Examining Age Structure and Estimating Mortality Rates in Ottoman Bursa Using Mid-Nineteenth-Century Population Registers

Abstract

This study aims to document the age structure and mortality by age in the Ottoman city of Bursa that served as a politically and commercially significant urban center over centuries. It uses a set of hitherto unexamined Ottoman population registers kept in 1839 and updated until 1842 that provide detailed self-reported data on all male inhabitants regardless of age, including deaths, births, and migration. The study tests the quality of age and mortality data in conjunction with the Coale and Demeny regional model life tables and compares the results to historical demographic studies conducted for European regions. The results point to a demographic structure marked by high birth and death rates and prove promising for extending back the study of Ottoman demographic transition and establishing historical comparison points with the global experience.

Key words: Ottoman Empire, Turkey, historical demography, age structure, mortality, fertility, demographic transition, Ottoman population registers, Ottoman census, Ottoman population

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Decreases in infant and child mortality have been responsible for much of the mortality decline in the world. Long-term decline in infant and early childhood mortality and increases in life expectancy has been observed, albeit to widely varying degrees, across the European continent since the turn of the twentieth century.[1] The last century witnessed profound transformations in the living conditions of the world's population. From 1950 to 2015, expected life at birth on average increased worldwide by 24 years. The probability of dying between ages 15 to 60 decreased worldwide by 60 per cent in the same period, while life expectancy at 60 has been progressively increasing by one year per decade.[2]

The chances of surviving the first crucial months and years of life have coexisted with rapid improvements in sanitation and health standards and nutritional status of children, weakening and or elimination of lethal infectious diseases, increasing education levels, and stable household income growth. Infant mortality rate is therefore regarded as a crucial measure of human development and a vital index to monitor the standard of health and social inequality in a society.[3] Data from Western European countries spanning from 1800 to 2010 shows that reduction in adult mortality has a large causal positive impact and mortality in middle adulthood (after 30) has the most detrimental effect on the long-run level of income per capita.[4] Mortality regimes have also played an essential role in determining fertility rates and patterns that existed before and after the transitional period in the developed world via its conditioning of nuptiality and marital fertility.[5]

This article is structured as follows: I will first evaluate mortality and fertility changes in Turkey since Ottoman times. After reviewing works of Ottoman population history, I will introduce the temporal and geographical scope of my study, which is the city of Bursa in the 1840s. Following an introduction to and discussion of caveats and strengths of my data sources, which are Ottoman population registers, I will introduce and discuss my chosen methodology of examination of the data with life tables. Then I will discuss my results regarding age structure, and crude death, birth, and infant mortality rates in comparison with available data from European countries and regions. I will finish by suggesting possible further research agendas.

Mortality and Fertility Changes in Turkey since the Late Ottoman Empire

Although considerably high in the European Union (EU) context, the rate of infant mortality (IMR) per 1000 births in Turkey stood at a record low of 9.1 in 2019 while under-5 mortality

(U5MR) was at another record low with 11.2 per thousand. Crude death rate (CDR) was 5.3 per thousand in 2019.[6] Total fertility rate (TFR) dropped to 1.88 in 2019 – the rate was 1.99 children per woman in 2018 and 2.07 in 2017 (below the replacement level of 2.10).[7] The 1963 National Survey on Population taken by Ministry of Health in collaboration with Social Assistance School of Public Health, the first nation-wide survey aimed at collecting vital statistics, demonstrates the crude birth rate (CBR) as 41.3, CDR 18.9, and IMR as 247.[8] While some decrease in death rates for some regions had already started in the Interwar Era, since the end of the Second World Turkey has been transitioning from a demographic regime characterized by a largely rural agrarian economy with high birthrates and mortality rates to an urban non-agrarian setting distinguished by low fertility and mortality rates.[9]

Although Turkey's demographic transition is not completely accomplished, the country 'has left behind the decades with the most rapid declines in mortality and fertility rates'.[10] However, past decades have not been adequately understood due to inadequacies inherent in the collection and systematic analysis of demographic data. Much research point to sporadic recording of vital statistics, under-reporting of mortality, and reliance on aggregate rather than region- and time-specific data.[11] Given the importance of long-term trends in tracking demographic transition, comparability of demographic developments in Turkey with those in Europe will be insufficient without examining the types of fertility, age structure, and mortality characteristics in the Ottoman Empire.

Infant mortality was widespread and constituted a crucial problem in Ottoman society in the nineteenth century. Clarence Ussher, an American physician and missionary who was stationed in the American hospital in Van between 1915 and 1917, observed that '[i]nfant mortality in Turkey was something frightful, about sixty per cent of all the babies dying before completing their second year'.[12] Extreme infant and child mortality rates were no exception to the royal family either: of the reformer sultan Mahmud II's (r. 1808-1839) 36 children, 20 died in their first year and 5 did not see their fifth birthday.[13] In the absence of depictions of high infant mortality in Ottoman archival and literary sources, a gravestone depicting infant and mother mortality in Figure 1 is a rare evidence of emotional and tangible response to this phenomenon.



Figure 1: A one-of-a-kind tombstone documenting maternal and infant death: Şerife Hanife Hanım, the wife of the timekeeper (muvakkit) of the Humbarahane mosque Hafız Osman Efendi, became a martyr (according to Islamic terminology) while giving birth to her child Seyyid Mustafa Hikmet mullah. The child also died, and his gravestone is inserted in the bottom half of the stone. Date: AH. 19 Rabi al-Awwal 1248 – 16 August 1832. The stone was originally in the Edirnekapı Cemetery and is currently exhibited at the Turkish and Islamic Arts Museum.[14]

Leaving aside deaths from wars, civil disorder, and famine that posed a constant threat to the lives of the Ottomans, mortality regimes varied by region due to endemics such as tuberculosis, dysentery and malaria taking a heavier toll on the population than epidemics (such as cholera and plague) that were an occasional disaster for the people.[15] Due to poor health and hygiene infrastructures and relatively closed economies with limited mobility, regional variations in fertility and mortality across the Ottoman Empire should be closely studied on urban, rural, and community levels.

It was not until the proclamation of the Turkish Republic that reforms in medicine and hygiene reduced the rate of infant mortality and increased the average life expectancy in Anatolia. Nevertheless, in order to modernize its army and increase its political efficacy, starting from the 1830s the Ottoman Empire recorded its subjects in population registers (*nüfus defteri*) along with their vital information. These sources' full potential has not been effectively tapped. They were made only available in 2011 and until 2020 we have only had descriptive/transliteration studies. The first two Ottoman population censuses of 1881 and 1907, on the other hand, are still unavailable for research. Lack of registration of births or baptisms and severe under-registration of deaths due to low level of medicalization make Ottoman population registers unique sources to study demography.

