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Studying socio-economic differences in mortality in nineteenth century cities with individual level data: The Copenhagen Historical Population Database

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Abstract

The effect of industrialization and urbanization in the appearance of socio-economic differences in mortality is still a heated topic in scholarship. Reliance on contemporary accounts and data published by statistical offices has only given us a static and broad, impressionistic image of how the working classes lived and died. Enormous efforts aimed at bypassing these limitations have consisted on reconstructing the life courses of complete historical populations, similarly to what has been done for contemporary populations, through linking administrative registries. In the case of cities, precisely where the main effects of industrialization were felt, the sheer amount of work needed to attain these types of projects has prevented much work being devoted to them. This article shows how, the historical sources for the city of Copenhagen can be utilized in the face of the challenges of contemporary research in historical demography and, particularly, in the study of socio-economic differences in mortality and deepen our understanding of the circumstances that influenced people's life courses.

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The role of industrialization and urbanization on the presence of socio-economic differences in mortality during the 19th century is still a contested topic in the scholarship. Until recently, contemporary accounts and data published by statistical offices had been the only sources available for researchers, while the study of population counts and information on vital statistics made the reconstruction of general mortality trends possible, uncovering the existence of socio-economic differences in some geographical areas. The image these sources at the aggregated level offer is, however, a bit broad and impressionistic, and we are far from having a clear idea of how different life and death were for different social classes or socio-economic groups in the past.

In fact, such sources are not particularly well suited to study socio-economic differences in mortality for individuals. For instance, finding associations between wealth and health in an area does not necessarily mean that wealthy individuals experienced lower mortality risks when compared to other, less wealthy, individuals, as pointed at by current modern epidemiological, demographic and sociological research. Indeed, research in these fields has showed us the complexity of the interaction between social, demographic and contextual factors (age, gender, marital status, place of birth, place of residence, etc.), on the one hand, and measures of socio-economic status or class (however it is measured, i.e. education, occupation, income, etc.) on the other, in buffering or heightening mortality risks.

In order to address these limitations, contempo-

rary research has partially shifted its focus from the aggregated figures to the individuals that comprised the populations under study, taking advantage of the availability of individual level data originated from administrative records. By linking individuals' information through different registries, scholars are able to collect individual and household information over time, as well as individual reproductive, migration, health and labor market histories. In historical research, the same path has been taken. Reconstructing life courses for whole populations is, however, a much more daunting challenge, albeit one that has garnered much scholarly attention.

The community of family historians and historical demographers started in the mid-1960s (Henry 1953, Henry 1956) to reconstruct the population history of villages and parishes through the use of parish registries, census information, population registers and vital statistics. Their work has unraveled a fascinating history of life and death in the Ancient Regime, reaching also the early 20th century, although mostly in rural areas as, so far, relatively less work has been done for cities[1], mainly due to the sheer amount of effort required in producing this type of databases. However, these areas are particularly relevant to the debate on the origin of socio-economic differences in mortality, as it was in cities and, in particular industrial and capital cities, where industrialization and urbanization first manifested and took hold. Cities were the motors of the sweeping economic, political social and demographic changes that transformed the Western world.

This article will illustrate how Denmark and, in particular, the city in Copenhagen, is a particularly good context to address this debate. Here, the construction of the *Copenhagen Historical Population Database* (CHPD) will offer the possibility of studying in depth one of the most pervading issues in 19th century historical research: the origin and presence of socio-economic health and mortality differences.

The debate on the onset of socio-economic differences in mortality

A seemingly pervading view on the historicity of socio-economic differences in mortality, often found in modern-day research, is the claim of its universality across time and space. The almost ubiquitous presence of differences in mortality according to socioeconomic status -often meaning occupation-, has given credence to the "historical inevitability of social class differences in mortality" (Link and Phelan 1995, Wilkinson and Marmot 2003, Marmot 2004).

