ABOUT MORTALITY DATA FOR EAST GERMANY

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GENERAL

For the purposes of the Human Mortality Database (HMD), the territory of the former German Democratic Republic (GDR) is referred to as "East Germany". The area designated here as East Germany includes the federal states of Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt, Sachsen, Thüringen, and East Berlin. Since January 2016 the whole city of Berlin is included in the territory of East Germany.

Since 1946, the statistical system in the eastern part of Germany has produced annual statistics on deaths and population. The demographic information is based on census counts and vital registration.

The first census after the Second World War took place in 1946 in the "Soviet occupied zone" of Germany. The census years in the GDR were 1950, 1964, 1971, and 1981. The first census after reunification took place in East Germany in 2011 only. Thus, there is a 30-year gap between the preceding and the most recent census. This represents a very unusual case for a developed country.

Since 1956, the annual tables showing death counts by sex, single year of age, and year of birth, as well as the population counts by single year at year-end are published in the statistical yearbook of the GDR. For the years 1946–1955, no data were published, which explains why the HMD series starts in 1956. At the beginning of the 1970s, a population register was introduced (central resident register), similar to those in the Nordic countries. On October 3rd, 1990, the population register was updated, which provided the basis for population statistics in subsequent years.

Between 1876 and 1945, vital registration statistics in all parts of Germany had been based on the Civil Status Act (*Personenstandsgesetz*) [1]. In the period between 1876 and 1945, the Civil Status Act was subject to slight revisions. During the division of Germany in the period 1946-1989, East Germany and West Germany implemented changes to this law independently from each other [2, 3]. On October 3rd, 1990, the official day of reunification, the legal situation changed again, as the Civil Status Act that had been developed by West Germany during the period of the German division was from then on also applied on East Germany.

The differences in the collection of population statistics between the two parts of Germany before 1990 resulted from the different definitions used for live births and resident population. In the GDR, the term "live birth" was used when the newborn exhibited at least two signs of life instead of one only in the Federal Republic of Germany (FRG) (see details in the section on Birth Count Data). Also, in the GDR, foreigners who had arrived in the country less than six months before were not included in the "resident population" whereas in the FRG, all residents were included.

DATA SOURCES

All of the data included in the Human Mortality Database (HMD) come from the Federal Statistical Office in Wiesbaden [4,5]. The Input Database (InputDB) includes death and population counts for all years since 1956. The data for the period 1956-1981 were published in the statistical yearbooks of the GDR. For the years 1982-89, a scientific project was established at the Federal Statistical Office in Wiesbaden for recalculation of the population statistics [6]. All birth counts come from the statistical yearbooks of the GDR [7]. Since 1990, all input data for the HMD are provided by the Federal Statistical Office in electronic format.

TERRITORIAL COVERAGE

In 2001, the administrative structure of Berlin was revised. The former 23 Berlin districts were merged into 12 new districts ('Bezirke'). As a result, it was no longer possible to derive data for the previous divisions of Germany into East Germany (including East Berlin) and West Germany (including West Berlin) directly from official published statistics. However, it was possible to reconstruct the old division of Berlin for the period since 2001 in a very precise manner from the available statistics using *Melderegister* data as a complementary source of information (see Appendix 2). These data allowed us to maintain the former distinction between East and West Germany until 2015. However, since January 2016, the HMD data for East Germany refer to the East German territory, including Berlin as a whole (East and West) while in 2015 and prior years, Berlin was split between the East and West German series.

DEATH COUNT DATA

Coverage and Completeness

The registration of deaths in the GDR was highly centralised. Annual statistics included all registered deaths of permanent residents of the GDR (source: laws for the registration of births, marriages and deaths [8]). The degree of misreporting and incompleteness of the data is unknown. The quality of **age** reporting is relatively high because, since 1876, birth and death registration has been conducted by the registry office in all territories of Germany, and death registration has required a birth certificate from the registry office. Death registration typically proceeded as follows.

A physician compiled the medical report and coded the cause of death. Only an authorised physician was allowed to compile this report. Normally, the report was sent to the registry office with the local authority (town) where the legal (official) death certificate was recorded and documented. The information from the death certificate was coded, the registration card was completed, and the information was sent to the Federal Central Office for Statistics (*Staatliche Zentralverwaltung für Statistik*, or SZS). The original death certificate was also sent to the SZS and archived there for 20 years. A copy of the death certificate was sent to the district physician or to the physician in charge of controlling all documents. Until 1965, the coding and verification of the coding were organised in the regions, the information was sent to the regional statistical office, and then, finally, to the SZS. Since 1965, the death certificates have been sent directly to the SZS where the cause of death was recorded and that information is sent back to regional statistical offices.

