attachment to a business likely reduced the spatial mobility of small entrepreneurs relative to other occupational groups. In a linked-records study this may lead to higher linkage rates, and furthermore to increased mortality rates among small entrepreneurs. However, the relatively limited variation in linkage rates in our data suggests that this is of minor importance.

[13] In models estimated for adults aged 60 and over (not shown), the excess mortality of small entrepreneurs was 104% higher than the reference group.

Furthermore, the results indicate considerable variation in mortality differentials between men and women. Given the popularity of the breadwinner-homemaker family model, one might anticipate that the advantage of upper-level non-manual occupations would be more prevalent among men. However, the model estimates indicate the opposite. Although the limited number of observations prevents the difference from reaching statistical significance, women in professional occupations (mostly school-teachers) feature markedly lower mortality risks (–40%) relative to their counterparts in manual occupations (seamstresses, laundresses, day labourers, etc.); among working-age women the difference appears even more pronounced. By contrast, the advantage of upper-level non-manual occupations is virtually non-existent for men. Guided by the literature (Razzell and Spence 2006; Edvinsson and Lindkvist 2011), we are inclined to believe that sex-specific life-style factors overrode the advantage of greater wealth for men.

Another noteworthy result that underscores the salience of the sex-specific perspective relates to domestic servants. For adult men the mortality risks among the latter are not significantly different from those of the reference group. Among women, however, the rate ratio for domestic servants is 30% lower than for manual workers; in models for working-age women, servants appear to possess an even greater advantage (–47%). These findings suggest that apart from the work itself, women who provided domestic service for wealthy households evidently benefitted from the higher living standards of their employers, possibly through improved nutrition and housing conditions. The absence of a similar protective effect for men could be explained by sex-specific lifestyle factors, a smaller difference in work-related hazards between manual and service occupations, or by some other mechanisms. Finally, the small number of observations prevents us from presenting estimates for self-employed women.[14] This leaves us with only one occupational group (lower-level non-manual workers) for which the pattern of mortality differentials is largely similar between men and women.

All the results presented in Table 2 refer to individual occupations. To account for the breadwinner-homemaker family model we estimated a complementary set of models for adult women. In these models the occupational group of non-employed women was defined according to their husband's or father's occupation. Overall, the pattern of occupational mortality differentials in these additional models closely resembles those reported for women's own occupation (Table A-2 in the Appendix). The only departure from the latter relates to small entrepreneurs: wives and daughters in the households of men who were employed as small entrepreneurs exhibit elevated

[14] In our study, women constituted 15% of small entrepreneurs. There was only one death recorded among this group of women during the three-year observation period.

mortality risks relative to the reference group, like their husbands and fathers. However, due to the small number of observations the difference is not statistically significant.

Education. Table 3 presents the modelling results for educational differences in adult mortality. The rate ratios suggest that better education is associated with improved chances of survival. In the models for all adults the difference runs from the bottom to the top of the educational ladder, but the advantage provided by education appears rather modest. Relative to having no education at all, secondary or tertiary education reduces mortality risks (–12%). Among working-age adults, education makes a far more substantial difference. Relative to the reference group (primary education), secondary or tertiary education entails a reduction (–25%) in death risks among the 15–59 age group; the lack of primary education is associated with an increase (+41%) in the latter. Only the small numbers of individuals in the top and bottom groups prevents these differences from achieving the level of statistical significance.

Table 3: Rate ratios for educational differences in adult mortality (Poisson regression models), Lutheran parishes of Tartu, Estonia, 1897–1900

Education	Both sexes		Men		Women	
	15+	15–59	15+	15–59	15+	15–59
No education	1.04	1.41	1.15	1.73*	0.95	0.99
Primary (ref)	1	1	1	1	1	1
Secondary or tertiary	0.88	0.75	0.90	0.97	0.88	0.55*
Number of persons	25,116	21,334	10,839	9,585	14,277	11,749
Number of deaths	1,084	563	526	320	558	243

Note: *p<0.1;**p<0.01; *** p<0.001.
Education refers to individuals' own education.
Models are controlled for sex, age, occupation, ethnicity/language, migrant status and sanitary characteristics.
Source: As for Table 1, authors' calculations.