This assumption seems quite sensible, as it finds support in the collective imagery of 19th century industrializing cities. The long working hours, the hot, damp, dusty, and overcrowded environments and the poor food that characterized the "dark Satanic mills" of the Industrial Revolution, according to contemporaries and reformers (Chadwick 1842, Engels 1845), seem to be connected to a higher susceptibility to disease among the working poor and a consequent higher death toll. Moreover, it is not difficult to picture the same large inequalities in access to food, shelter and, in general, living conditions, also before the Industrial Revolution, between peasants and noblemen, serfs and masters, all the way to the first manifestations of social stratification. However, when looking carefully at the actual scholarship documenting socioeconomic differences in mortality in the past, evidence of this consistency is nowhere to be seen, particularly as we go far back in time.

One of the most cited references against this hypothesis is Antonovsky's divergence-convergence scenario, which stated that socioeconomic differences did not exist prior to 1650, but that they did afterwards: there was a process of divergence between 1650 and 1850 and a process of convergence since then (Antonovsky 1967). Scholarship has found no consistent evidence of convergence within the last century, but rather clear signs of a widening of socio-economic dif-

1. Among some of the early efforts undertaken for cities, it is important to note the work of Thestrom (1973) in Boston in 1973, who reconstructed the lives of a sample of men across different censuses between 1880 and 1958.

ferences over the last decades (Woods 2004, Strand, Grøholt et al. 2010, Mackenbach, Kulhánová et al. 2014). As for the earlier period, historical demographers have consistently casted doubts on the existence of large mortality differences in pre-industrial Europe. Indeed, empirical evidence has found non-existent or even inverse gradients (i.e. the rich were much more likely to die than the poor) in many historical settings prior to late 19th century (Henry 1956, Hollingsworth 1981, Woods 2004).

The seemingly straightforward and universal association between low socio-economic status or class (differently defined according to disciplines, authors and data availability (Elo 2009)), deteriorated living conditions, higher prevalence of disease and higher mortality that would explain a long-term trend of mortality inequality needs to be challenged. The interaction between biological and social factors that accounted for the variability of disease experience is a very complex one. On the one hand, poverty is generally associated to deficient living conditions (nutrition, housing, hygiene, etc.), but these conditions do not necessarily translate into mortality differences. Nutrition plays a part in health measures like height, that show socio-economic differences, but insufficient nutrition, although linked to decreased immunological resistance, is only linked to higher mortality beyond the threshold of severe malnutrition, such as in famines (Livi Bacci 2000). In fact, before the early 20th century, mortality was driven by infectious diseases (comprising up to three fourths of all deaths), and no real preventive or curative measures were differentially available to the wealthy, so mortality depended mainly on the exposure to disease (Bengtsson and Van Poppel 2011).

On the other hand, cultural or contextual practices determined particular relationships between wealth and health in different time periods and areas. For instance, infant mortality was higher for the wealthy in 19th century Denmark, as "luxury" substitute foods were given to infants instead of breastfeeding, thus increasing their susceptibility to disease and, in turn, creating an inverse gradient (Løkke 2002). Another example is doctors in 19th century Great Britain, who experienced higher mortality risks than other groups with lower status, which is easily explained by their increased exposure to infection (Woods 2004).

The interaction between the social/cultural and the biological is thus not just an isolated phenomenon but a common finding, also in contemporary societies. In developing countries, the wealthy have been shown to be the first to benefit from public health investments, but also the first to modify cultural practices and adopt "more modern", but sometimes riskier, behaviors that can create inverse gradients: unhealthier diets and habits that lead to a higher level of obesity, cardiovascular disease, and risky behaviors, sexual and otherwise, that cause an inverse gradient in HIV infections and accidents (Rossier, Soura et al. (in press)). Although the debate is still ongoing, most scholarship in historical demography agrees that the process of divergence towards the current wealth/status and health association started around mid-19th or early 20th century, but the specific moment it happened seems to have varied according to many biological and social factors. Geography, which many scholars have found to be more important than class, also plays a great role, nationally and internationally, with a large emphasis on the urban/rural differences (Szreter and Woolcock 2004, Woods 2004).