This study aims to document the age structure and mortality by age, especially infant mortality, using the population registers of the city of Bursa kept and updated in the period 1839-1842 (AH 1255-1259). Since using the registers is the only and most precise means to learn about mortality patterns in the Ottoman realms, it is possible to interpret the history of modernization from the angle of demography and find historical reference points with which comparisons with European mortality shifts can be made.

General Overview of Previous Studies in Ottoman Population History

Only a small number of academic works exist on the Ottoman population in the nineteenth century due to the unavailability of population registration records and censuses. Studies by Enver Ziya Karal, Stanford J. Shaw, Justin McCarthy, Kemal Karpat, Engin Deniz Akarlı, and Cem Behar among others have relied on census summaries compiled for the state interests or published in travelers' accounts (Ubicini's *Letters on Turkey* has been often cited) and focused mostly on determining the total population of the Ottoman Empire and its subdivisions.[16]

Despite the impossibility of working on demography before 2011, recent MA theses using the population registers have been limited to transcribing the sources with little or no insights being offered into the data.[17] Turbulent events of the nineteenth and early twentieth century that uprooted many millions stood as a major obstacle to estimating annual population changes. Population aggregates published in crude fashion and on shaky methodological foundations have established the demographic basis for much social, economic, political and health research on the Empire and Turkish Republic.[18]

Estimates on nuptiality, fertility and mortality for the nineteenth century have been included in only a minority of studies. Karpat (1985) published his statistics for Ottoman provinces and sub-provinces (large administrative units) where data is available in aggregate form while tabulating the data as appearing on the census summaries, for instance half-year or biannual averages, thereby making calculating yearly growth rates nearly impossible.[19] Justin McCarthy (1987) could rely on only 8 randomly selected (hence with no sense of space) Muslim population registers from 1831 belonging to towns in the Black Sea region, Central, and Western Anatolia.[20] Focusing solely on death numbers, he observed a pattern of under-enumeration of infant and child deaths and high number of adolescent deaths. Since the context for mortality trends varied greatly from one region to another, his aggregate use of death counts hid many nuances and was far from being representative. In another study, McCarthy examined age, household, and migration patterns in 1846/47 by using Muslim population registers of three districts in the Black Sea region that are hundreds of kilometers apart.[21] He found that extensive family was the norm and conscription, polygamy, and migration changed the demographic composition. However, apart from the non-rule-based sampling method, the registers were compiled solely for conscription purposes and directed at Muslims, and thus gives no room for comparison with the large non-Muslim population in the Black Sea region. The scantiness of Ottoman sources also posed serious problems for Balkan demographic studies. Maria Todorova's examination of the nineteenth century Bulgarian family structure and demographic variables of fertility and mortality relied heavily on generalizations from limited numbers of Bulgarian Catholic parish registers.[22]

On the other hand, Cem Behar and Alan Duben in their *Istanbul Households* (1991) had studied 1885 and 1907 censuses comparatively by making creative use of the window of availability, before the General Directorate of Civil Registration and Citizenship blocked the use, through five per cent samples of five neighborhoods of Istanbul but by excluding non-

Muslim and non-permanent residents, in such a way as to 'make household, nuptiality and fertility analysis possible.'[23] They found that family lives and household structures of Muslim Istanbulites resembled European patterns more than the Middle Eastern already before the end of the nineteenth century. These censuses, the largest and most detailed demographic materials about the Ottoman population are scattered around the Balkans and the Middle East and records in Turkey are still unavailable to researchers, a problem that shadows historiographic debate and demographic research.[24] In the absence of the originals, a recent article by Daniel Ohanian, Mehmed Başkurt, and M. Erdem Kabadayı has transcribed and digitized microfilm copies of the c. 1907 Armenian population of Istanbul that cover 40,000 inhabitants and is kept in New York.[25] Individual entries in the census were georeferenced using contemporaneous historical maps with the help of historical GIS (geographic information system) applications to analyze the spatial and occupational distribution of the population.

In sum, demographic research on the Ottoman Empire of the nineteenth century has long suffered from data shortage and a lack of a methodological standard. Compilation of vital statistics (fertility, mortality, nuptiality, and migration) that prove crucial for demographical transition arguments has remained quite limited and so has the data's explanatory adequacy. The evolution of the field of historical demography since the 1960s has determined the course of demographic studies in Turkey. Following a boom phase to the 1980s that mainly focused on demographic behavior, the field has witnessed a relative stagnation until the 2000s. The application of computational methods and digital tools, revisiting of historical demographic material, and development of large population databases has led to a proliferation in historical demography in the recent years with new aspirations and challenges.

A Socio-Economic Overview of the City of Bursa in the 1840s

Located in the southern Marmara basin in northwestern Anatolia, Bursa was a major urban center that served as the first capital of the Ottoman Empire in the fourteenth century. It has maintained its identity as a politically and commercially significant city and as the most important entrepot for east-west trade especially for silk products.

The city of Bursa was populated with 16,451 (15,201 permanently resident) males in 1839 (AH 1255). Muslims constituted more than 60 per cent of the total population (9293 permanent + 578 temporary residents) with Muslim Roma (117), while the next most crowded

community, Armenians, accounted for 18 per cent (2848 + 50). The Greeks (*Rum*) followed them with 14.5 per cent (2159 + 239). The rest of the population was comprised of Jews (652 + 3), Catholics (132 + 25), foreign citizens (110), laborers and merchants staying in the inns or different workplaces, and madrasa students. More than half of Bursa's hypothetical working age population (15 to 64) was engaged primarily in the manufacturing and transportation of textile products, regardless of ethno-religious identity. Hülya Canbakal's study of wealth and inequality in Ottoman Bursa between the period from 1500 to 1840 based on probate inventories points to high levels of inequality in the city, with a Gini coefficient of 0.73 (closer to 1 means less equal) for the period 1820-1840.[26]

The city of Bursa in the 1840s provides a good case study for purposes of mortality statistics. It had a lively urban center with a large ethno-religiously mixed population and suffered from economic inequality. Leila Erder's study of factory districts in the city assert that 'by the mid-nineteenth century Bursa's present manufacturing distribution had already stamped itself on the city's landscape'.[27] Bursa's location stretching on a plain on the slopes of Mount Uludağ blessed it with plenty of natural water sources and many hot springs/mineral baths that were frequented by the population, and, together with its warm climate made the city a health destination for many. In terms of the population's diet, in contrast to wealth inequality, its suitable climate and soil quality enabled the people of the city to store cheap and large quantities of grains and fruits in the first half of the nineteenth century.[28] In addition, by 1840, Bursa had a handful of physicians, chemists and herbalists as indicated by the occupational information gathered from the population registers. An early state and multiple non-Muslim charity hospitals existed in the city.[29] The impact of medical institutions and their accessibility to people are unknown but it can be argued that superstitions and false beliefs might have considerably affected health-related behavior and health outcomes.