Similar to occupational group mortality differentials, those associated with education appear to be sex-specific. Among men, the educational difference is wholly concentrated at the bottom of the educational hierarchy. During their working ages, men with a complete lack of schooling feature a 73% excess risk of dying compared with their counterparts with primary education; however, having secondary or tertiary education provides men with no further advantage over the reference group. By contrast, the protective effect of education for women is concentrated at the top of the educational ladder. During their working ages, secondary or tertiary education almost halves women's mortality risks relative to the reference group, while lacking primary education does not imply any further disadvantage. We assume that the mechanism producing the sex-specificity for advanced education is the same as that discussed earlier in this section in relation to upper-level manual occupations: men's unhealthy lifestyle choices seem to nullify the advantage of their higher socioeconomic position.[15] The greater vulnerability of men associated with a lack of schooling may reflect dissimilar expectations towards men and women in the 19th century context, ensuing from the breadwinner-homemaker family model which placed responsibility on men for earning an income. In the context of near-total literacy, the lack of any education may have undermined men's capacity to successfully perform their provider role, thus exposing them disproportionately to various risks and stresses.

Finally, to ascertain the extent to which the mortality differentials associated with education are mediated by occupational group, we estimated additional models that excluded the latter variable (not shown). In the reduced models, the rate ratios for education remained virtually unchanged for men and women alike. The same holds true for the estimates for occupational group obtained from another set of reduced models that excluded education. The results from these additional models indicate that the effects of education and occupation reported in Tables 2 and 3 are mutually independent.

Ethnicity/language. The comparison of mortality risks between ethnic/language groups reveals no survival advantage for Baltic Germans; this pattern persists in all the models (Table 4). In fact, in models for men and working-age women, Baltic Germans feature somewhat higher death risks relative to Estonians, but the limited number of observations for the minority group prevents the difference from reaching the level of statistical significance.

Table 4: Rate ratios for ethnic/language differences in adult mortality (Poisson regression models), Lutheran parishes of Tartu, Estonia, 1897–1900

Ethnic/language group	Both sexes		Men		Women	
	15+	15–59	15+	15–59	15+	15–59
Estonians (ref)	1	1	1	1	1	1
Baltic Germans	1.12	1.23	1.25	1.30	1.04	1.21
Number of persons	25,116	21,334	10,839	9,585	14,277	11,749
Number of deaths	1,084	563	526	320	558	243

Note: *p<0.1;**p<0.01; *** p<0.001.
Models are controlled for sex, age, occupation, education, migrant status and sanitary characteristics.
Source: As for Table 1, authors' calculations.

[15] Until the mid-20th century, the proportion never married was remarkably high among women with advanced education (Morgan 1991; Van Bavel 2014). Using evidence on causes of death, we checked the extent to which the observed mortality advantage of highly educated women could be explained by their low exposure to maternal mortality. According to our results, this factor played no significant role in Tartu.

In order to provide insight into the role of socioeconomic and sanitary conditions in shaping the mortality difference between Estonians and Baltic Germans, we estimated a series of additional models with the controls for socioeconomic status and sanitary conditions removed (not shown). To our surprise, even these reduced models failed to reveal an advantage for Baltic Germans. For women, the reduced models exhibited parity in the death risks between ethnic/language groups. For men, however, the moderate disadvantage of Baltic Germans, reported in Table 4, persisted in the reduced models. Among working-age men the difference from the majority group reached the level of statistical significance.[16] Evidently, some factors that are not directly accounted for in our data have cancelled out the anticipated positive effect of superior socioeconomic status and better sanitary conditions characteristic of the German minority.

6.2.2 Differentials in child mortality

Table 5 presents the modelling results for the child mortality differentials (age groups 1–14).[17] In these models the measures of children's socioeconomic status are derived from their father's characteristics (or mother's, if the father was not present in the household during the census).