How do we measure socio-economic differences in mortality?

Historically, the process of socio-economic differentiation in mortality has been studied using mainly published statistics and contemporary sources, which have been essential for discovering trends in the past. However, as our hypotheses become more refined, and our questions not only concern populations, but also the individuals living and dying in them, aggregated sources are no longer sufficient to answer them.

One of the main problems related to the use of aggregated sources is the danger of the ecological fallacy, i.e. interpreting associations found at the population level as indication of associations at the individual level. This mismatch was first identified in

the scholarship in the 1950s by Robinson (1950). He showed that the association found between higher rates of literacy and higher rates of immigration in certain US states, according to the census of 1930, was not the result of higher literacy rates in migrants. It hid, in fact, the opposite situation: migrants had lower literacy rates but were attracted to the states with higher literacy rates, thus producing a higher-level correlation (for states) that was completely opposite to that found for individuals.

Unfortunately, in the absence of individual level data for historical periods, the scholarship has often been reduced to discussing associations of health and wealth across neighborhoods, district, municipalities, provinces, states, etc., not always emphasizing the differences between inference at the individual and the aggregated levels.

The dangers of aggregated data do not only fall in the realm of interpretation but also in its computations, especially if the registration practices responsible for the production of the data are not able to properly capture the dynamics of the societies under study. This is a particularly relevant problem in the study of socio-economic differences in mortality. For instance, if migrants arrived to the cities to make use of health and charity institutions and died shortly after, estimations of mortality would include their deaths but not their presence as residents. The same would occur with deaths of seasonal migrants, hardly likely to have been reported in the population counts. Both cases would imply overestimating mortality and misjudging any mortality differences studied (Mooney, Lucking et al. 1999, Ramiro Fariñas 2007). And in fact, the sensitivity of estimations to both types of mis-registration have been systematically found for southern Europe (Revuelta Eugercios and Ramiro Fariñas forthcoming).

Lastly, aggregated data and mortality computations derived from aggregates can only tell us about the average of individuals, that sometimes do not even reflect real individuals or only comprise a minimal part of the population. In real world populations, individuals are exposed to different risks and, thus, endure different experiences of disease and mortality, with risks factors potentially contributing differently to the explanation of their mortality. These reasons varied across age, sex, socio-economic differences, etc. In some cases, contemporary doctors or officials in charge of statistics may have computed sex, age or socio-economic specific mortality rates, but the tabulations offered are not sufficient to help us comprehend the diversity of the population experience. Thus, we are forced to think of them as part of a homogeneous group made up of interchangeable units, even if we are well aware that particular groups can be more vulnerable than others -single women, children, the elderly, etc.

The promise and challenge of individual level data

The limitations posed by aggregated data can and have been already overcome by the reconstruction of the individual lives and circumstances of entire populations. So far, and mostly in pre-industrial small populations, extraordinary databases have been collected, providing insights to individuals in their contexts, families and societies.

Historical demographers and family historians first engaged in family reconstitutions (i.e. linking births, marriages, and deaths of individuals through parish registries) in the 1950s, and then more intensely in the 1970s, to cover periods for which no published data or official statistics were available, leading demographers to produce their own aggregated population measures (Henry 1956, Laslett 1965, Thestrup 1972). Population registries and other nominal sources, including censuses and vital statistics, were incorporated later, linking people through administrative records. Soon, analyses extended from the earliest parish registries up to the 20th century. Additionally, accompanying the sweeping changes in the social sciences around the importance of the individual within his/her context, the attention also shifted to the individuals themselves and their life courses, as in Alter's early work (1988), connecting with the growing life-course approach paradigm in its sociological or epidemiological incarnations (Kuh and Ben-Schlomo 1997, Elder, Kirkpatrick Johnson et al. 2003). The fo-

cus turned to the examination of people's life events, i.e. the milestones of human life -i.e. birth, marriage, parenthood, work engagement and social mobility, migrating, death-, studied not only as aggregated numbers, but also as possible "outcomes" for individual life courses. The likelihood of experiencing one or other can be partially explained by people's own characteristics, their family situation, their circumstances and previous experiences, e.g. sex, age, marital status, migrant status, place of residence, household composition (Alter and Gutmann 1999).

