ABOUT MORTALITY DATA FOR SWEDEN

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GENERAL

For more than 300 years, each parish in Sweden has kept a complete and continually updated register of its population. Registration began with local initiatives. In 1686, these independent initiatives were followed by a unitary decree for all of Sweden. From that year onward, it was compulsory for each parish to record all baptisms, burials, marriages, divorces, and migration as well and to maintain a population register which progressively covered every parish inhabitant. Apart from these, Sweden had a special register named "husförhörslängden" (the catechetical examination register). This register was originally introduced to keep track of literacy, understanding of the bible, and other facts of interest for the clergy. What makes the population register special is the fact that it was continuously updated. That is, the population register showed the actual population (*de jure*) living in the parish at any time (provided that the clergy updated the register regularly as they were supposed to do). The various church registers were tightly linked. When a birth was registered, the child was also included in the population register. Conversely, when a death was registered, that person was removed from the population register. Thus, registration of all vital events was crucial to obtaining an accurate population register. Unreported out-migration was one problem. Another was the accuracy in keeping the registers. Some, if not most, of the errors were detected in the yearly updates of the tax roll.

The ecclesiastical decree of 1686, which prescribed that everyone in Sweden was to profess allegiance to the Lutheran church, was the most important event in making Swedish population registration efficient, even at an early stage. Furthermore, the Converticle Edict forbade laymen to gather people for the purpose of prayer and bible reading. It was not until 1858 that this Edict was repealed. Because the Lutheran clergy acted as official registrar, the lack of religious freedom meant more complete registers than would have otherwise been possible.

The first attempts to collect population statistics from the church registers began in 1721. This first, not altogether successful, attempt was followed by a plan for the systematic collection of population statistics, the so-called *Tabellverket*. Data collection started in 1749. In every parish, the clergy were required to complete standard forms using data from the parish registers. Summaries were then made for the rectorial districts, the rural deaneries, and the diocese. Finally, the forms for the diocese were sent to the Chancery Committee. It was more or less impossible to keep track of errors that could arise at any stage in the process. The data collection system was gradually revised. Problems of missing forms and other errors were resolved over time and since 1802, the statistics can be considered more reliable. In 1858, with the founding of Statistics Sweden [Statistiska Centralbyrån] (http://www.scb.se/), the compilation of population statistics was reorganized.

Since 1860, the compilation has been based on copies of all parish registers sent to Statistics Sweden. Thus, for the first time, it was possible to very carefully check all of the information. When in doubt, the local parish was contacted and data corrected if necessary. Age was, for the first time, centrally calculated based on register information. Since 1860, population data can be considered of very high quality. The only remaining minor problem was, and still is, that not all migration was registered, leading to minor errors in population size for those aged 20 to 40.

The improvement in data quality is clearly evident in plots of deaths by age. Before 1860, an unusually high number of the deceased were reported to be older than age 100, with deaths at very old ages being quite common. Beginning in 1860, this pattern changed. Suddenly, there were few deaths at very old ages, but the numbers increased gradually over time and up to the present day. This pattern suggests that age exaggeration was a problem prior to 1860.

During census years (e.g., 1860, 1870, etc.), no regular census was taken. Instead, all the necessary information was collected from the population register. Between census years, population size by sex and age was calculated based on the available vital statistics. In these calculations, errors could accumulate until the population estimates were adjusted at the next census. Apart from a few mistakes in calculations, the errors were mainly due to incorrect migration data.

Registration of the population was re-organized in 1946, with the changes taking effect in 1950. A national registration schedule replaced the extract from the parish registers; statistics were based on information given by the clergy to the County Boards, who then sent the data to Statistics Sweden. In 1967, the population registration system was computerized. The County Boards now have population registers on magnetic tapes, which are continuously updated with information received from the parishes (Statistiska Centralbyrån, 1969).

Age reporting is thought to be extremely accurate for data from 1861 onward, even at the highest ages for the native-born population (Wilmoth and Lundström 1996). Such accuracy was achieved by cross-verification of age records within the registration system. In dubious cases, the clergy were asked to check dates of birth and death in the parish registries and if necessary, other sources of information. When Statistics Sweden was founded in 1858, even the oldest people living in the country were born after the creation of the first national statistical system in 1749. As discussed below (see the Data Quality Issues section), there are however some problems resulting from missing information on some out-migrants and from age inaccuracies for immigrants.

It is only in 1991 that responsibility for the population registers was transferred from the church to the national tax administration. For additional details regarding the historical collection of population statistics in Sweden, the reader can usefully refer to publications by Erland Hofsten and Hans Lundström (1976) and by Hans Lundström (1995).