The results indicate that children born to parents who belonged to the middle and upper social strata had a higher probability of survival, although due to the small number of deaths among these children the difference does not reach the level of statistical significance. The advantage over the reference group (children of manual workers) is particularly pronounced (–80%) for the children of upper-level non-manual workers. Reduced mortality risks are also characteristic of children born to families of lower-level non-manual workers (–44%) and small entrepreneurs (–26%), but the difference does not reach the level of statistical significance for either of these groups. Interestingly, unlike their parents, the children of domestic servants were not better protected than their counterparts born to manual workers, although the difference in mortality risks is not statistically significant. Somewhat higher mortality risks among

[16] Rate ratio 1.27; the model included controls for age group and migrant status. A slightly higher linkage rate between the census and death records among Estonians reasonably excludes the possibility of the reported pattern's being a statistical artefact.

[17] The results presented in Table 5 are mainly driven by the mortality differentials of children aged 1–4, as more than 60% of children's deaths occurred among this age group. The small number of events prevents us from presenting the results separately for early and late childhood mortality. Results for infant mortality are available from earlier studies (Jaadla and Klesment 2014; Jaadla and Puur 2016).

the offspring of domestic servants (+53%) can be partially explained by the higher prevalence of single parenthood in the latter group.[18]

Table 5: Rate ratios for occupational, educational, and ethnic/language differences in child mortality (Poisson regression models), Lutheran parishes of Tartu, Estonia, 1897–1900

Variable	Children aged 1–14
Parents' occupational group	
Upper non-manual	0.20
Lower non-manual	0.56
Small entrepreneurs	0.74
Manual (ref)	1
Domestic servants	1.53
Non-employed	0.88
Parents' education	
No education	n.a.
Primary (ref)	1
Secondary or tertiary	1.03
Ethnic/language group	
Estonians (ref)	1
Baltic Germans	1.01
Number of persons	8,965
Number of deaths	165

Note: *p<0.1;**p<0.01; *** p<0.001.
Models are controlled for sex, age, migrant status, and sanitary characteristics. Results for children to parents with no education are not available due to small number of events.
Source: As for Table 1, authors' calculations.

Parents' advanced education is not associated with a greater likelihood of their children's survival. The small number of observations does not allow us to present the estimates for parents with no education.[19]

Finally, there is no evidence that ethnic/language differences affect child mortality once other variables are controlled, as shown in Table 5. However, this finding does not preclude differences in child mortality between Estonians and Baltic Germans at the

[18] 45% of the children of domestic servants did not have a father present in the household in the census.
[19] Only 2% of children belonged to parents with no primary education (2 deaths were observed in this population).

group level when the socioeconomic status of the parents is not considered. To ascertain whether this is correct we fitted additional models with the controls for occupational group and education removed. The results from these reduced models revealed a moderate mortality advantage (–20%) for children of Baltic Germans, driven by their parents' superior occupational and educational characteristics.[20]

Other factors included as controls in the models are beyond the main focus of our study and the discussion of their corresponding results is omitted from the article. However, the estimates for the control variables are available in Table A-3 of the Appendix.

7. Summary and conclusions

In this article we investigated socioeconomic and cultural mortality differentials among the Lutheran population of Tartu, a medium-sized university town, at the close of the 19th century. Previous research has generated a wealth of evidence pertaining to survival disparities in historical populations. This study's contribution to the literature stems from three facts. First, owing to the unique collection of microdata based on the First Russian Imperial census in 1897, the study focuses on an Eastern European context, which to a large extent has been neglected with respect to historical mortality differentials. Second, the presence of a university in the town resulted in a substantial proportion of the population's possessing advanced education. This permitted the examination of mortality differences associated with both occupation and education, a possibility seldom available in 19th-century settings. A third contribution of this study is derived from the coverage of a variety of sub-groups (men and women, adults and children), which provides us with a comprehensive account of mortality patterns among the population.

The results generally support our main expectations concerning the presence of socioeconomic disparity among the urban population. In accord with the divergence-convergence hypothesis (Antonovsky 1967; Bengtsson and van Poppel 2011), we found evidence that sub-groups with high socioeconomic status (employment in managerial and professional occupations) featured lower death risks relative to their working-class counterparts. According to the health transition perspective (Vallin and Meslé 2004; 2005), these higher social strata could be seen as forerunners who outpaced other groups in the trend towards declining mortality rates and rising life expectancy.