Besides demographic interest, these efforts have also shed new light on the history of the people without history: how they lived and how they died and to what extent their circumstances shaped not only their own life courses but also those of their offspring. In fact, the potential of this new approach for history and demography has made the linkage of all sorts of social, economic and demographic data, for complete populations at different points in time, and even following generations evolving over time, a staple of historical demographic research in recent decades.

Where they exist, population registries are used to track individuals' life courses. Where there are none, researchers collect data on individuals from parish records (birth, marriage, reproductive life and death), censuses (household composition, occupation, income, rent, etc.) and a myriad other records (tax rolls, land registration, business lists, conscription rolls, etc.).

Examples of such undertakings are found for many places of the world. One such is the *Historical Sample of the Netherlands*, that collects information on the life courses of 0,5% of the Dutch population during the 19th and 20th centuries (Mandemakers 2000). There are many similar undertakings in Sweden, Belgium, Italy, Spain, Scotland, France, etc. Recently, the *European Historical Population Sample Network* has brought together some of these scholars to create a common format for databases containing non-aggregated information on individuals, families and households[2]. Collaboration on joint projects has a long history. The *Eurasia Project* was a joint effort to compare data from several European and Asian contexts from the 18th century onwards, providing enormous insights into life and death in the past (Bengtsson, Campbell et al. 2004, Tsuya, Feng et al. 2010, Lundh, Kurosu et al. 2014). Other efforts have been the *North Atlantic Population Project* (Ruggles, Roberts et al. 2011) and the *Mosaic Project*[3], which have collected census data that includes non-Western European regions, and there are other ongoing projects also creating databases for African (Walters 2008) and colonial contexts (Kok 2013).

Research using these unparalleled databases has allowed us to understand many local communities better and, particularly, has shown the variability of the historical experience of socio-economic differences in mortality. For instance, in a recent number of the journal *Explorations in Economic History*, eight settings in continental Europe and North America (predominantly rural or small cities under 22,000 inhabitants) were examined in relation to the question of the study of socio-economic differences in mortality during the 19th and early 20th century, and researchers found that industrialization and urbanization were unconnected to the onset of socio-economic differences. Some contexts did show a socio-economic gradient before the onset of any industrialization (Breschi, Fornasin et al. 2011, Schumacher and Oris 2011), while little or no trace of it could be found in other studies until much later (Bengtsson and Dribe 2011, Edvinsson and Lindkvist 2011), once more underlying the importance of the 'place of residence' in shaping the health patterns of different socio-economic groups (Woods 2004, Szreter 2005).

However, the full extent of the variation in the geography-class interactions is still unknown, as we are still missing large urban contexts. Even though urban populations only accounted for a small share of national populations in the 1850s, capital and industrial cities were the motors of change in the 19th century, and the places where the full extent of industrialization and urbanization processes was felt. Moreover,

2. See http://www.ehps-net.eu/content/about.

3. See http://censusmosaic.org

their changing mortality patterns make them exceptional places for research: first considered literally "graveyards"(Sharlin 1978), they would later become pioneers in mortality improvements through changes in sanitation, sewage, water, etc. (Woods 2003). Accounting for this gap is thus particularly important in the literature on mortality, as rural areas, provincial towns, industrial cities and capitals most likely experienced very different scenarios of inequality. However, the burden of the of work involved in this large-scale urban population reconstruction projects, requiring large amounts of financial and human resources to see them through, has prevented projects until recently from focusing on cities.