Sources of Data

There are no detailed data available for the years prior to 1751, which explains why the HMD series starts with this year. For the period 1751-1860, death counts in five-year age groups correspond to the revised data published retrospectively by Gustav Sundbärg (Sundbärg, 1906; Sundbärg, 1908). Annual population estimates in five-year age groups for the years 1751 to 1859 also come from Gustav Sundbärg (Sundbärg, 1906; Sundbärg, 1908). The death counts for ages 90 years and over in 1851-1860 are available by single years of age from official published tables. (See Appendix I for details regarding the format of the raw data.)

For the period 1861-1900, two overlapping sources are available for death counts. First, the official data are available by single-year age groups ("1x1" data). Data for five-year age groups ("5x1" data) were also published retrospectively (Sundbärg, 1906) and are considered more accurate (Statistiska Centralbyrån, 1969). The former listed deaths of unknown age separately, but in the latter source, such deaths have been redistributed across ages before publication. Even after accounting for deaths of unknown age, there are still some inconsistencies between the two data sources:

- 1863, Males: There were a total of 10 more deaths in the 5x1 as compared with the 1x1 data.
- 1865, Females: There were 113 additional deaths in the 5x1 data.
- 1865, Males: There were 159 additional deaths in the 5x1 data.
- 1868, Females: There were 9 additional deaths in the 5x1 data.
- 1868, Males: There were 6 additional deaths in the 5x1 data.
- 1870, Males: There was 1 additional death in the 5x1 data.

In these cases, it was assumed that the total counts from the 5x1 data were correct as they presumably include some late-registered deaths. Nonetheless, it was desirable to retain greater age detail (i.e., 1x1). Therefore, the "extra" deaths were distributed proportionately into the 1x1 data in such a manner that the sum across five-year age groups exactly matched the 5x1 data.

For years 1860 to 1959, annual population estimates by sex and single year of age were constructed by Statistics Sweden from census and vital statistics data (see the "Revision History" section for more details). For years since 1960, annual population estimates are published by Statistics Sweden from the population registers.

Most of the Swedish data come from publications by Statistics Sweden. Recent vital statistics (i.e., births and deaths) and population register counts since 1965 were received as electronic files from Hans Lundström, Ewa Eriksson and Tomas Johansson, all at Statistics Sweden. Some of the death counts prior to 1918 also come from unpublished sources.

Specific Episodes in Sweden Demographic History

In general, the crude birth rates and the crude death rates declined from 1750 to 1950 (Hofsten and Lundström, 1976, Figure 1.4, p. 15). There were, however, some interruptions in the downward trend.

The crude birth rate increased around 1825 and again around 1860 only to decline again in the late 1860s. The decline in birth rates was especially steep through the early 1900s, but exhibited a post World War II baby boom in the late 1940s.

Declining mortality was also interrupted by periods of high death rates due to epidemics (Hofsten and Lundström, 1976: p. 45). In 1771-72, a harvest failure led to famine and epidemics, resulting in an increased death rate in 1772-73. Another increase in mortality during the first decade of the 19th century coincided with the Finnish War of 1808-09, but probably resulted more from epidemics than from war casualties (Hofsten and Lundström, 1976: p. 47). The Spanish influenza epidemic of 1918-19 also resulted in increased death rates, especially among those aged 15 to 40 (Hofsten and Lundström, 1976: p. 50). Because Sweden remained neutral during both World Wars, its population was minimally affected relative to other European countries.

On December 26th, 2004, Sweden suffered approximately 500 deaths as a result of the Southeast Asian Tsunami (i.e., Swedish tourists in Southeast Asia at the time), but these deaths were not included in the official death counts because of reporting delays (since deaths reported later than January of the subsequent year are not included in the official death counts for any given year). Our calculations suggest that the inclusion of these deaths may nearly double the mortality rate for ages 5-14 years in 2004 (because rates are very low at these ages); the death rates for ages 15-50 years may be increased by about 5% among males and 10-15% among females; above age 50 years, the effect is likely to be negligible. Furthermore, because population estimates for December 31st, 2004, have not been adjusted for the extra 500 deaths resulting from the tsunami, the estimated exposures for 2005—when calculated based on the average population size on December 31st, 2004, and December 31st, 2005—is slightly overestimated. Thus, death rates for 2005 are slightly underestimated.

TERRITORIAL COVERAGE

There have been no significant territorial changes in Sweden during the period covered by the Human Mortality Database.

DEATH COUNT DATA

Coverage and Completeness

The data cover all usual residents of Sweden (i.e., the *de jure* population). The data are generally thought to have been nearly 100% complete and accurate since 1860. Prior to 1860, there were some errors in reporting age at the time of death. Nonetheless, it is

likely that the same kind of errors affected the population registers with minimal impact on the calculation of mortality rates (Sundbärg, 1908).