For the years 2018-2020, the German Statistical Office (DESTATIS) introduced a new procedure to deal with small numbers of deaths. When the number of cases is less than 3 or when there are single values identical to the marginal total, the non-zero number of death counts in that cell is suppressed for privacy protection. The relative additional non-risky cells are also suppressed (secondary suppression or complementary suppression) to avoid re-identification of the deceased individuals, following German rules

There are many different approaches to resolving this kind of problems. We decided to use the Iterative Proportional Fitting method as it is well known, extensively used, and easy to implement. The Iterative Proportional Fitting (IPF) algorithm was initially developed by Fienberg (1970) and later revised by Bishop et al. (1975). The IPF iteratively recalculates the cell values in a contingency table so that the row and column sums of the cells become equal to the marginal totals (see details in Appendix 2 in Background and Documentation of Total Germany).

The algorithm is computed independently for each year (2018-2020) and sex and results in adjusted age-specific data cells that do correspond to the marginal totals for East Germany. Suppressed cells in the West German dataset were calculated by the difference between the Total and the East German counts.

Infant Mortality

International comparability of infant mortality in the former GDR is problematic because the definitions of live births and stillbirths differed from those of the World Health Organization (WHO). In the GDR, a live birth was defined by two indications of life: heartbeat and respiration. Therefore, a newborn with a heartbeat but no respiration even after applying intensive neonatal care, was counted as a stillbirth, whereas according to the WHO definition, it would have been first recorded as a live birth, and subsequently as an infant death. The difference in definitions of life births explains the apparent lower infant mortality in the GDR as compared to the FRG.

Even before the introduction of the 9th revision of the International Classification of Diseases (ICD), this topic was widely discussed by GDR physicians. However, due to health politics (keeping infant mortality at a level as low as possible) as well as the concerns of some gynaecologists and obstetricians in connection with the laws on abortion at that time—which allowed abortion after the 12th week of pregnancy—the WHO definitions were not adopted. Thus, prior to 1991, many live births (based on the WHO definition) were classified as stillbirths or abortions. In the GDR, the definition of a live birth was modified several times during the period covered by the HMD:

- Period 1962–1978: Newborn child whose breathing AND heartbeat started after complete separation from the mother [9].
- Period 1979–1990: Newborn child whose breathing AND heartbeat started after complete separation from the mother independent of cutting the umbilical cord and delivery of the placenta [10].
- Period since 1991: Newborn child whose breathing OR heartbeat started after complete separation from the mother independent of cutting the umbilical cord and delivery of the placenta.

Thus, since the reunification of Germany, the definition of a live birth has been conformed to the WHO definition in both parts of Germany.

The definition of a stillbirth has changed accordingly over time:

- Period until 1978: Death of a fetus whose breathing AND heartbeat did not start after complete separation from the mother and whose body length was no more than 35 centimeters [9].
- 1979-1990: Death of a fetus whose breathing AND heartbeat did not start after complete separation from the mother independent of cutting the umbilical cord and delivery of the placenta and whose body weight was no more than 1,000 grams [10].
- 1991-1993: Death of a fetus whose breathing OR heartbeat did not start after complete separation from the mother independent of cutting the umbilical cord and delivery of the placenta and whose body weight was no more than 1,000 grams [10].
- Period since 1994: Death of a fetus whose breathing OR heartbeat did not start after complete separation from the mother independent of cutting the umbilical cord and delivery of the placenta, and whose body weight was no more than 500 grams [11].

BIRTH COUNT DATA

Coverage and completeness

The number of live births has been under-estimated during the period 1956-1990 because the definitions of "live-births" and "stillbirths" differed from internationally accepted WHO definitions. As detailed above, in the GDR a "live-birth" was defined by two indications of life: heartbeat and breathing. For the years prior to 1994, the number of stillbirths was under-estimated because the minimum birth weight for classification as a stillbirth rather than as a spontaneous abortion (i.e., miscarriage) changed on March 31st, 1994 from 1,000 grams to 500 grams [7].

POPULATION COUNT DATA

Coverage and completeness

Population estimates are based on census counts. Between census years, birth, death, and migration counts are used to calculate the population on the last day of each year (December 31st). After each census, the population count was corrected by the SZS, but not recalculated for the previous inter-censal period. In the territories of the former GDR, before reunification, censuses took place on:

October 29th, 1946,
August 31st, 1950,
December 31st, 1964,
January 1st, 1971,
December 31st, 1981.