The Copenhagen Historical Population Database

The development of urban databases has been slow but steady in the last decade: there are available samples for Antwerp (Matthijs and Moreels 2010), ongoing projects of full coverage for Stockholm, the *Roteman* database (Geschwind and Fogelvik 2000), and Madrid (Bosque González, García Ferrero et al. 2010). There are also large-scale efforts involved in full national coverage digitation for Norway (Thorvaldsen 2011) and Scotland (Huang, Razzell et al. 2012), as well as samples, such as the already mentioned *Historical Sample of the Netherlands* and the *Historical Population Database of Transylvania. The Copenhagen Historical Population Database* will join these efforts for Denmark, continuing the pioneering efforts in Odense by Prof. Johansen (1994).

Denmark and, in particular, Copenhagen around 1880, are extraordinary settings for the development of such database. There are two main reasons that explain this relevance: first, the role of the city as capital, port and industrial center characterized as a scenario of rapid change; and, second, the availability of extraordinary sources for the city.

Copenhagen, as the capital city, comprising 12% of the total population (234,850 inhabitants in 1880), was an important port and, as such, was a center not only of communication, but also of political, economic and social activity. The 1880s were a period of economic and demographic growth in the city (Hyldtoft 1984), characterized by a growing socio-economic stratification, the most diversified labor market (Johansen 2002) and a population in strikingly poor health. Still suffering from the initial effects of urbanization, albeit engaged in a process of improvement, infant mortality rates were double that of the rest of the country (Løkke 2002).

Along with the wealth of data available for Denmark, in the form of parish registration of vital events (births, marriages, deaths) that goes as far back as the 16th century and decennial national censuses (starting in 1801), there are additional sources available only for Copenhagen. Faced with the revolutionary currents across Europe, Danish authorities made keeping the peace their priority, mainly in the form of police control via censuses of adults every 6 months, of incoming and outgoing migration through the port of Copenhagen, and additional population censuses. From 1840 onwards, the capital also implemented the requirement of a medical certification of death prior to burial, which allowed the publication of statistics of cause of death. These sources allowed a very early adoption and application of historical demography techniques (Matthiesen 1970, Thestrup 1972, Johansen 1975), and will now permit the creation of a database for the city of Copenhagen to study socio-economic differences in mortality, as well as the patterns and changes of individual behavior in relation to partner choice, fertility, migration, etc.

A strong genealogical community, amateur historian circles and enthusiasts of family reconstitution, noted and took advantage of this wealth and availability of sources, starting to gather data already in the 1970s and 1980s, to be then followed by the enthusiastic effort of hundreds of volunteers cooperating in its digitization from the early 1990s, under the coordination of the Danish Data Archive (Floor Clausen and Jørgen Marker 2000). These projects, now hosted at the *Danish Demographic Database*, have all made the construction of *The Copenhagen Historical Population Database* possible.

However, even under these unparalleled favorable conditions, the reconstruction of a population of roughly a quarter million of inhabitants for a number of years will involve a great effort in terms of time and funding. The first step towards the full construction of *The Copenhagen Historical Population Database* is the ongoing construction of a dataset for a five-year period, 1880-1885. The project is a two-year plan funded by a Mobilex Fellowship under the name: *A tale of two cities: inequality in death in Copenhagen and Madrid in late 19th and early 20th century*, co-financed by the Danish Council for Independent Research and the FP7 Marie Curie Actions-COFUND (DFF-1321-00136).

A longitudinal database, following all residents in the city for a period of 5 years, will be constructed from censuses, that normally offer a cross-sectional perspective, the population at a given moment in time, and vital registration and police records that record events at particular points in time (births, deaths and migration). The dataset will provide a short window of observation between 1880 and 1885, taking advantage of the wealth of available sources, either digitized in scanned format, or available from the Danish States Archives (*Rigsarkivet*) in Copenhagen. The population present in the 1880 census (236,000 individuals) will be linked to their information in the special census of 1885, which was only undertaken in Copenhagen. Additionally, those not found in 1885 will be linked to the death and migration records from between 1880 and 1885. Finally, in order to study infant-child mortality (a difficult task, as censuses tend to underestimate the number of infants), births that occurred in 1880 will be linked to the parental information in 1880 and their own (potential) 1885 census, death and migration records. This will allow to assess whether each individual living in the city survived to the next census, or died or migrated within that period (see figure 1).