Specific Details

During the period 1751-1860, death counts show evidence of age heaping: there is a consistently greater number of deaths reported in each five-year age groups 30-34, 40-44, … to 70-74 years (i.e., those beginning with a multiple of 10) and fewer deaths reported for the age groups 25-29, 35-39, … 65-69. This apparent age heaping was most pronounced prior to 1800 and had virtually disappeared by 1860.

POPULATION COUNT DATA

Coverage and Completeness

The data represent the usually resident (i.e., *de jure)* population. Prior to 1860, however, the population counted in Stockholm was based on tax registers and thus represented the *de facto* population (Hofsten and Lundström, 1976: p. 156). The data are generally thought to have been nearly 100% complete and accurate since 1860. There appear to be some problems with coverage and completeness prior to 1861, especially before 1810. During the early period, there was also some age misreporting. The census figures for 1751-1860 have been corrected by Gustav Sundbärg for errors in the age distribution. However, the official population estimates have not been corrected. Because errors in age are thought to be similar in both the death data and the population data (Sundbärg, 1908), the uncorrected exposure estimates (i.e., the arithmetic mean of population estimates at the beginning and at the end of the year) are used for the HMD, rather than the corrected census counts for this period. Thus, the errors in deaths and population are expected to cancel out in the death rate calculations.

Specific Details

From 1751 to 1860, population data come from exposure estimates, but these data are available only by five-year age groups. Therefore, they are split into one-year age groups according to the method described in the Methods Protocol (pp. 27-28), working backwards from the 1860 census and using death counts between the time of the estimate and the 1860 census. For this period (1751-1860), the exposure estimates also suggest some problems of age heaping. The population counts by five-year age groups for all age groups starting with a multiple of ten from 40-44 years to 70-74 years tend to be greater than those for the age groups ending with 5 from 35-39 years to 65-69 years. This pattern is most apparent prior to 1800.

BIRTH COUNT DATA

Coverage and Completeness

To the authors' knowledge, the data cover all births to the usual residents of Sweden (i.e., the *de jure* population). The data are generally thought to have been nearly 100% complete and accurate since 1861. Prior to 1860, there were some problems of under-registration, especially before 1800 (Hofsten and Lundström, 1976: pp. 154-155).

For the years 1970 to 2011, birth-by-month data come from the Historic Population Register (HPR). These data incorporate late registered births, and differ slightly from those published by Statistics Sweden (Persson et al., 2016). For years after 2011, birth data are publicly available and they have been downloaded from Statistics Sweden website.

DATA QUALITY ISSUES

The data prior to 1861 should be used with extra caution due to problems of data quality.

- For 1751 to 1860, the original death counts and population estimates were available only in five-year age groups (see Appendix I for details regarding the format of the raw data). Thus, in order to calculate life tables by single year of age the methods described in the Methods Protocol were implemented to estimate deaths and population by single year of age.
- As noted above, there are problems of age heaping in both the death counts and the population estimates during this period. As a result, these problems get propagated within the calculations, causing strange patterns in the resulting data. For example, among females in 1751 (see Figure 1a below), the population estimates exhibit a saw-tooth pattern with peaks at ages ending in "0" and valleys at ages ending in "5". Death counts also demonstrate an implausible saw-tooth pattern (see Figure 1b below). Consequently, the death rates reflect these age heaping problems (see Figure 2 below). **We recommend using the HMD life tables by five-year (or ten-year) age groups rather than the single-year of age data, especially for years prior to 1800. By 1800, most of these data quality problems disappear.**