Furthermore, the study also underscores the considerable complexity of historical mortality patterns. Among the adult population, for instance, the gradient of

[20] We also experimented with further removal of the controls for sanitary conditions from the model, but this entailed only a marginal change in the child mortality advantage of Baltic Germans over Estonians.

socioeconomic differentials does not run smoothly from the top to the bottom of the social hierarchy. On the one hand, we found that the middle strata comprised of shopkeepers and other small entrepreneurs displayed elevated death risks. We think that these elevated risks may be primarily artefactual, caused by selection. On the other hand, domestic servants – a lower-strata occupational group – exhibited highly favourable mortality outcomes. In the demographic literature the mortality of domestic servants has rarely attracted attention, although the latter group accounted for a substantial share of the urban workforce in the 19th century. In the article we proposed some explanations for the findings pertaining to mortality patterns among small entrepreneurs and domestic servants.

Our results make a case for systematic consideration of the sex-specific perspective in the study of historical mortality differentials. Although there is a widespread practice of defining women's occupational and educational status according to their husband's or father's characteristics (Cambois 2004; Bengtsson and Dribe 2011; Schenk and van Poppel 2011), we applied an individual approach to men and women alike. The results were surprising, in that socioeconomic differentials in survival based on individual characteristics proved no less conspicuous for women than for men in the late 19th century context. In fact, the adult mortality advantage associated with employment in upper-level non-manual occupations was wholly driven by the pattern characteristic of women.[21] By contrast, adult men at the top of the occupational hierarchy demonstrated no visible advantage over their counterparts employed in manual jobs. The sex-specificity of the association lends support to arguments that among affluent men an unhealthy lifestyle, including the excessive consumption of food, tobacco, and alcohol, must have cancelled out the benefits of a secure economic position (Razzell and Spence 2006; Edvinsson and Lindkvist 2011).

Our findings did not support the assumption that socioeconomic mortality differentials would be particularly pronounced among adults (Antonovsky 1967). In our study the advantage associated with high occupational status was also found among children, although the small number of deaths among upper-social-strata children prevented the result from reaching the level of statistical significance. This is in line with evidence according to which the shift towards improved survival in the 19th century usually started from a reduction in child mortality (Vallin 1991). With regard to education, the results show that advanced schooling showed a positive association with the survival chances of adult women. Among men, advanced education entailed no reduction in death risks; however, the lack of elementary education, which often meant illiteracy, implied significantly worse mortality outcomes. The effect of education did not disappear with the inclusion of occupation and other controls in the models, lending

[21] The strongly sex-specific findings also include the low mortality of domestic servants (driven by women) and the high mortality of small entrepreneurs (driven by men).

support to the view that its influence does not wholly overlap with that of occupational group (Martikainen, Blomgren, and Valkonen 2007).

Finally, the modelling results for ethnic/language groups did not reveal any significant mortality advantage (when other variables are controlled) for the German minority, which held a superior social position in Estonia until the 20th century. This implies that the mortality difference between Baltic Germans and the majority population was fully accounted for by disparities in socioeconomic status, in accord with findings from a recent study of infant mortality in the same setting (Jaadla and Puur 2016). Although the population of Tartu was divided along ethnic/language lines, socioeconomic differentials in mortality clearly prevailed over those related to culture.

Admittedly, there are several methodological issues that may call into question the validity of the reported results. Although the linkage rate between the census and parish registers is no lower than the level typically encountered in historical studies (Edvinsson 1995; Hautaniemi, Anderton, and Swedlund 2000; Thornton and Olson 2011), such rates may vary across the groups of main interest to us. That being said, the comparison of all and successfully linked records for several characteristics suggests that the bias is not large enough to invalidate our main findings. Evidence in support of the reliability of the data is also provided by life-table estimates, which showed a moderate urban disadvantage and gradual extension of life expectancy for our study population, in line with expectations. The limited number of observations prevented us from creating models with a more precise disaggregation of age groups (e.g., early and late childhood). Our study attempted to control for a number of observable factors (sex, age group, migrant status, several aspects of sanitary conditions), but it cannot be argued to have considered all the potentially confounding risk factors. It seems reasonable to assume that groups with low socioeconomic status were disproportionately affected by poor nutrition, inadequate domestic hygiene, and limited access to health care, etc., thus potentially strengthening the effect of occupational group and education. However, we are inclined to believe that the associations found in this study are too complex to be reduced to measurement artefacts. Finally, the linked records approach with a relatively short observation window is thought to have circumvented problems that plague studies based on independent population and death counts.