High population densities of cities are known to have facilitated infection, filth, and fire frequency and spread. The great fire of 1801, outbreak of plague in 1814[30] lasting at intervals until the early 1830s,[31] and the cholera pandemic in 1847-48[32] took a heavy toll on the population of Bursa. However, contemporary sources and archival documents mention no widespread endemic diseases reigning for the period under study except for malaria (attributed to the nature of rice cultivation) and dysentery observed sporadically in some villages around the city.[33] Through the imposition of quarantine in the early 1830s[34] at the ports and strategic roads that connected Bursa with Anatolia and Istanbul, the spread of infectious diseases was

effectively controlled.[35] Donald Sandison, the acting British Vice-Consul of Bursa noted that by 1840 the plague had entirely disappeared from the district and inhabitants of the city were 'generally healthy in constitution and appearance'.[36] Among the unhealthy habits of the urbanites, some point to hazardous ones such as excessive smoking and dumping of filth[37] and industrial waste into the streams, yet a commercial report from 1843 describes it as 'the cleanest of the Turkish cities'.[38] All in all, the city of Bursa presents a good case for estimating mortality rates uninfluenced by exceptional mortality crises caused by famines, widespread epidemics and wars.

Data

The Ottoman Empire conducted its first population registers in 1830. The abolishment of the Janissary corps in 1826 and imperial border changes following the defeat to Russia (1829-1831) constituted the main causes of this practice. The principal aim of the registers was to conscript Muslim males into the new regular (*Mansûre*) army and allocate the poll-tax (jizya) for non-Muslims. A population register bureau (*Cerîde Kalemi*) was founded with a network of offices in the districts. Population officials were instructed 'to register all births, deaths, and migrations and to report several times a year to the central office'.[39] They were tasked to compile vital events registers (*vukuat defteri*) and to send them to the central bureau once every three months. In order to complete the registration process securely and with ease, the help of local and religious headmen of each community (neighborhood, village, town, or tribe) was sought.[40]

In the following post-Tanzimat registration period from 1839 to 1865, the Ministry of War undertook the operation to conscript Muslim males into the newly created reserve (*redif*) troops and in a wider sense to assess the newly-assigned tax called *temettü*.[41] For the first time, people were given population certificates called *mürur tezkiresi* to document their movement within the Empire that necessitated the detailed recording of migration events. The Ottoman population registers can be described as proto-censuses because they aimed to achieve specific goals by recording all, but only, males regardless of age and completing records at different times for different regions. Only in the last two decades of the nineteenth century, 1881/82-93 and 1906/07-1914, did the Ottoman Empire conduct proper empire-wide universal censuses that included females and were designed for purposes other than taxation and conscription.

The second wave of registers for the city of Bursa started to be compiled in 1839 (AH. 1255) and was updated until 1842 (1258),[42] making them living documents. The structure of these 1839-1842 Population Registers for Bursa is as follows: the archival code for the Muslim population register is NFS.d.1396 and 7140 and the non-Muslims were recorded in NFS.d.1398. Vital events registers, on the other hand, were updated twice a year and recorded until 1864-65 (AH. 1280). This study relies only on the population registers. The registers of Bursa are divided along ethno-religious lines (Muslim, Roma, Armenian, Catholic, *Rum*/Orthodox Christian, and Jew) following the categories of Ottoman *millet* system[43] and group the information on neighborhood and other residential levels. There exist 166 neighborhoods regardless of ethno-religious composition. To only show the migrants in the city, around a hundred locations ranging from mills to madrasas to bakeries were recorded. Altogether, they contain detailed information on the male dwellers, including infants.

In terms of individual-level data in the registers, people's physical characteristics (height, facial hair, eye color) are described, along with information on whether they are handicapped or carry a disease publicly known by the time (i.e. *sar'a* – epilepsy). Their family names and titles (ranging from religious titles to birthplace denominators) are given. Occupational descriptors, the most important data to determine the economic situation, also exist. In- and out-migration information is kept in detail. Ages are provided (more on this later in the age distribution and mortality sections) and birth and death dates are sometimes defined in day-month-year fashion (mostly expressed in years). In addition, while the age when a Muslim will be eligible for or exempt from military duty and the post he performs his duty is recorded, the categories of poll-tax burden for non-Muslims (high-*ala*, medium-*evsat*, and small-*edna*) or the exemption thereof are also specified. An annotated example page from the Muslim population register is provided in Figure 2.