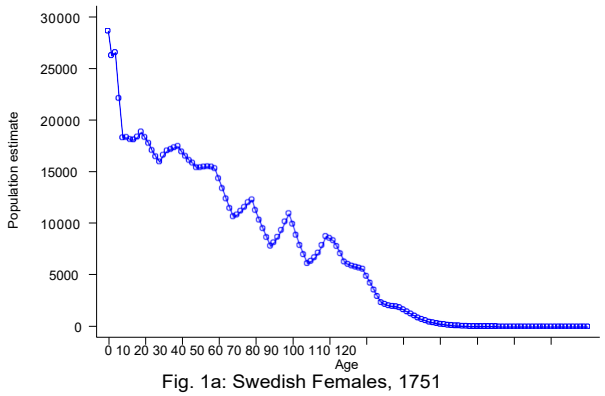

Fig. 1a: Swedish Females, 1751

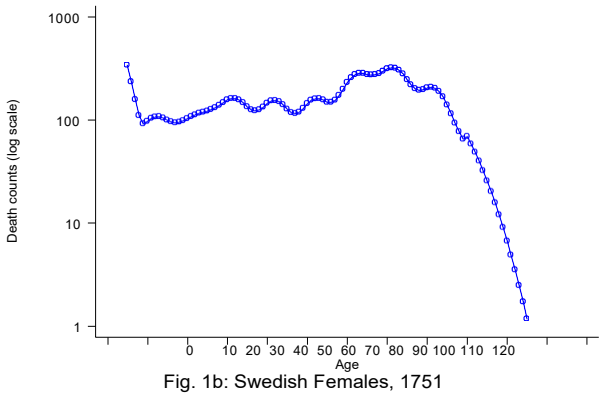

Fig. 1b: Swedish Females, 1751

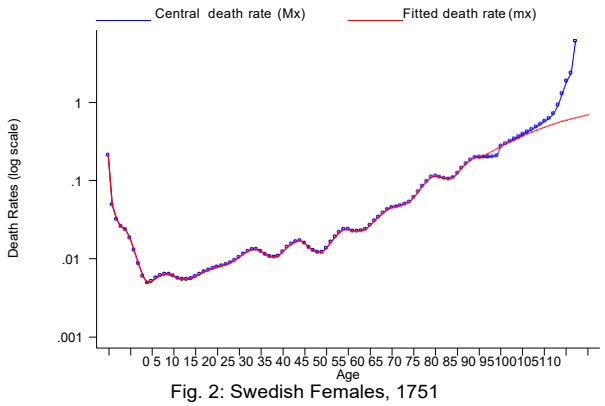

Fig. 2: Swedish Females, 1751

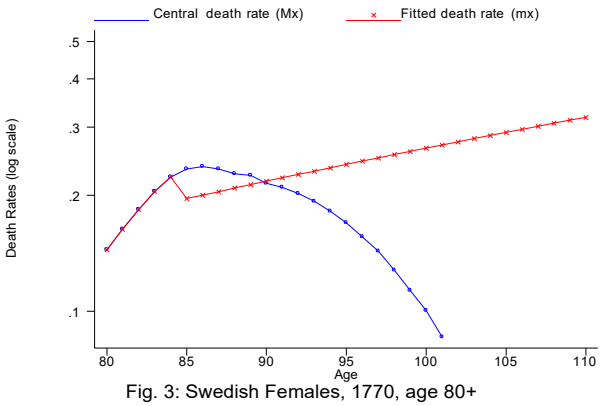

Fig. 3: Swedish Females, 1770, age 80+

- Furthermore, users should be careful not to over-interpret estimates at older ages. Prior to 1851, the original death counts and population estimates were available only up to an open age interval (90+ or 100+). Thus, the HMD estimates by single year of age at these older ages are subject to a great deal of uncertainty. In fact, because of data quality problems, the methods used produce implausible patterns in some cases. For example, among females in 1770, the estimates for the central death rates ("Mx") decline above age 85 (see Figure 3 below). For calculating the life table, a parametric model was fitted to these data in order to obtain fitted death rates (life table "mx"), which do increase at older ages as would be expected. Nonetheless, users should not interpret these data as representing "real" patterns. These estimates may differ substantially from the true values (which are unknown). Similarly, implausible patterns of declining hazards at older ages were observed among females in 1788 and 1838; and among males in 1814, 1828, 1832, 1834, 1836, 1837, and 1849.
- In recent years, death and population data for advanced ages may contain age-reporting and registration biases. One of the main issues in this respect regards the growing immigrant population. While age misreporting for the Swedish-born population is an unlikely event because birth registration is a historical tradition, migrants increasingly originate from countries with unreliable vital statistics systems and a sizeable proportion might provide inaccurate information about their ages or dates of birth. Would a systematic age overstatement affect reports from immigrants, as suspected by Statistics Sweden1, the bias would increase at very old ages, when the number of Swedish-born survivors becomes very small, leading to an under- estimation of mortality at these high ages. Indeed, the proportion of foreign-born in the population increases from 10.7% in the age group 90-94 to 16.3% at 105+ years in 2023. By contrast, the proportion foreign-born in the death counts is more unstable from year to year. In 2023 the proportion of foreign-born deaths decreased from 9.9% in the age group 90-94 years to 3.9% at 105+ years (Table 1). In 2023 the proportion of foreign-born in the population aged 105+ remains higher than in the younger age groups in 2020, and 2021, and 2022. At the same time in 2023 it is on par with the 105+ year-old proportions at 17.0%, 17.07%, and 15.7%, in the respective preceding years. The proportion foreign-born in the death counts for the open-ended age interval was 11.4% in 2020, 10.3% in 2021, but spikes to 16.3% in 2023. HMD mortality indicators at 105+ years are thus probably underestimated and mortality at these very high ages should be interpreted with caution.