This endeavor will be possible because its two main sources, which offer the basic individual sociodemographic and economic information, have already been fully digitized and are available through the *Danish Demographic Database* at the *Rigsarkivet*. Each census page lists the information by household (head of household first and then rest of family members with their position in said household), including address, name, surname, age in completed years, place of birth, occupation, possible handicaps, number of rooms of the apartment, rent, number of children alive in the household - and also of previous child deaths-, etc.

In addition to the two censuses, the migration records kept by the police in Copenhagen on people moving in and out the city will also be used, as found in the *Dansk oversøisk udvandring 1868-1900* records. These have also been fully digitized and are now part of the *Danish Demographic Database*. They include information on the name, surname, age of the person emigrating, last residence (parish and county) and destination, as well as the date of registration. Finally, these sources will be complemented by the undertaking of the digitation of two more sources: deaths for the period 1880-1885, and births for the year 1880.

Information on death is available through parish books (*kirkebøger*), but for deaths a unique source, available only for Copenhagen, will be used: the death certificates issued by doctors (*dødsattester*), which offer unique information on cause of death and medical treatment that is not available in the parish books. These certificates are available in paper and in microfilm at the *Rigsarkivet*, and will be photographed and transcribed for the period 1880-1885. The information included in these certificates includes: name and surname of the deceased, sex, age, marital status, occupation, place of residence and place of death, cause of death, medical treatment prior to death and doctor authorized to certify. A team of student assistants is currently transcribing these records. A similar effort will be undertaken for birth certificates and included in the database, using the scanned images of parish books made freely available at the *Rigsarkivet*'s webpage. These give information on the births occurring in each parish about: birthdate, baptism date, given name and surname of the child, name and surname of parents, age of the mother, marital status of the mother (if unmarried), occupation of the father, address, name and additional information on godparents.