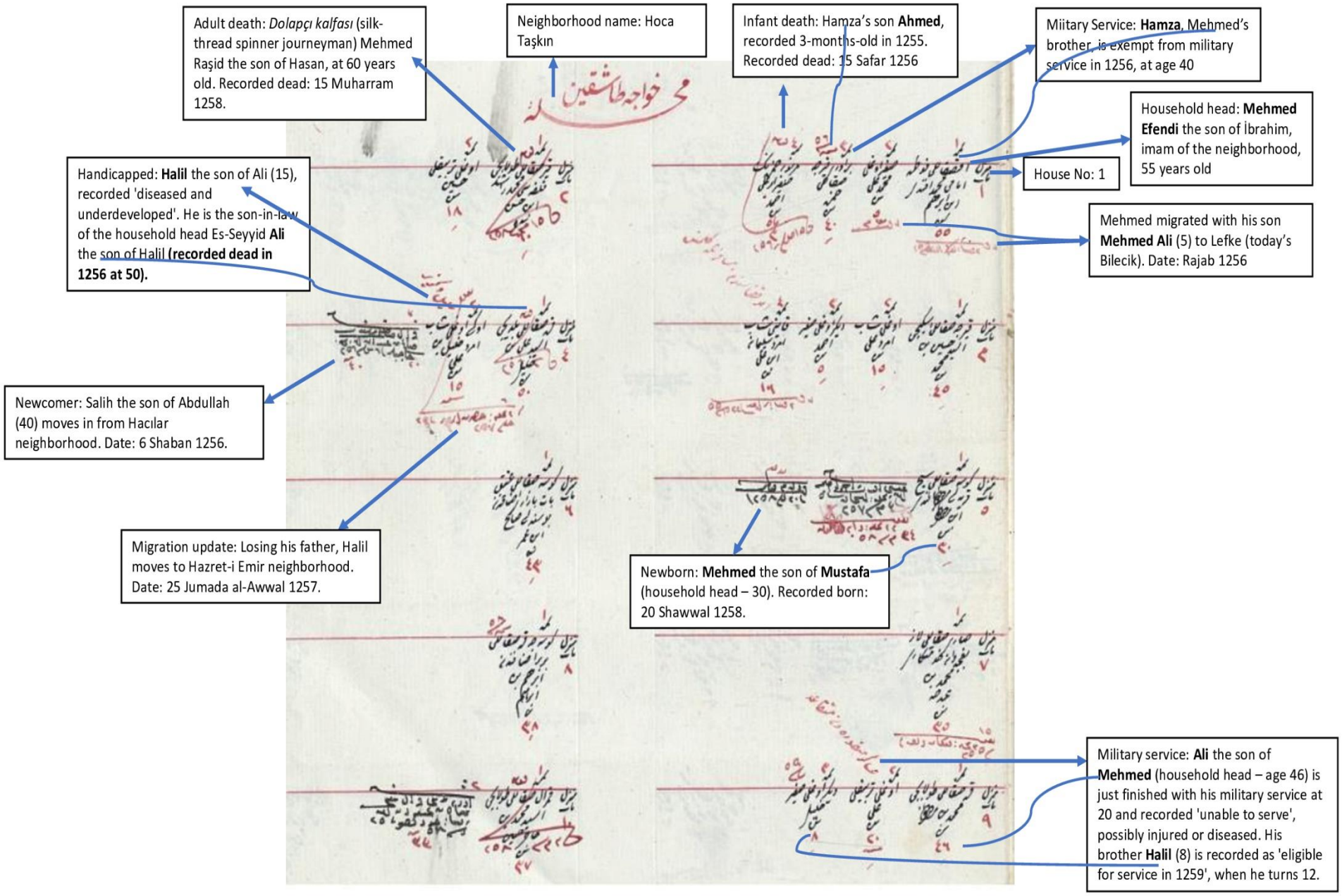


Figure 2: An example population register page for a Muslim neighborhood in Bursa (NFS. d. 1396)

In addition to the well-kept and frequently updated structure of the Bursa population registers, they have some present and foreseeable limits. So long as the shortcomings of the data the and the methodological preferences are recognized, there is much valuable information to gather. The major limitation is that only males were recorded, which prevents us from exactly assessing fertility and mortality rates. Although how many females a household had cannot be accurately guessed, the registers can still be used to estimate the entire population of Bursa based on sex ratios of later periods. However, as this study's focus is concentrated on age distribution and mortality rates, the Coale and Demeny regional model life tables[44] are matched with data from the population registers to determine fertility rates, life expectancies and defective data.

The size of the data suffers from the fact that the Muslim register misses three full and two half Muslim neighborhoods. Coale and Demeny's tables are based on theoretical stable populations undisturbed by migrations where the schedules of fertility and mortality have been constant for a long period. Working with permanent residents must be preferred to benefit from the tables. Deducing the number of people living in inns, shops, and madrasas to approximate a stable population reduce the total number of males to 14,942. That said, the Ottoman population registers give a snapshot of a population at their time of completion. This means that those who were absent during the registration period such as work-related migrants, conscripts, and pilgrims were not recorded but added later during the update period. However, it must be noted that most migrations out of the city were short-term and primarily for economic reasons. Model life tables help understand the impact of external migration on the demographics of a society. In addition, Bursa did not experience major waves of migration into the city until the Ottoman-Russo War of 1877-1878. Finally, subtracting those registered with no or undeciphered ages bring the total number of observations down to 14,867. A short introduction to the model life tables is made below.

Model life tables are collected for a population at a certain time. They demonstrate mean expectation of life at birth and older ages, the probability of dying at one age and the next, and the rate of survivorship at different ages. They are useful instruments for the analysis of historical mortality for which data is often marred by deficiencies.

Ansley J. Coale and Paul Demeny's model life tables for stable populations, first published in 1966 and revised in 1983, are perhaps the most popular among demographers.

The tables are based on stringently selected 192 life tables, by sex, coming from registration data of actual populations. Registration data is predominantly European and 39 are from the nineteenth century and 69 from the post-Second World War period. Coale and Demeny have identified four patterns of mortality in relation to the geographical location of the population: North, East, West, and South, labeled for the regions of Europe supplying 176 of the tables. As noted earlier, the models are stable populations where there is a stable health and fertility situation and no migration.

Twenty-five hypothetical model life tables were derived from each pattern using logarithmic regression based on life expectancy at 10. Each table is associated with a certain mortality level. Mortality and survivorship estimations in the tables are multiple and represented in relation to a Gross Reproduction Rate (GRR). Switching to a mortality level results in changing age structure and mortality distribution among ages. The assumption of a proper mortality level and GRR is crucial to assess a mortality regime of a population.

Although Coale and Demeny's model life tables have been widely used to correct inaccuracies in historical records, several criticisms and counterexamples have been raised against them: 1) Coale and Demeny model life tables use data drawn to a great extent from modern populations which have overcome endemic infectious diseases. Especially all tables coming from the nineteenth century are European and none of them has a life expectancy of life at birth of less than 35 years. This fact places into question the capacity of the tables to capture mortality patterns of populations with high mortality populations, especially historical populations;[45] 2) except for the South model mortality levels 1-5, infant mortality rates (IMR) always exceed early childhood mortality rates (ECMR). Data from 614 districts of England and Wales between 1840 and 1920-22 point to excess IMRs occurring often in small condensed units such as urban areas and for the whole country but only in a few particular years.[46] In another example, the exclusion of Brazil from the construction of model life tables made the Brazilian mortality pattern in the late nineteenth and early twentieth century (lower child and higher young adult mortality) distinct from the model life tables;[47] 3) The application of mortality patterns in the tables to modern populations have also caused discrepancies between figures. Even though it is found that the Turkish mortality experience is best represented by the East model, child mortality in Turkey in 1974-75 was 15 per cent higher and adult mortality 9 per cent lower than the corresponding model life table.[48]

Overall, regional bias is often regarded as an obstacle to employing the tables. However, the rationale behind using them is based on the expected similarity between the age-specific mortality rates of a real population with same parameters given in a model population. It is more important to have credible sources documenting real mortality patterns than to have region-specific patterns of mortality based on less credible data. In a similar vein, an objection to the use of a stable population model might be raised. No population is ever truly stable but comparing them to model stable populations reveal important aspects of change in a society that might not otherwise be known.