[1] Personal communication with Tomas Johansson (Statistics Sweden).

Table 1 – Population and death counts, total and foreign-born – Sweden, 2023

Age group	Population			Death counts		
	Total	Foreign-born	Proportion of foreign-born (%)	Total	Foreign-born	Proportion of foreign-born (%)
90-94	14,784	1,632	9.9%	78,821	9,437	10.7%
95-99	6,865	6,72	8.9%	21,113	2,332	9.9%
100-104	1,308	106	7.5%	2,632	310	10.5%
105 +	74	3	3.9%	118	23	16.3%

Source: private communication from Statistics Sweden

- For the period since 1960, when population census has been replaced by population registers as the main source for constructing annual population estimates, an additional problem has arisen: it appears that a number of emigrants remain in the population registers after they leave the country, which creates a numerator/denominator bias since when these people die abroad, their death records are not accounted for in Swedish statistics. For this reason, as well as for the issue raised above (age misreporting among the non-native born), work is underway at Statistics Sweden to verify the information for all centenarians in the population. The HMD input data will be updated as results from these verifications become available. Until then, Statistics Sweden recommends extreme caution in interpreting age-specific death rates above age 105 years or so up to the most recent calendar year. Original death counts for years 2012 and after have been provided by Statistics Sweden with an open age interval of 105+ years.

REVISION NOTES

Changes with the September 2015 revision:

Population: In February 2015, Statistics Sweden published a new series of annual population estimates by sex and single year of age for all years from 1860 to 2014. This new series differs from the previous one for all years from 1861 to 1991, except for census years (1945 excluded), when the population counts are similar by sex and age. Differences between the two series appear to affect only marginally the HMD life table estimates (see Appendix II for more detailed diagnostics) but, because the revised numbers seem to better represent the demographic dynamics of Sweden, we decided to use this new dataset for all years from 1861 to 1991, except for census years 1870, 1890, 1900, 1910, 1920, 1935, 1940 when age information is provided in more details for the population counts. For 1945, we also elected not to use the population estimates from the new data series after discussion with our colleagues at Statistics Sweden as these new data appear to introduce some important and unexplained disruptions

in the single-year of age distribution compared to the surrounding calendar years[2].

Changes with the December 2017 revision:

Life tables: All life tables have been recalculated using a modified methods protocol. The revised protocol (Version 6) includes two changes: 1) a more precise way to calculate a0, the mean age at death for children dying during the first year of life and 2) the use of birth-by-month data (where and when available) to more accurately estimate population exposures. These changes have been implemented simultaneously for ALL HMD series/countries. For more details about these changes, see the revised Methods Protocol (at http://v6.mortality.org/Public/Docs/MethodsProtocol.pdf), particularly section 7.1 on Period life tables and section 6 and Appendix E, on death rates. The life tables calculated under the prior methods (Version 5) remain available at v5.mortality.org but will not be further updated in the future.

ACKNOWLEDGEMENTS

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[2] Statistics Sweden is revising the population figures currently available on their website, and this problem should be corrected by the end of 2015.

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APPENDIX I:

DESCRIPTION OF THE ORIGINAL DATA USED FOR HMD CALCULATIONS

DEATHS

Period	Type of Data	Age Grouping	Comments	RefCode(s)†
1751-1815	Annual number of deaths, by sex and age groups (5x1) with open interval age 90+.	0, 1-2, 3-4, 5-9, ... 85-89, 90+	Data published by Sundbärg (1906)	21
1816-1840	Annual number of deaths, by sex and age groups (5x1) with open interval age 100+.	0, 1-2, 3-4, 5-9, ... 95-99, 100+	Data published by Sundbärg (1906)	21
1841-1850	Annual number of deaths, by sex and age groups (5x1) with open interval age 90+.	0, 1-2, 3-4, 5-9, ... 85-89, 90+	Data published by Sundbärg (1906)	21
1851-1860	Annual number of deaths, by sex and age groups (5x1) to age 89 and single year of age (1x1) for age 90 and older.	0, 1-2, 3-4, 5-9, ... 85-89, 90, 91, 92, … max	5x1 data published by Sundbärg (1906) and 1x1 data from official published tables.	19-21
1863, 1865, 1868, 1870	Annual number of deaths, by sex and age groups (5x1) with open interval age 100+.	0, 1-2, 3-4, 5-9, ... 95-99, 100+	Data published by Sundbärg (1906); deaths of unknown age were already redistributed across age. (These data are used only to adjust the 1x1 counts listed below—refcode=22; See note in “Source of Data” section.)	21
1861-1894	Annual number of deaths, by sex and single year of age (1x1)	0, 1, 2…maximum age attained, unk	Official published tables.	22
1895-1900	Annual number of deaths, by sex and single year of age (1x1) for ages 0-49 and single year of age and birth cohort (Lexis triangles) for ages 50 and above.	1x1: 0, 1, 2…49 Triangles: 50, 51…max, unk	1x1 data from official published tables; Triangle data come from unpublished archives provided by Hans Lundström.	22, 24
1901-1954	Annual number of deaths, by sex, single year of age, and birth cohort (Lexis triangles)	0, 1, 2…max, unk	Data before 1918 come from unpublished sources, while later data come from published sources; Data for 1945 include some deaths of unknown age.	25, 26

