

Data sources

This file provides the metadata related to the data sources used for the United States in the Human Multiple Births Database (<https://www.twinbirths.org/en/data-metadata/>).

Summary

Data from 1915 to 2021:

Source: Bureau of the census and National Center for Health Statistics.

Coverage and completeness:

- Until 1969, data include the births which occurred within the continental United States, including those to foreign non-residents. From 1970 onwards, births to non-residents occurring in the United States are excluded.
- Data for the earliest years cover the national birth-registration area, which was established in 1915. In that year, that area consisted of only ten States. Coverage increased to 100% by 1933, as the other States were admitted into the national birth-registration area (Hawaii and Alaska were included when they became States in 1959). To be admitted in the national birth-registration area, a State had to demonstrate a birth registration completeness of at least 90%.
- Registration completeness of live births improved over time, from about 90.5% in 1935 to 99.3% in 1969. By 1960, registration completeness of live births was considered sufficiently high (98.9%), so as to discontinue the publication of birth rates adjusted for under-registration in the national Vital Statistics reports. Registration completeness of fetal deaths also improved over time, but it was affected by under-registration to a much larger extent than live births. Furthermore, comparability and coverage of data on fetal deaths in the United States is affected by variations between States in the definition of fetal death used (especially before 1950) as well as differences in the reporting requirements, which persist in 2020.
- Birth statistics up until 1950 are based on the total file of birth records. Data from 1951 to 1971 are based on a 50% sample. Data from 1972 to 1984 are based the total file of birth records (100%) for certain States, and a 50% sample for all other States. Beginning in 1985, birth statistics for all States and the District of Columbia are based on information from the total file of records.

Treatment of births by vitality:

- The Vital Statistics reports underline the difficulty to produce comparable statistics for the entire territory, as each State used its own definitions of a live-birth and a stillbirth. Nevertheless, in an effort to introduce consistency in terminology, the definitions put forward by the World Health Organization were adopted as the nationally recommended definitions. However, many States continued to use their own definitions for registration purposes. Starting in 1945, in an effort to produce comparable statistics, the Vital Statistics reports provide the number of fetal deaths according to certain characteristics, including only those fetal deaths with a stated or presumed gestational age of 20 weeks or more.
- US data on multiple births concern mainly the live births. Nevertheless, for some years, the distribution of fetal deaths by plurality is also available, but there are some quality issues for those data, as explained in this metadata sheet. For this reason, the series that includes the fetal deaths (i.e., the years with values *Stillbirths* = 1) is only included in the input data file of the United States, but it is excluded from HMBD's pooled data file. Data from 1915 until 1958 have a "mixed" treatment of the fetal deaths in the statistics (i.e., years with values *Stillbirths* = 2 in the input data file), as the number of deliveries by plurality include only those cases where at least one baby was born alive. Data from 1959 onwards concern only the live births (i.e., years with values *Stillbirths*=0 in the input data file). However, in HMBD's pooled data file, the variable *Stillbirths* is set to 2 for this series (i.e., mixed treatment of the stillbirths), as estimates on deliveries by plurality take into consideration the stillbirths, in those cases where there is at least one baby born alive. Nevertheless, when there are too many fetal deaths, this approach may result in an underestimation of the number of twin and other multiple deliveries.

Detailed metadata by source

Source: Bureau of the Census and National Center for Health Statistics (NCHS)