Age Distribution and Life Expectancy in 1839 (AH. 1255)

Ages were not updated after the completion of the master register in 1839/AH. 1255. A strong tendency to round ages to the nearest multiple of five is evident. Age understatement, overstatement and symmetric age misreporting are found to have different yet significant impacts on mortality estimates, especially at advanced ages.[49] On the other hand, the implementation and use of age-heaping is a very basic measure of human capital and speaks for a wide spectrum of population rather than for instance the socioeconomic elite. It provides comprehensive insights into illiteracy levels and poor numeracy skills.[50] Without introducing the popular age preference indices (Bachi's, Myers', Whipple's or Zelnik's)[51] to the data to detect the quality of age reporting, only descriptive analysis is used to interpret the research findings. The propensity to heap ages is more pronounced for those aged 25 and older and is not peculiar to any ethno-religious community.

The incidence of age heaping cannot be explained away as errors caused by the 'carelessness' of the officials. In fact, the register-keepers (scribes) gathered self-reported information. Their record-keeping methods do not vary by region and the existence of unique ages such as only two persons being 98 and 106 years old (the oldest in the dataset, two Armenians) prove their commitment to documenting what they heard. Multiples of 10 seem to have been preferred to refer to the vast majority of old ages (50 instead of 55, 60 instead of 65 and so on). Moreover, age-reporting *seems* to be more accurate for those below 25 as frequencies for ages below this level do not differ dramatically from each other. Age frequencies are visualized in Figure 3.

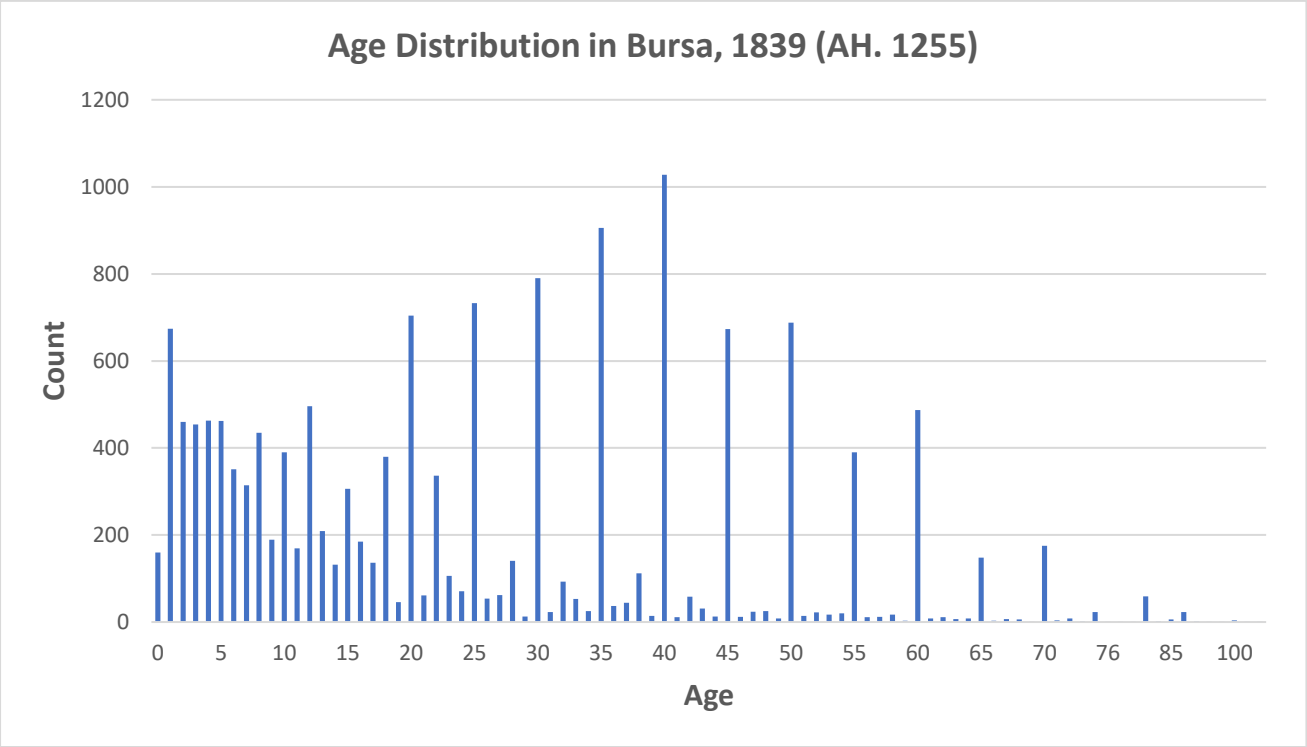


Figure 3: Age Distribution of Bursa Urbanites in 1839 (AH. 1255)

Analysis of the raw data shows that the average age is 25.56. Children under age 5 (2211) constitute 126 per cent of that of children aged between 5 and 9 years (1751), indicating a high U5MR. Children under 10 years constitute 26.65 per cent of the total population. Children and adolescents aged from 0 to 15 make up 36.04 per cent while the share of the hypothetical working-age population (15-64) is 57.23 per cent. In Table 1 the age frequencies for five-year age groups are listed. Notice the number of individuals surviving each age cohort that demonstrates high mortality, especially in infancy.

Age	Count	Percentage of Total Population	Coale & Demeny, GRR=3.0, L4-6, Pop. at Age (%)	Adjusted Population
0-1	160	1.08	3.65 - 3.74	646 - 662
1-4	2051	13.80	10.51 - 11.29	1865 - 2003
5-9	1751	11.78	11.4 - 12.19	2023 - 2163
10-14	1396	9.39	10.52 - 11.01	1867 - 1954
15-19	1053	7.08	9.76 - 9.98	1733 - 1772
20-24	1278	8.60	8.91 - 8.93	1581 - 1584
25-29	1003	6.75	8.05 - 7.92	1428 - 1405
30-34	984	6.62	7.24 - 7	1285 - 1242
35-39	1113	7.49	6.44 - 6.13	1143 - 1088
40-44	1141	7.67	5.63 - 5.29	1000 - 940
45-49	742	4.99	4.83 - 4.48	857 - 795
50-54	761	5.12	4.03 - 3.71	715 - 658
55-59	433	2.91	3.24 - 2.96	576 - 526
60-64	521	3.50	2.46 - 2.24	437 - 398
65-69	165	1.11	1.69 - 1.55	300 - 275
70-74	189	1.27	1 - 0.93	178 - 165
75-79	26	0.17	0.46 - 0.45	84 - 82
80-84	61	0.41	0.14 - 0.15	25 - 27
85-89	6	0.04	0.03 - 0.03	5 - 5
90-94	23	0.15	0	0
95-99	4	0.03	0	0
100+	6	0.04	0	0