Period	Type of Data	Age Grouping	Comments	RefCode(s)†
1955-1964	Annual number of deaths, by sex, single year of age, and birth cohort (Lexis triangles)	0, 1, 2…max	Original raw data were available in 1x1 and period-cohort formats. These data were combined to derive the Lexis triangles.	26, 27
1965-2011	Annual number of deaths, by sex, single year of age, and birth cohort (Lexis triangles)	0, 1, 2…max		27-30, 43, 44, 46, 49, 50, 52, 56, 57, 58
2012-2023	Annual number of deaths, by sex, single year of age, and birth cohort (Lexis triangles)	0, 1, 2…105+	Data provided with open age group 105, See section "Data quality issues"	61, 69, 73, 77, 81, 85, 89, 93, 97

† The reference code is used in the raw data files (Input Database) to link data with sources.
max=maximum age attained; unk=deaths of unknown age

POPULATION

Period	Type of Data	Age Grouping	Comments	RefCode(s)
1751-1860	Annual average population (i.e., exposure) estimates, by sex and five-year age groups	0, 1-2, 3-4, 5-9, 10-14, … 85-89, 90+	Data published by Sundbärg (1908)	31
1860, 1870	Census counts of population as of December 31st, by sex and single year of age	0, 1, 2, …maximum age attained	Data also includes an "age unknown" category	32
1890, 1900, 1910, 1920, 1935, 1940, 1945	Census counts of population as of December 31st, by sex and single year of age	0, 1, 2, …maximum age attained		32-36

Period	Type of Data	Age Grouping	Comments	RefCode(s)
1861-1991 except census years: 1860,1870, 1890,1900, 1910,1920, 1935,1940, 1945	Annual official population estimates as of December 31st, by sex and single year of age	0, 1, 2 …, 90+ 91+,95+ or 100+	Except for the following census years: 1860,1870, 1890,1900, 1910,1920, 1935,1940, 1945	59
1992-2023	Annual official population register counts as of December 31st, by sex and single year of age	0, 1, 2, …maximum age attained		39, 42, 45, 47, 48, 51, 53, 15, 17, 55, 60, 68, 72, 76, 80, 84, 88, 92, 96