Notwithstanding these limitations, we think that some important conclusions can be drawn from this study. First, it demonstrates that significant inequalities in mortality are associated with socioeconomic status. According to the developmental perspective, these disparities can be seen at least in part as manifestations of a divide between forerunners of and laggards behind the trend towards reduced mortality and longer life expectancy. Second, the considerable variation observed in the results for different sub-groups cautions against making far-reaching generalisations about socioeconomic mortality differentials based solely on a few groups (e.g., adult men). The results underscore the importance of taking a comprehensive approach to mortality differentials that pays equal attention to the effects of men's and women's individual employment and educational characteristics. Third, our study lends support to the view that even in contexts of low living standards and marked social inequality, socioeconomic advantages do not automatically translate into survival advantages. We need to take into consideration other factors, plausibly related to lifestyle. Failure to do so makes historical mortality patterns far more difficult to comprehend.

8. Acknowledgements

This work was supported by the Estonian Ministry of Education and Science under the research theme SF0130018s11, institutional research funding IUT-5, and research grant (PUT-1517) "Early demographic modernisation in Estonia: a micro-level study of nineteenth-century rural and urban settings". The authors are indebted to Veiko Berendsen and Margus Maiste for granting access to the computerised microdata of the 1897 census of Tartu. Very useful comments by Alice Reid, Mati Rahu, and two anonymous reviewers have helped to improve the presentation at several points.

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Appendix

Table A-1: Abridged life table, Lutheran parishes of Tartu, Estonia, 1896–1897

Age	Males				Females			
	m_x	q_x	l_x	e_x	m_x	q_x	l_x	e_x
0	0.18330	0.16325	100,000	36.4	0.15367	0.13971	100,000	42.7
1	0.04282	0.15383	83,675	42.4	0.05142	0.18111	86,029	48.6
5	0.00627	0.03085	70,803	45.9	0.00860	0.04208	70,448	55.0
10	0.00417	0.02066	68,618	42.2	0.00488	0.02408	67,483	52.4
15	0.00575	0.02838	67,201	38.1	0.00575	0.02834	65,858	48.6
20	0.01389	0.06722	65,294	34.1	0.00470	0.02325	63,992	44.9
25	0.01155	0.05612	60,905	31.4	0.00677	0.03333	62,504	40.9
30	0.01615	0.07765	57,487	28.1	0.00835	0.04090	60,421	37.3
35	0.01480	0.07140	53,023	25.2	0.00841	0.04121	57,950	33.7
40	0.02165	0.10285	49,237	22.0	0.01009	0.04925	55,561	30.1
45	0.02799	0.13101	44,173	19.2	0.01228	0.05959	52,825	26.5
50	0.03866	0.17621	38,385	16.7	0.01237	0.06007	49,677	23.0
55	0.04014	0.18205	31,621	14.8	0.02076	0.09891	46,693	19.3
60	0.04499	0.20240	25,865	12.5	0.02793	0.13070	42,074	16.2
65	0.07062	0.30034	20,630	10.0	0.03377	0.15603	36,575	13.2
70	0.09664	0.38307	14,434	8.3	0.05297	0.23475	30,869	10.2
75	0.06957	0.29654	8,905	7.0	0.08446	0.34972	23,622	7.5
80	0.20690	0.65740	6,264	3.9	0.15135	0.54326	15,361	5.2
85	0.47976	–	2,146	2.1	0.27756	–	7,016	3.6

Source: As for Table 1, authors' calculations.