As a result, the end-of-year population estimates for 1964, 1970, and 1981 are, in fact, census results. In 1985, a discrepancy between the register and the traditional statistical system became apparent, with the systematic underestimation of the population by approximately 55,000 people (0.3%). For 1985-1989, the SZS carried

out stepwise annual corrections to the data in the statistical system for some regions of the GDR. For this reason, a scientific project was conducted to recalculate population statistics for the whole territory for the years 1982-1989, and these data were published by the Federal Statistical Office in Wiesbaden in 1996 [5, p. 9]. The East German population register was used as the basis for an enumeration in East Germany on October 3rd, 1990, when West and East Germany were reunited. The population register was closed in 1992 because it was not compatible with the rules on data protection in the FRG. The main problem with population statistics is that of migration because many people did not notify the authorities before they left the country and thus remained in the registers. This problem was particularly severe in 1989 when an estimated 297,000 people emigrated from the GDR and 360,000 immigrated into the FRG.

Because of the strict East-German border regime (German wall), there was hardly any migration out of East Germany from 1961 until 1988. Thus, errors in population statistics as a result of emigration were relatively small. The extent of age heaping and over-registration of centenarians is unknown.

A publication by the Federal Statistical Office in Wiesbaden [5] included data for 1950-1955. Age heaping was identified at ages 55, 60, 65, 70, 75, 80, 90 in the original data for East-German females for the years 1950, 1953, and 1954. Consequently, this is one of the reasons why the HMD series only starts in 1956.

The population registration system in East Germany evolved through the following stages [8]:
1. Until 1965: Decentralised data collection and analysis at the district level.
2. 1965-1975: Decentralised data collection, but centralised data analyses and publication of results. A reorganisation of the official statistics office took place during this period. Much of the work was undertaken centrally (e.g., data acquisition, preparation, and validation). The implementation of electronic data processing led to yet another modification in the organisational structure.
3. 1975-1985: Centralised electronic data acquisition.
   a) Collection of population data via traditional methods
   b) Creation of a database (i.e., central resident register), which includes all registered information for residents, under the responsibility of the Ministry of the Interior (police).
4. 1985–October 2nd, 1990: Population statistics were created using the information from the register described under 3b.
5. From October 2nd, 1990 on: Decentralised data collection and analyses at the district level (*Länder*). Centralised data compilation at the Federal Statistical Office in Wiesbaden for East Germany.

The first census after reunification was carried out in 2011 only and for the first time in Germany, it was a register-based census. There is some debate about whether register-based censuses can deliver results of the same quality as traditional censuses [12]. For an overview of the potential deficiencies of the 2011 census see [13]. The operation was quite challenging as demonstrated by the fact that the Federal Statistical Office decided not to use the officially published census results by age and sex as the basis for their post-censal population estimates. Instead, a modified version of the estimates was published, which used additional statistical information [14]. Like

the Federal Statistical Office, for the HMD calculations we decided to rely on the modified official census data.

The difference between the population estimates previously produced by the Federal Statistical Office in Wiesbaden and the Statistical Offices of the German states and the population estimates based on the new census of 2011, as obtained for the 1st of January 2012, is quite substantial. For Germany as a whole (East plus West), there were actually 977,000 fewer males and 539,000 fewer females compared to the previously published official population estimates.

DATA QUALITY ISSUES

Quality of data on population counts

As mentioned above, the differences between the population estimates constructed from the most recent census of 2011 and those constructed from the former census of 1981 are quite substantial. Unfortunately, the Federal Statistical Office decided not to recalculate back the population estimates by age and sex for the complete inter-censal period. Some of the discrepancies between the two series of estimates arises in part from the massive internal and international migration flows experienced by Germany in the late 1980s and in the 1990s due to the fall of the Iron Curtain and German reunification. In consequence, the standard HMD inter-censal method, which assumes that migration is uniformly distributed across the inter-censal period is not applicable in this case.

Another problem is related to substantial efforts by the statistical office to improve its estimation of the population by cleaning its registers in the years prior to the 2011 census. This was done with the help of local (regional) statistical offices which were instructed to make sure that all out-migrants had been de-registered and that no one was registered in two different areas simultaneously, using alternative sources of information such as tax records. Without these prior cleaning activities, the differences between the population estimates based on the 1981 census and those based on the 2011 census would have been even larger. Unfortunately, these adjustments were only taken into account in the year when the error was detected while the undocumented outmigration event or multiple registrations might have occurred years or decades before. Data cleaning operations were implemented by the State Statistical Offices in various degrees throughout the inter-censal period, but two periods witnessed substantial corrections: 2004 and 2008–2010. To our knowledge, information about the exact number of individuals removed from the registers and the exact dates of the removals from the resident population counts is unknown.