BIRTHS BY SEX

Type of data: Annual live birth counts by sex

Period covered: 1749 to 2023

RefCodes: 8, 11-14, 16, 10, 18, 23, 54, 62, 70, 74, 78, 82, 86, 90, 94, and 98

BIRTHS BY MONTH

Type of data: Annual live birth counts by month

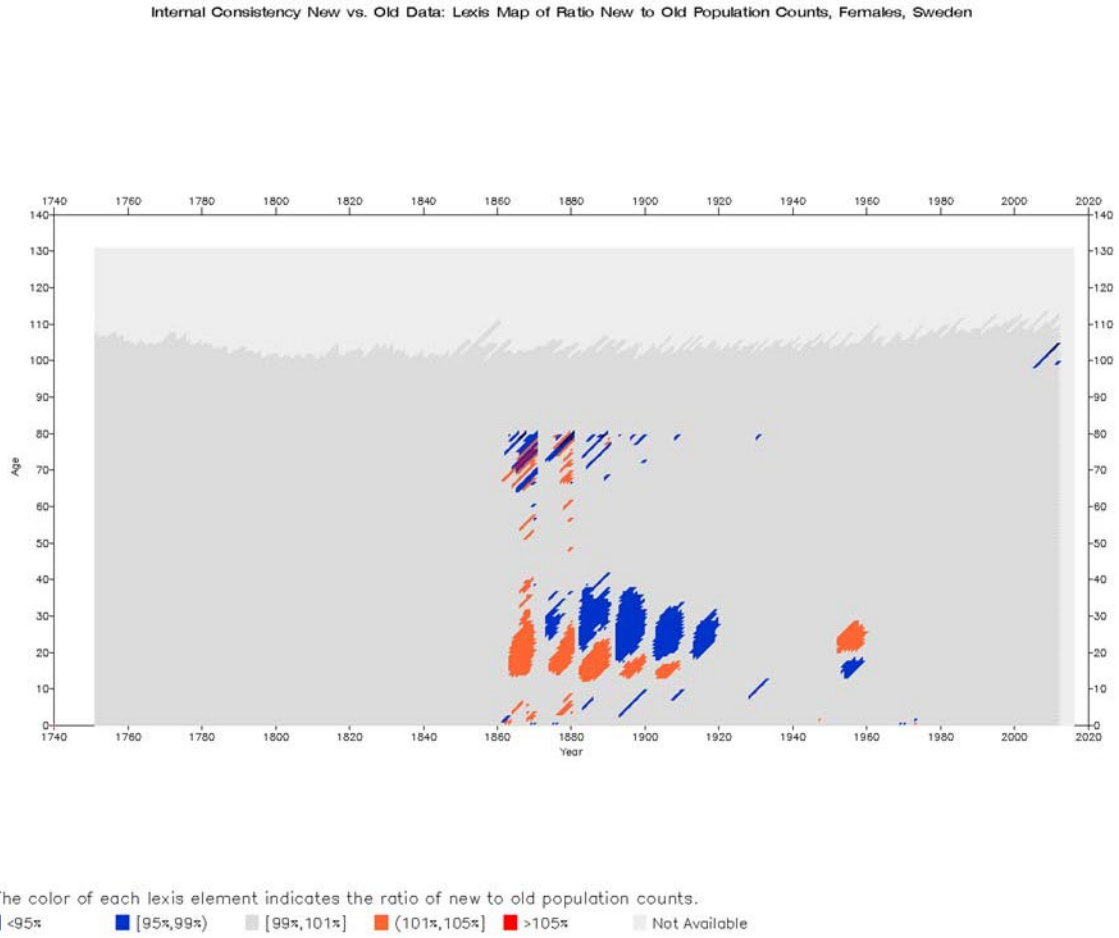
Period covered: 1911 to 2023

RefCodes: 63, 64, 65, 66, 67, 71,75, 79, 83, 87, 91, 95, and 99

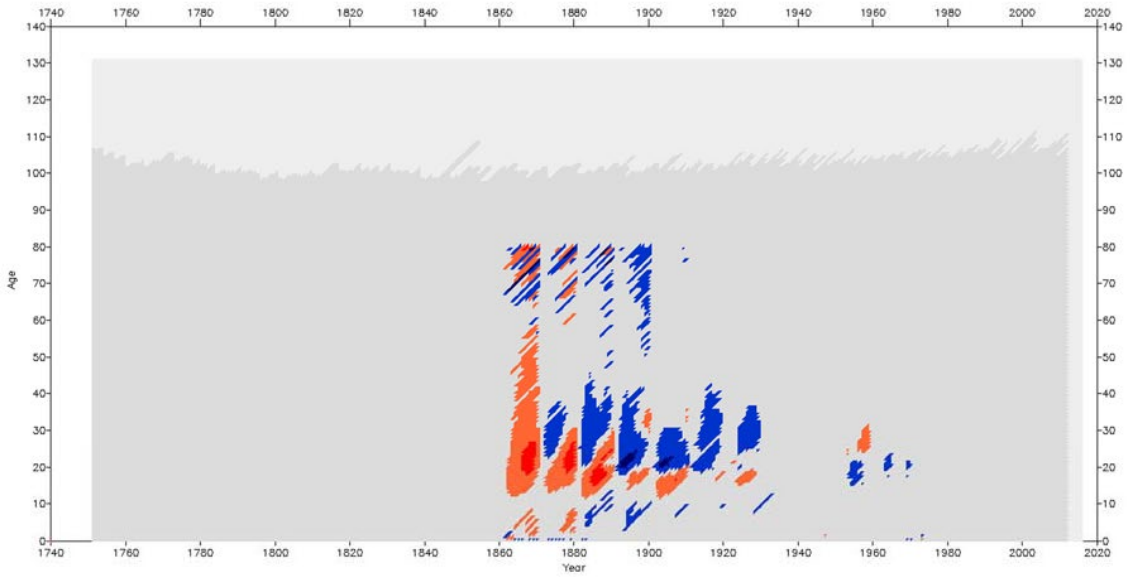
APPENDIX II:

CHANGES TO THE POPULATION ESTIMATES WITH THE SEPT. 2015 UPDATE

The figures below show differences in the population counts and mortality rates between the prior HMD series and the current series, updated using the newly released historical data from Statistics Sweden. The largest differences between mortality estimates based on these two series reach between 5 and 10%. They are only significant for the male population and are concentrated in the young adult ages for the years 1860-1910, with only marginal effect on life expectancies.