Table A-2: Rate ratios for occupational differences in mortality among working-age women (Poisson regression models), Lutheran parishes of Tartu, Estonia, 1897–1900

Variable	Women 15+	
	Women's own occupation	Women's own occupation, supplemented with husbands or fathers occupation
Occupational group		
Upper non-manual	0.60	0.67
Lower non-manual	1.29	1.38
Small entrepreneurs	n.a.	1.23
Manual (ref)	1	1
Domestic servants	0.70*	0.70*
Non-employed	1.18	1.11
Number of persons	14,277	14,277
Number of deaths	558	558

Note: *p<0.1;**p<0.01; *** p<0.001.
Models are controlled for sex, age group, education, ethnicity/language, migrant status and sanitary characteristics. Results for women who were employed as small entrepreneurs, based on individual occupation, are not available due to small number of events.
Source: As for Table 1, authors' calculations.

Table A-3: Descriptive statistics for control variables, children aged 1–14 and adults, Lutheran parishes of Tartu, Estonia, 1897–1900

Variable	Men	Women	Total	Men (%)	Women (%)	Total (%)	Deaths
Age group							
1–4	1,429	1,388	2,817	9.3	7.4	8.3	113
5–14	3,111	3,037	6,148	20.2	16.2	18.0	52
15–24	2,855	3,039	5,894	18.5	16.3	17.3	66
25–39	3,854	4,838	8,692	25.1	25.9	25.5	178
40–59	2,876	3,872	6,748	18.7	20.7	19.8	319
60–69	842	1,575	2,417	5.5	8.4	7.1	219
70+	412	953	1,365	2.7	5.1	4.0	302
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249
Migrant status							
Non-migrant	6,975	8,146	15,121	45.4	43.5	44.4	490
Migrant	8,292	10,410	18,702	53.9	55.7	54.9	754
Unknown	112	146	258	0.7	0.8	0.7	5
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249
Water supply							
Well	7,230	8,806	16,036	47.0	47.1	47.0	565
River	259	278	537	1.7	1.5	1.6	23
Unknown	7,890	9,618	17,508	51.3	51.4	51.4	661
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249
Privy							
In-house	3,327	4,328	7,655	21.6	23.1	22.5	240
In the yard	4,048	4,549	8,597	26.3	24.3	25.2	334
Unknown	8,004	9,825	17,829	52.1	52.6	52.3	675
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249
Presence of carters							
No	7,706	9,088	16,794	50.1	48.6	49.3	648
Yes	3,936	5,087	9,023	25.6	27.2	26.5	288
Unknown	3,737	4,527	8,264	24.3	24.2	24.2	313
Total	15,379	18,702	34,081	100.0	100.0	100.0	1,249

Source: As for Table 1, authors calculations.

Table A-4: Rate ratios (Poisson regression model) for the control variables, Lutheran parishes of Tartu, Estonia, 1897–1900

Variable	Adult men and women		Adult men		Adult women		Children
	15+	15–59	15+	15–59	15+	15–59	1–14
Sex							
Male	1	1	–	–	–	–	1
Female	0.60***	0.50***	–	–	–	–	1.18
Age group							
1–4	–	–	–	–	–	–	1
5–14	–	–	–	–	–	–	0.23***
15–24	0.51***	0.49***	0.41***	0.41***	0.65*	0.63*	–
25–39	1	1	1	1	1	1	–
40–59	2.24***	2.22***	2.45***	2.43***	2.01***	1.95***	–
60–69	4.50***	–	4.23***	–	4.80***	–	–
70+	11.68***	–	9.41***	–	13.41***	–	–
Migrant status							
Non-migrant	1	1	1	1	1	1	1
Migrant	0.88*	0.78**	0.86	0.77*	0.90	0.78*	0.71
Water supply							
Well	1	1	1	1	1	1	1
River	1.12	0.46	1.31	0.54	0.86	0.30	2.92**
Privy							
In-house	1	1	1	1	1	1	1
In the yard	1.25*	1.17	1.16	1.20	1.37*	1.13	0.69
Presence of carters							
No	1	1	1	1	1	1	1
Yes	1.11	1.11	1.11	1.09	1.12	1.14	1.13

Note: * p<0.1; ** p<0.01; *** p<0.001. The models also include occupation, education and ethnicity/language. The results for the latter variables are presented in Tables 2–5.
Source: As for Table 1, authors calculations.