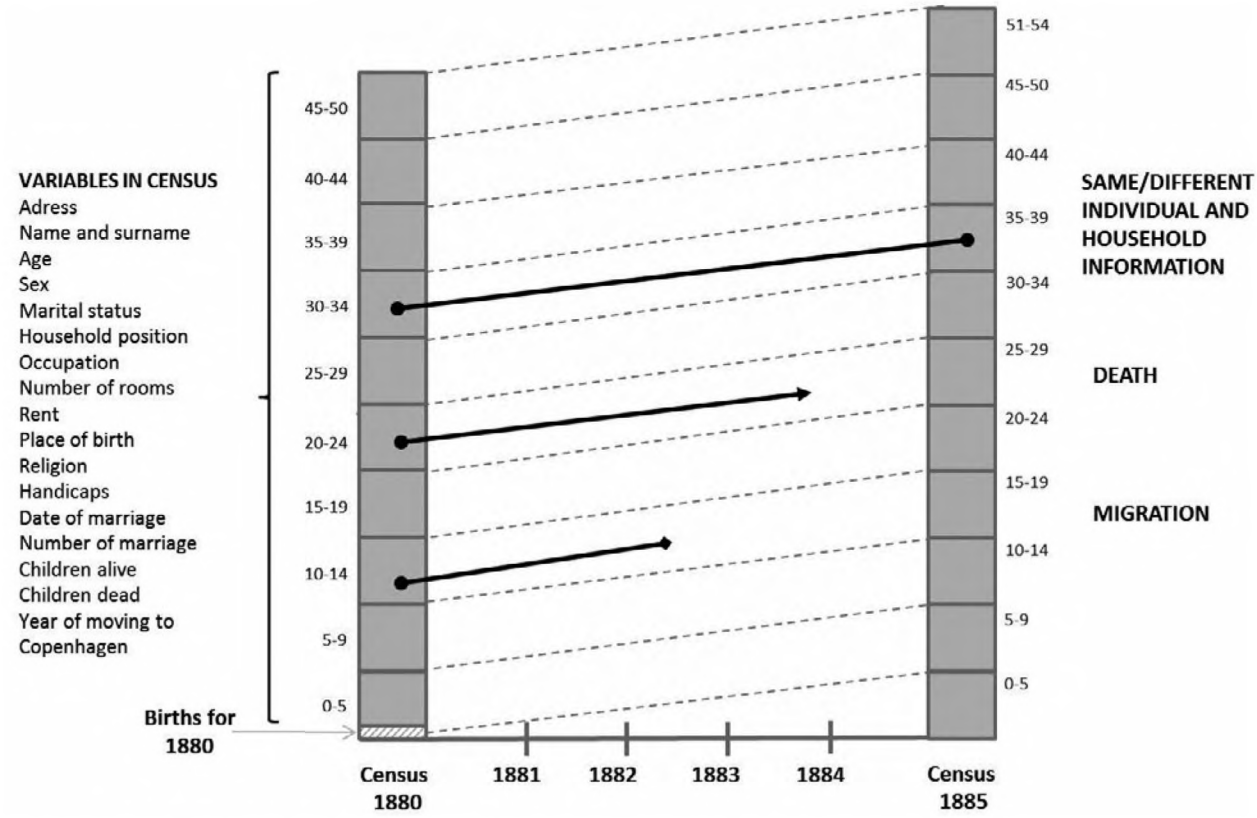

Figure 1. Reconstruction of partial life courses in Copenhagen, 1880-1885.

All the sources will be linked using the names and identifying details of individuals. Data cleaning and standardization will be built on the efforts already taken by the *Danish Demographic Database* at the *Rigsarkivet* (Floor Clausen 2015) and the most current practices in historical population reconstruction (Bloothooft, Christen et al. 2015) developed by other European countries. Standardization and variations lists will be created and made available to other researchers to ensure transparency and further follow-up efforts. The linkage will be undertaken through the software freely available (Febrl) developed by the National Australian University (Christen 2008), that has been tested for other Scandinavian countries, such as Norway (Thorvaldsen 2011). Indexing, record pair comparison by several methods, classification, and evaluation will be undertaken in order to obtain the best quality of linkages. The most recent recommendations on data matching, especially the seminal work by Christen (2012) will be followed. In particular, especial attention will be devoted to the establishment of reliability criteria for the linkages established, involving clerical work.

Conclusion

This article has shown how Danish historical sources and, particularly, those of the city of Copenhagen, can be utilized in the face of the challenges of contemporary research in historical demography and, in particular, in the study of socio-economic differences in mortality. The wealth and availability of the Danish data, especially that for Copenhagen, will clearly be able to overcome the limitations and biases of aggregated statistics that are usually experienced by historical demographers and will deepen our under-

standing of the circumstances that influenced people's life courses.

By taking advantage of these unparalleled conditions, of which the size and characteristics of the city of Copenhagen is not the least, it will be possible to create a database similar to those already being developed elsewhere. The lives of individuals being born and living in Copenhagen around 1880 will be reconstructed up to 1885, allowing the careful study of mortality differences in the same way they are studied in contemporary epidemiological research, offering simultaneously a uniquely rich perspective on the lives and experiences of the people living in the city. The resulting scientific contributions will shed light on socio-economic differences on mortality for children, adults and the elderly, as well as on gender differences, especially those of particularly vulnerable groups: single women, the residents of poorhouses, etc.

Once this initial window of observation into the city is completed, the scope for extension in time, size and representation is gigantic. In the near future, provided adequate funding, *The Copenhagen Historical Population Database* could become a comprehensive source on the lives of inhabitants in the city, leading to the inclusion of even more sources, linking any kind of material coded with a date and a name or address. The database will become public, at the disposal of the buoyant historian and genealogical community, as well as the student body at both gymnasium and university levels, compounding the social relevance of this momentous public endeavor.

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