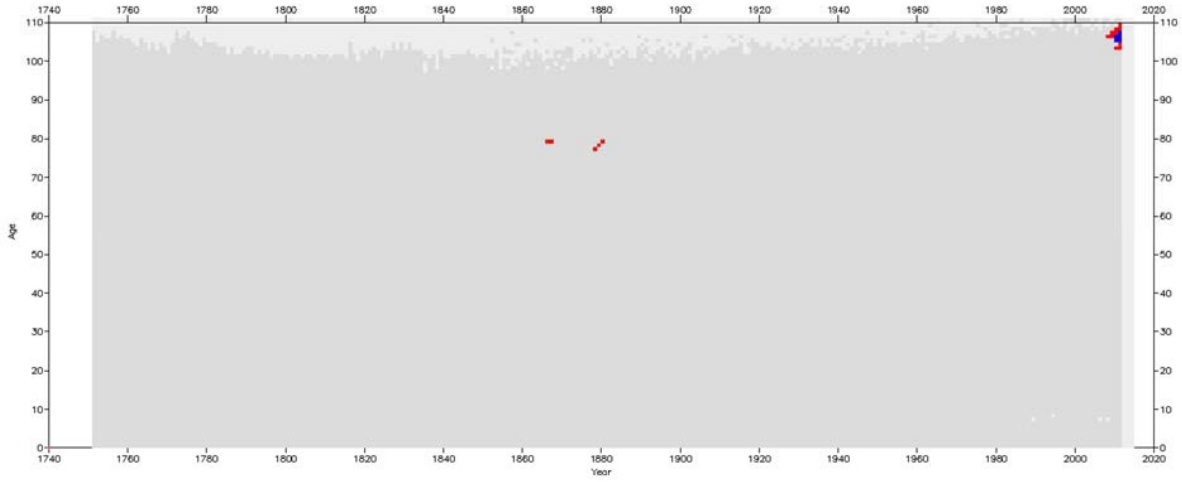
Internal Consistency New vs. Old Data: Lexis Map of Ratio New to Old Population Counts, Males, Sweden



Note: The color of each lexis element indicates the ratio of new to old population counts.

<95% [95%,99%) [99%,101%] (101%,105%] >105% Not Available

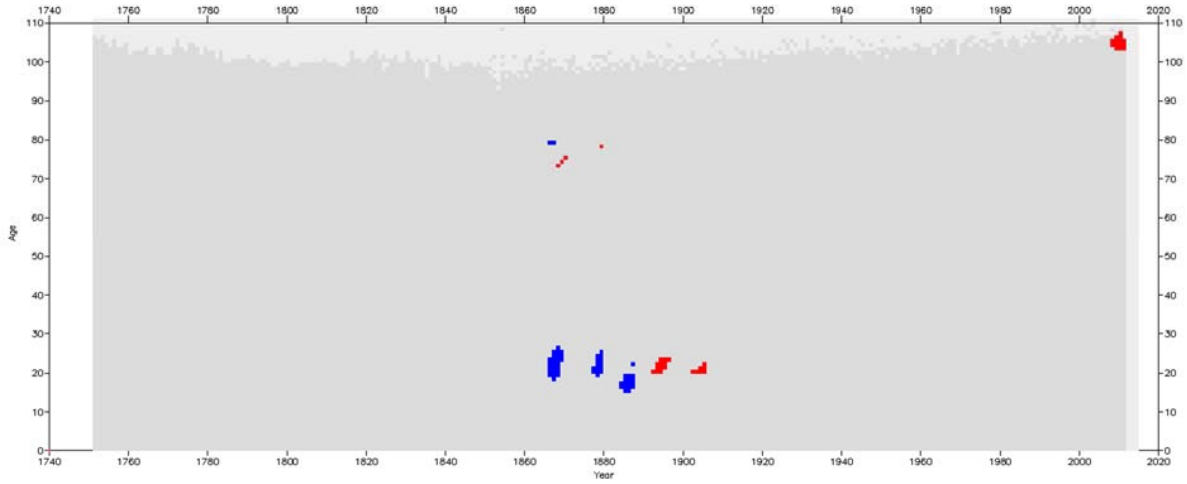
Internal Consistency New vs. Old Data: Map of Ratio of New to Old Raw Mortality Rates, Females, Sweden



Note: The color of each lexis element indicates the ratio of new to old mortality rates.

<95% [95%,105%] >105% Not Available

Internal Consistency New vs. Old Data: Map of Ratio of New to Old Raw Mortality Rates, Males, Sweden



Note: The color of each lexis element indicates the ratio of new to old mortality rates.

<95% [95%,105%] >105% Not Available