Table 1: Distribution of ages in 1839 in 5-year brackets and their expected shares in the Coale and Demeny life tables

Cumulative age groups at each five-year age interval correspond best to the East Model Life table of Coale and Demeny having a Gross Reproduction Rate (GRR) of 3.00 at mortality levels from 4 to 6, suggesting a life expectancy at birth (e0) of 25 to 30 years at age-5 (e5) of 45 to 47.5 years.[52] According to the estimates based on model life tables, age-heaping inflates age estimates but the most problematic group remains the infants whose rates should be around 3.6-3.7 per cent. This comparison suggests that some children under 12 months of age were entered into age 1. Considering that the age group 1-4 should be around 10.5-11.29 per cent, a 2.5 to 2.7 per cent shift to the age 0-1 group will normalize the levels for both.

Large differences between the observed and expected populations of the age group 15-40 prove the impact of migration and conscription on the population. In fact, the comments written on names in the registers such as "Gone to Izmir" or "Gone to/Serving in the Army" and a considerable number of houses recorded with the inscription "empty of males" (*zükûrdan hâlî*) support this observation. Assuming that migration was constant, projecting that migration back would fill the gaps in the age structure table. The effect of rounding ages to the multiples of ten and possible age understatement or overstatement among those aged above 50 also adds to the discrepancies between the unadjusted and adjusted population umbers.

There may be two explanations for the observed accuracy for the ages of children and adolescents. First, in 1826, the old army establishment, Janissaries, was disbanded and a new regular army called the Victorious Soldiers of Muhammed (*Asâkir-i Mansûre-i Muhammediye*) was established along European lines. The recruitment age for the new army was between 15 and 30 and military service was mandatory for 12 years.[53] With the creation of a reserve army called *Redif* in 1834, able-bodied males of 23 to 32 years old were required to be trained in or near their residence (town or district center) a few days a week and with the regular army twice a year.[54] Second, the eligibility for poll-tax payment for non-Muslims was determined by age for centuries. For the non-Muslim population register of Bursa, this age was 11. The first wave of population registers (1830-1838) had already been tracking the males' draft status. Having at least nine years of experience in keeping and regularly updating population registers and specifically targeting an age cohort led the Ottoman State to know its young subjects' age accurately. The specific aims of the registers may have led parents to be more aware of their children's age. To sum up, conscription required more accurate age registration for Muslims and poll-tax for non-Muslims.

Age Distribution of Deaths in 1839 (AH. 1255)

The distribution of deaths by age for the year 1839 (AH. 1255) are visualized in Figure 4. The total number of deaths in the year 1839 (AH. 1255) is 514. A high mortality pattern among the general population is observed, notwithstanding the low number of deaths among infants. The effect of age heaping is still present, such as no person dying at 38, 39 and 41 years old, and can be gathered from the percentages in Table 2. Although this bias cannot be washed out, ages are grouped in five-year intervals to increase their expressive power.

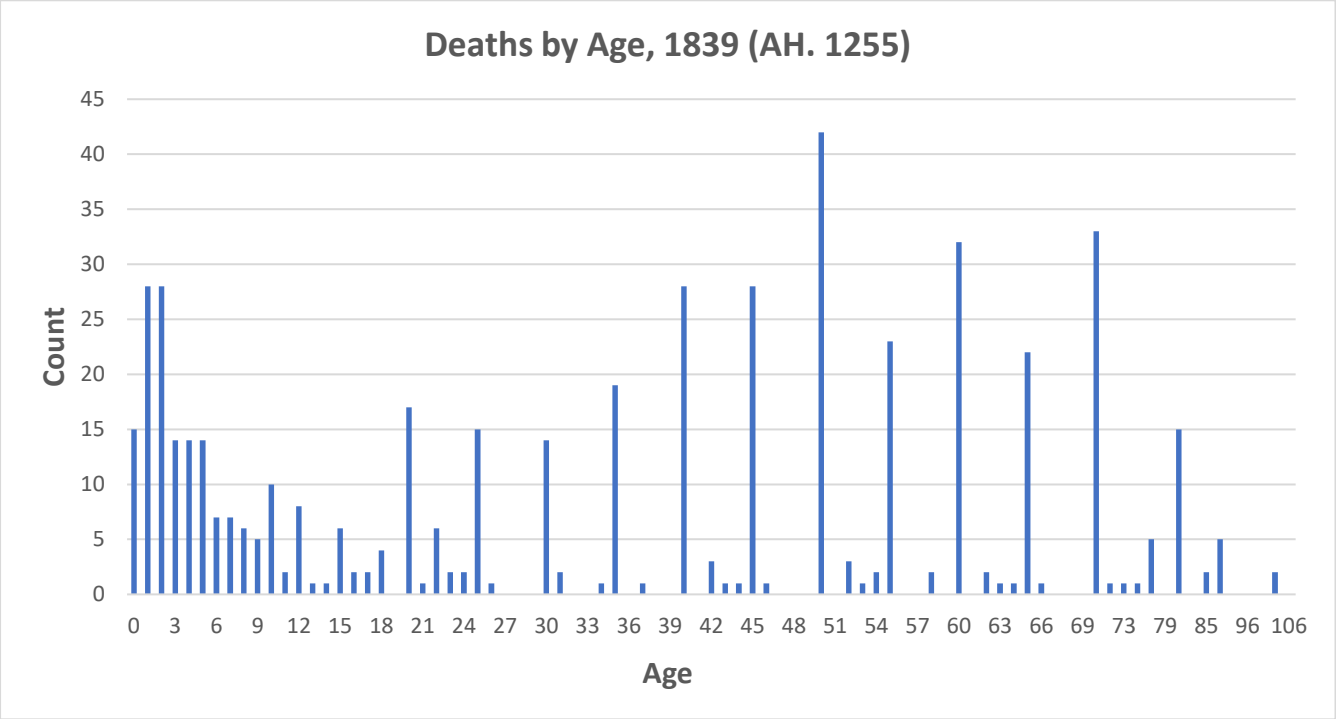


Figure 4: Distribution of deaths by age in 1839 (AH. 1255)