The Syrian refugee crisis and the massive migration flow into Germany during the most recent years have had a notable impact on the size and age-structure of the population. According to the 2014 official estimates, net migration in Germany reached 550,000 and it increased again in 2015, reaching one million (with two million arrivals and one million departures [15]). Most of the migrants were young males with a sex ratio particularly skewed in their favour in 2015.

Intensive in-migration eventually affected the quality of population estimates at younger ages because of problems related to the registration of refugees and asylum seekers. Though migrants are required to be registered, official estimates of the number of refugees are affected by an under-coverage which is difficult to quantify,

though issues of multiple counts have also been raised as migrants could have registered each time they moved to a new area within the country[1].

REVISION HISTORY

Changes with the December 2018 revision:

Since January 2016 the territory of East Germany includes the city of Berlin as a whole, while it only included East Berlin in previous years.

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.

Changes with April 2017 Revision

We carried out some further refinement to the adjustment implemented with the previous revision to construct population estimates for the inter-censal period 1987-2011 [16]. This modification resulted in very minor changes in population size (predominantly at ages above 80 years), and had a negligible impact on mortality rates.

Changes with April 2016 Revision

The inter-censal population estimates for the period 1987–2011 have been revised to account for the results of the last census. We used a special method to redistribute the statistical error (observed in 2011) accumulated over the inter-censal period across years and birth cohorts [16,17]. In brief, adjustments to the population estimate were implemented in two steps. In the first step, we accounted for the corrections made by the statistical offices of Germany to their population estimates prior to the 2011 census. This adjustment accounted for errors that occurred due to multiple registrations and undocumented out-migration. The adjustments assumed that when they were implemented (in 2004 and in 2008–2010), all outmigration rates above an 'expected' level of outmigration could be attributed to the adjustments made by the statistical offices. Using a simple spline interpolation we estimated the 'expected' migration rates by cohort. The difference between 'expected' and 'observed' events in

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[1] The Statistical Office acknowledges the problems related to refugee registration, stating that: "It must be assumed that the 2015 figures on people seeking refuge are affected by undercoverage which cannot be quantified because the registration authorities were unable to register all people seeking refuge in a timely manner. In addition, double counting may have occurred because of false register entries in connection with the distribution of people seeking refuge within Germany" (https://www.destatis.de/EN/FactsFigures/_CrossSection/Refugees/Refugees.html)

the years 2004 and 2008–2010 was assumed to reflect artificial migration counts, which were then added to the accumulated error. In the second step, this error was redistributed by cohort and by sex assuming that it had accumulated in a linear manner over the inter-censal period.

In previous revisions, we applied an adjustment factor to the population older than 90 years because of the low quality of population estimates at advanced ages. With the results of the new census, which are considered to be of good quality, it is no longer necessary to carry out this adjustment. See the Revision history section in the *Background and Documentation* file for Germany as a whole for additional details.

ACKNOWLEDGEMENTS

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APPENDIX 1:
DESCRIPTION OF THE ORIGINAL DATA USED FOR HMD CALCULATIONS

DEATHS

Period	Type of Data	Age Grouping	Comments	RefCode(s)†
1956-1989	Annual death counts among permanent residents, by sex, age, and birth cohort (Lexis triangles)	0, 1, 2, 3, …, 100+		01
1990-2000	Annual death counts among permanent residents, by sex, age, and birth cohort (Lexis triangles)	0, 1, 2, 3, …, maximum age attained		02 03 04 15
2001-2004	Annual death counts among permanent residents, by sex, age and birth cohort (Lexis triangles)	0, 1, 2, 3, …, maximum age attained	Reconstructed data (see Appendix 2)	16 17 24 25
2005-2015	Annual death counts among permanent residents, by sex, age and birth cohort (Lexis triangles)	0, 1, 2, 3, …, 108+	Reconstructed data (see Appendix 2)	28 31 35 38
2016-2017	Annual death counts among permanent residents, by sex, age and birth cohort (Lexis triangles)	0, 1, 2, 3, …, 110+		41
2018-2020	Annual death counts among permanent residents, by sex, age and birth cohort (Lexis triangles)	0, 1, 2, 3, …, 106+		49, 55, 56

POPULATION

Period	Type of Data	Age Grouping	Comments	RefCode(s)†
1955-1963	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, …, 90+		05
1964-1969	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, …, 99+	1964: census counts, last age 100+	06 07
1971	Census counts (as of January 1st), by sex and age	0, 1, 2, 3, …, 100+		06