Age	Death Count	Percentage of All Deaths	Coale & Demeny, GRR=3.0, L4-6, Deaths at Age (%)
0-1	15	2.92	47.39 - 46.55
1-4	84	16.34	13.39 - 13.96
5-9	39	7.59	2.96 - 3.15
10-14	22	4.28	1.27 - 1.35
15-19	14	2.72	1.8 - 1.89
20-24	28	5.45	2.42 - 2.48
25-29	16	3.11	2.24 - 2.25
30-34	17	3.31	2.27 - 2.23
35-39	20	3.89	2.48 - 2.41
40-44	33	6.42	2.68 - 2.58
45-49	29	5.64	2.81 - 2.7

Age	Death Count	Percentage of All Deaths	Coale & Demeny, GRR=3.0, L4-6, Deaths at Age (%)
50-54	48	9.34	2.92 - 2.83
55-59	25	4.86	3.06 - 2.99
60-64	36	7.00	3.2 - 3.14
65-69	23	4.47	3.24 - 3.21
70-74	36	7.00	2.79 - 2.85
75-79	5	0.97	1.92 - 2.05
80-84	15	2.92	0.86 - 1
85-89	2	0.39	0.26 - 0.33
90-94	5	0.97	0.04 - 0.05
95-99	0	0	0
100+	2	0.39	0

Table 2: Distribution of deaths in 1839 in 5-year age brackets and their expected share in the Coale and Demeny life tables

Mortality records from the population register do not conform to any deaths at age approximations of Coale and Demeny's Eastern model life table (GRR=3.00, mortality levels 4 to 6), suggesting that deaths had been under-registered. Behar and Duben made the same observation regarding the 1885 and 1907 censuses that are considered more successful and comprehensive: 'One of the main shortcomings of the late Ottoman population registration system (as well as of its implementation) is that data on mortality are extremely defective.'[55]

Under-5 mortality is 19.26 per cent, that should be more than thrice this share (~60 per cent - 308 deaths). The low number of mortality cases for this group makes the death among the older population proportionately higher. The share of the 20-24 age group, 5.45 per cent, on the other hand, is 2.2 times the expected share of deaths (2.45 per cent). The 20-29 age bracket's share (8.56 per cent) is almost double what the tables suggest (4.68 per cent). As within this age cohort individuals are likely to migrate and be drafted, their relatively low share in the overall population may have resulted in them having a higher share of deaths.

The biggest difference between the register's statistics and Coale and Demeny's respective age-specific mortality indicators stems from discrepancies between infant mortality rates and expectations. Under-1 or infant mortality rate being far lower than the expected level of around 47 per cent (241) attests to the under-registration of deaths among them. Given the numbers provided by the data, the CDR ($\frac{\text{Total number of deaths}}{\text{All population}}$ x 1000) for males is $\frac{514}{14867} x\ 1000 =$ 34.57, which is slightly higher than around 33 per thousand of that for the Turkish Republic in the period 1940-45.[56] Given that the population count is affected by migration and conscription, it seems safe to apply the Coale and Demeny model life tables' very high expected CDRs of 36 to 42 per thousand (between 535 and 624) to the city of Bursa in 1839.

Annual Births and Infant Mortality Rates, 1839-1842 (AH. 1255-1258)

Births and deaths were occasionally recorded in day/month/year or month/year format for infants. In many cases, births and/or deaths were given in years. This impedes the calculation of exact age at death. Moreover, birth and death dates may not reflect the exact dates. For instance, it is sometimes observed that two newborns in two separate households in the same neighborhood were recorded with the same birth or death date. Births and deaths may simply reflect their registration date and should be taken cautiously. Another factor complicating the

estimation of death age is that updates on the register were written in *siyaqat*, a special Ottoman chancery shorthand script. This script makes it difficult to determine the month of death. Especially short versions of the fourth and eleventh months of Islamic calendar, namely Rabiulakhir (ر) and Zilhijja (ز), can be easily conflated.

For the cases where births or deaths could not be linked to a date, death ages (=differences between death and birth years) of 0 and 1 have been considered together as infant deaths in order not to miss deaths under age 1. This way, a baby born/recorded born at the end of 1839 and died/recorded dead in the first months of 1840 will be included in the analysis. Given the high probability of mis-entering age 0 into 1, under-registration of infant deaths and the relatively low number of those who died within the same year of birth support this preference. Table 3 below shows births, deaths, and infant mortality rate ($\frac{\text{Deaths under age 1 in year}}{\text{Live births in year}}$ x 1000) for the years from 1839 to 1842. Note that vital statistics ceased to be added to the master register in 1842, which precludes the calculation of annual mortality.

Year (Hijri/AH)	Births	Infant Deaths (ages 0 + 1)	IMR (per thousand)
1839 (1255)	416	48 (6+42)	115.4
1840 (1256)	320	38 (9+29)	118.75
1841 (1257)	323	29 (6+23)	89.7
1842 (1258)	252	7	-

Table 3: Annual Infant Deaths and Infant Mortality Rate, 1839-1842

The results show inconsistencies with regards to birth and death numbers. Although seasonality fluctuations in fertility and mortality have been observed in every society, it is important to note that they might have impacted the timing of record-keeping, thus leading to fewer recorded births and/or deaths. In addition, the data has a survivorship bias: miscarriages, stillbirths, premature births, and sudden infant deaths do not appear in the registers. In fact, the rates for each year is less than the national average of 160 per thousand of England in 1850,[57] 137 of Norway and 166.4 of Sweden in mid-1830s,[58] and 178 of Finland in 1840.[59]

Nevertheless, based on the expected CDR levels, the number of infant deaths for 1839 should be as low as 251 ($14867\ x\ \frac{36}{1000}\ x\frac{\sim 47}{100}$), and as high as 293 ($14867\ x\ \frac{42}{1000}\ x\frac{\sim 47}{100}$). Coale and Demeny's tables suggest a crude birth rate of around 50.1 per thousand which signifies a rapid replacement level (also understandable from the most suitable GRR level of 3). If this rate is taken as the reference point, the number of live births would be 745 ($14867\ x\ \frac{50.1}{1000}$), which produces an IMR of between 336.5 ($\frac{251}{745}$ x 1000) and 393.6 ($\frac{293}{745}$ x 1000) – meaning 3 to 4 in every 10 children died before their first birthday. This IMR is comparable with data from Central and Eastern European urban centers. For instance, by 1833-1837 upper Bavaria had an IMR of 380 and lower Bavaria 337[60] while Wuerttemberg had a rate of 337.9 from 1846 to 1856.[61] Austria was marked by high rates of 300 and 325 from 1830 to 1840.[62] High IMR of between 300 and 360 prevailed in Moscow city for the period 1883-1900.[63]

The following lengthy quote from Elizabeth A. C. Schneider, an American missionary in Bursa from 1835 to 1842, is illuminating for it shows the prevalence of infant and child mortality among Muslim and non-Muslim communities of Bursa:

> An Armenian female attended my Bible class recently. I inquired if she was a mother. She replied in the negative. She said she had been, but both her children died about two weeks since. 'Of what?' I inquired. She answered with perfect non-chalance, 'I don't know. They both had some sores come out upon their faces, and they went off.' They were of the ages of four and seven, she said. She had none to survive them! yet not one tear did she drop — not one expression of a lacerated heart escaped her lips!
>
> A Mussulman woman was once in our family room, and during a season of conversation, I inquired of her, whether she had any family. She replied in the negative. 'Had you never any children?' again inquired. 'Yes,'- she answered indifferently, 'but they are all gone now.' 'How

> many?' I continued. 'Sixteen – some of them died of the meazles, some of them of the smallpox, and some of them of other diseases.'[64]

The ability to make comparisons with European countries and regions is encouraging for extending back the study of Turkish demographic transition and for establishing data points for the global literature on mortality decline.

Conclusion

Several conclusions regarding age structure and mortality in the Ottoman Empire in the mid-nineteenth century can be tentatively advanced in the light of the data presented in this study. The Ottoman population registers started in 1830 are the first microlevel population data for Turkey and former Ottoman territories in the Balkan, Caucasian, and Arab provinces where population studies go no further than post-Ottoman nation-state statistics due to the inaccessibility of 1880s and 1900s censuses (Israel is the only exception). They provide self-reported data on all male inhabitants' ages, names, occupations, household structure, ethno-religious identity, and physical characteristics. They were regularly updated to reflect births, deaths, and migrations within, into and out of social groupings.

In line with studying age distribution and mortality by age, the present study has aimed also to test the quality of the data contained in the Ottoman population registers for historical population studies. It has focused on the city of Bursa in northwestern Anatolia that served as the first capital of the Empire and as a politically and commercially significant urban center. In 1839 (AH 1255), Bursa had a large ethno-religiously mixed population of 16,451 males of whom 15,201 were permanent residents. Bursa provides an ideal environment for studying mortality rates unaffected by exceptional mortality crises caused by war, famine, and widespread epidemics. Because the population registers reflect a discrete point in time, the number of permanent residents was affected by short-term migration and conscription of Muslims into the military. References to Coale and Demeny life tables have helped detect and correct defects in data and yielded instructive comparisons.

This study found that the age data for the city in 1839 (AH. 1255) is significantly affected by age-heaping to the nearest five-year interval. This phenomenon is more pronounced for those aged 25 and older and is not peculiar to any ethno-religious community. The age distribution for 1839 gathered from raw data revealed that the average age for males is 25.56.

Age groups at five-year intervals formed to minimize the impact of age-heaping corresponded best to the Coale and Demeny's regional model life tables (East, GRR=3.00, L=4-6) with the exception of infants under 12 months of age some of whom are assumed to have been entered into age 1. The average life expectancy at birth is 25 to 30 and at 5 years of age is 45 to 47.5 years.

The age distribution of 514 recorded deaths in 1839 resulted in a very skewed picture when compared to the Coale and Demeny tables. The data turns a crude death rate (CDR) of 34.57, which is slightly higher than around 33 per thousand of that for the Turkish Republic in the period 1940-45. The discrepancy between the percentage of infant deaths (2.92 per cent – 15 deaths) and its expected share (46.55 – 47.39 per cent) points to severe under-registration of deaths under the age of one year. Considering that under-5 deaths (19.26 per cent – 100 deaths) are only a third of its expected share (60.51 – 60.78 per cent), the low number of mortality cases for infants and children makes the death among the older population proportionately higher. However, the Coale and Demeny CDR of 36 to 42 per thousand is likely to fit the population of Bursa if the rest of deaths are adjusted for underreporting and age-heaping.

The calculation of infant mortality rate (IMR) for consecutive years from 1839 through 1842 (AH. 1255-1258) is also affected by the undercount of infant deaths and, to a lesser extent, births. The suggested crude birth rate (CBR) of 50.1 per thousand for Bursa indicates that high birth and death rates could not be properly captured during vital registration and update periods. In addition, the data has a survivorship bias, that is, miscarriages, stillbirths, premature births, and sudden infant deaths are not accounted for in the registers. Overall, the IMR of around 100 for each year given by the registers is less than one-third of the corrected result of between 336.5 and 393.6. This corrected IMR suggests that 3 to 4 in every 10 children died before reaching their first birthday and is similar to that of Central and Eastern European regions.

All in all, the demographic structure of the city of Bursa in the early 1840s was characterized by high birth and death rates. The present study has provided only a few examples of potential analyses which might be carried out using such rich and detailed territorial data. Validation of the quality of the age data opens up interesting directions for future research regarding mortality regimes that can be summed up as follows:

(1) Although quite challenging, population counts of the population registers can be used in conjunction with later Ottoman statistics to estimate annual growth rates up to the

foundation of the Turkish Republic. Moreover, the approximate female population can be reconstructed by using indirect estimates from later periods such as life tables and nation-state statistics.

(2) Household and mortality data can be crossed with occupational and ethno-religious identity information to examine socioeconomic differentials in household size and mortality.

(3) Different life tables such as that of Brass,[65] the United Nations,[66] and those prepared by Aysel Alpay for Turkey[67] should be used in conjunction with the age data provided by the registers to compare the results achieved through the Coale and Demeny model life tables.

(4) Age structure and mortality differentials in the urban and rural environments of the mid-nineteenth century Ottoman Empire can be uncovered. The results can shed a new light on the historiography on urbanization and contribute to the problematization of the urban-rural dichotomy.

(5) The results of the 1839-1842 registers should be cross-checked with the 1830-1838 population registers that are the earliest population records kept in a similar fashion. This way consistencies in record keeping and differences in mortality and age structure can be evaluated.

(6) In order to give meaning to quantitative results in any context, the study of contemporaneous sources such as memoirs and travelogues are essential to learn about the prevalence of endemics, epidemics, infectious and contagious diseases, environmental and external factors, and health behaviors in a population.

The results of this study have for the first time empirically shown the long way Turkey has come in terms of reducing infant and overall mortality using the Ottoman population registers from the mid-nineteenth century. Further detailed uses of these valuable sources will add the Ottoman dimension to the global literature on historical mortality patterns and mortality decline by introducing rich population data on a large territory spanning from Eastern Europe to the Caucasus to Arab provinces.

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