Period	Type of Data	Age Grouping	Comments	RefCode(s)[†]
1971-1983	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, …, 99+	1981: census counts, last age 100+	06 07 08
1984-1986	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, ..., 100+		09
1987-2011	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, …, 95+	Reconstructed data (see Background and Documentation file for Germany and Appendix 2 for this document)	33
2012-2015	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, …, 100+	Reconstructed data (see Appendix 2)	34 37
2015[2]-2020	Annual population estimates (as of December 31st), by sex and age	0, 1, 2, 3, …, 100+		40, 48, 53, 54

BIRTHS

Period	Type of Data	Comments	RefCode(s)[†]
1946-2000	Annual live birth counts by sex		13 14
2001-2015	Annual live birth counts by sex	Reconstructed data (see Appendix 2)	21 22 23 29 32 36 39
2016-2020	Annual live birth counts by sex		42 46, 50

BIRTHS BY MONTH

Type of data: Annual live birth counts by month

Period covered: 1946–2020

RefCodes: 43, 44, 45, 47, 51, 52

† The reference code is used to link 'Input Data' with the primary data source

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[2] For 2015 we both have reconstructed and observed data

APPENDIX 2

RECONSTRUCTION OF POPULATION, DEATH, AND BIRTH COUNT DATA FOR EAST AND WEST BERLIN FOR THE PERIOD 2001–2015

Between 1949 and 1990, Berlin consisted of two parts: West Berlin with 12 districts and East Berlin with 11 districts. The two parts of Berlin were re-unified together with East and West Germany in 1990. After the "district reform" of January 1st, 2001, Berlin was divided into 12 new districts, and a division into districts that formerly belonged entirely to either West or East Berlin was no longer possible as many of the new districts overlap the border between the former West and East sections of the city. The old and the new administrative divisions of the districts of Berlin are showed in Table 1. Since 2014, official population statistics for Berlin-Brandenburg are no longer tabulated at the district level[3].

To extend the time series for East and West Germany in the Human Mortality Database, the MPIDR has created separated datasets (for the years since 2001) for the two parts of Germany that include very precise estimates for East and West Berlin which have been derived based on official data from the statistical office and the registry office (*Melderegister*) in Berlin.

The individual level data from the *Melderegister* are based on the original addresses of registered inhabitants of Berlin and can be broken down according to the old district structure. Therefore, the population, death, and birth counts can be separated into eastern and western counts by sex, age, and Lexis triangles. Although the total counts by year from the *Melderegister* and the statistical office should be identical, we found some differences between the two sources. Therefore, in order to be consistent with the counts from the statistical office, for each year, sex and age combination, we multiplied the relative distribution (East versus West) based on the *Melderegister* by the counts derived from the official statistics from Berlin.

For cases with an odd number of deaths (births, or population) for a given sex and age, the residual remaining after dividing evenly was alternately assigned to the East and to the West of Berlin. For cases where the regional statistical office reported at least one death while the *Melderegister* showed no death for a given sex and age, we allocated the former data to eastern districts, western districts, and mixed districts. In most cases, it was then possible to identify the region (East or West) to which the death should be allocated.

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[3] https://www.statistik-berlin-brandenburg.de/Publikationen/metadaten/MD_19211_2014.pdf

Table 1. Old and new districts of Berlin

No.	*Berlin* districts (new) since January 1st, 2001 Name	Region	*Berlin* districts (old) until December 31st, 2000 Name
1.	Mitte	East West West	Mitte (01) Tiergarten (02) Wedding (03)
2.	Friedrichshain-Kreuzberg	East West	Friedrichshain (05) Kreuzberg (06)
3.	Pankow	East East East	Prenzlauer Berg (04) Weißensee (18) Pankow (19)
4.	Charlottenburg-Wilmersdorf	West West	Charlottenburg (07) Wilmersdorf (09)
5.	Spandau	West	Spandau (08)
6.	Steglitz-Zehlendorf	West West	Zehlendorf (10) Steglitz (12)
7.	Tempelhof-Schöneberg	West West	Schöneberg (11) Tempelhof (13)
8.	Neukölln	West	Neukölln (14)
9.	Treptow-Köpenick	East East	Treptow (15) Köpenick (16)
10.	Marzahn-Hellersdorf	East East	Marzahn (21) Hellersdorf (23)
11.	Lichtenberg-Hohenschönhausen	East East	Lichtenberg (17) Hohenschönhausen (22)
12.	Reinickendorf	West	Reinickendorf (20)

Source: Regional statistical office, Berlin