References	<p>Data from 1915 to 2003 come from the following annual Vital Statistics reports, available online at the website of the NCHS: https://www.cdc.gov/nchs/products/vsus.htm (accessed: 06/01/2023)</p> <p>Bureau of the Census. 1934. <i>Birth, Stillbirth, and Infant Mortality Statistics for the Birth Registration Area of the United States 1931</i>. Washington: Government printing office.</p> <p>Bureau of the Census. 1934. <i>Birth, Stillbirth, and Infant Mortality Statistics for the Birth Registration Area of the United States 1932</i>. Washington: Government printing office.</p> <p>Bureau of the Census. 1936. <i>Birth, Stillbirth, and Infant Mortality Statistics for the Continental United States, the territory of Hawaii, the Virgin Islands 1933</i>. Washington: US Government printing office.</p> <p>Bureau of the Census. 1936. <i>Birth, Stillbirth, and Infant Mortality Statistics for the Continental United States, the territory of Hawaii, the Virgin Islands 1934</i>. Washington: US Government printing office.</p> <p>Bureau of the Census. 1937. <i>Birth, Stillbirth, and Infant Mortality Statistics for the Continental United States, the territory of Hawaii, the Virgin Islands 1935</i>. Washington: US Government printing office.</p> <p>Bureau of the Census. 1938. <i>Birth, Stillbirth, and Infant Mortality Statistics for the Continental United States, the territory of Hawaii, the Virgin Islands 1936</i>. Washington: US Government printing office.</p> <p>Bureau of the Census. 1939. <i>Vital Statistics of the United States 1937</i>, Part I. Washington: US Government printing office.</p> <p>Bureau of the Census. 1940. <i>Vital Statistics of the United States 1938</i>, Part I. Washington: US Government printing office.</p> <p>Bureau of the Census. 1941. <i>Vital Statistics of the United States 1939</i>, Part I. Washington: US Government printing office.</p> <p>Bureau of the Census. 1943. <i>Vital Statistics of the United States 1940</i>, Part I. Washington: US Government printing office.</p> <p>Bureau of the Census. 1943. <i>Vital Statistics of the United States 1941</i>, Part I. Washington: US Government printing office.</p> <p>Bureau of the Census. 1944. <i>Vital Statistics of the United States 1942</i>, Part II. Washington: US Government printing office.</p> <p>Bureau of the Census. 1945. <i>Vital Statistics of the United States 1943</i>, Part II. Washington: US Government printing office.</p> <p>Bureau of the Census. 1946. <i>Vital Statistics of the United States 1944</i>, Part II. Washington: US Government printing office.</p> <p>National Office of Vital Statistics. 1947. <i>Vital Statistics of the United States 1945</i>, Parts I and II. Washington: US Government printing office.</p> <p>National Office of Vital Statistics. 1948. <i>Vital Statistics of the United States 1946</i>, Parts I and II. Washington: US Government printing office.</p> <p>National Office of Vital Statistics. 1949. <i>Vital Statistics of the United States 1947</i>, Parts I and II. Washington: US Government printing office.</p> <p>National Office of Vital Statistics. 1950. <i>Vital Statistics of the United States 1948</i>, Parts I and II. Washington: US Government printing office.</p> <p>National Office of Vital Statistics. 1951. <i>Vital Statistics of the United States 1949</i>, Parts I and II. Washington: US Government printing office.</p>
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Period covered	1915-2021
Code in database	VSUS (for the data from 1915 to 2003) ¹ ; NVSR (for the data from 2004 onwards)
Coverage and completeness	<p>Data include only the births which occurred within the continental United States (US), including the births to foreign non-residents until 1969. Births to US citizens occurred abroad are not included.</p> <p>Concerning the births to foreign non-residents, the Vital Statistics report for the year 1993 (p. 4-4) indicates that:</p> <p>“Beginning in 1970 births to nonresidents of the United States occurring in the United States are excluded from these tabulations. From 1966 to 1969 births occurring in the United States to mothers who were nonresidents of the United States were considered as births to residents of the exact place of occurrence; in 1964 and 1965 all such births were allocated to “balance of county” of occurrence even if the birth occurred in a city. The change in coding beginning in 1970 to exclude births to nonresidents of the United States from residence data significantly affects the comparability of data with years before 1970 only for Texas”.</p> <p>Regarding geographic data coverage, the national birth-registration area was established in 1915. In that year, that area consisted of only ten States (Connecticut, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, Rhode Island, and Vermont) and the District of Columbia, covering about 30.9% of the total US population. Coverage increased to 100% by 1933, as the other States were admitted into the national birth-registration area.</p> <p>To be admitted in the national birth-registration area, a State had to demonstrate a birth registration completeness of at least 90%. Hawaii and Alaska, which became States in 1959, are included in the Vital Statistics together with the other States from 1960. Thus, data for all 50 States and the</p>

¹ There is no information on live births by plurality in the Vital Statistics reports for the years 1969 and 1970. However, the distribution of fetal deaths by plurality for those two years is available in the corresponding Vital Statistics reports (Part A – Mortality). See **References**.

	<p>District of Columbia are available only from 1960. According to the Vital Statistics reports for the years 1959 and 1960, the inclusion of Hawaii and Alaska does not affect most national Vital Statistics significantly, because of small population sizes. By 1969, the birth registration system of the United States covered 50 States, the District of Columbia, Puerto Rico, the US Virgin Islands, and Guam. However, data for Puerto Rico, the Virgin Islands and Guam are not included in the Vital Statistics reports for the United States used here (vital statistics for these areas were published separately by their respective Health agencies).</p> <p>Regarding the completeness of birth registration (live births), it was estimated to increase from 90.5% in 1935 to 99.3% in 1969. The first Nation-wide test of birth registration was conducted by the Bureau of the Census in 1940. The results of that test showed that in that year, birth registration completeness varied between States, between 75.9% and 99% or more. Substantial variations were also found by race, as the estimated registration completeness varied from 82% to 94% for births to non-white and white persons, respectively. The Vital Statistics reports provided birth rates adjusted for under-registration until 1959, but this was discontinued in 1960, as in that year the completeness of birth registration was estimated to be 98.9%. Figures adjusted for under-registration provided in the Vital Statistics reports before 1960 concern the totality of live-births, i.e., they do not include details on the distribution of births by plurality. Therefore, the data provided in the input data file for the United States in the HMBD are the unadjusted numbers. Nevertheless, the estimated annual number of live births adjusted for under-registration are also provided, in the 'supplements' sheet of the input data file.</p> <p>As for the registration completeness of fetal deaths, the 1947 Vital Statistics report indicates that, although there was little quantitative information, the extent of under-registration was considered to be quite large and to vary by certain characteristics of the population such as geographic area and race. By 1960, registration of fetal deaths was still incomplete. By 1980, there were still variations between States in the reporting requirements and registration completeness of stillbirths, but registration of fetal deaths of 28 weeks of gestation or more was "believed to be relatively complete", according to the Vital Statistics report for that year (Mortality – Part A). However, variations between States in the reporting requirements of fetal deaths and possibly also in the completeness of the reporting of those deaths persist in 2020 (see Gregory et al. 2021 in References).</p> <p>Annual birth statistics for the earliest years of the series up until 1950 are based on the total file of birth records. Data from 1951 to 1971 are based on a 50% sample (stratified random sampling) of microfilm copies of all certificates of live birth files throughout the United States (20%-50% sample varying by State for the year 1967, due to differences in time of receipt and processing of the birth records). Data from 1972 to 1984 are based on two sources: the total file of records (100%) on computer data tapes for certain States, and a 50% sample for all other States (sample based on the microfilm copies of all live birth certificates). In 1972, the number of States able to provide the total file records on births to the NCHS was only 6 (Florida, Maine, Missouri, New Hampshire, Rhode Island, and Vermont). By 1984, the majority of the States provided total files, and the 50% sample included only four States (Arizona, California,</p>
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	<p>Delaware, and Georgia) and the District of Columbia. Beginning in 1985, birth statistics for all States and the District of Columbia are based on information from the total file of records for these areas (information is received in computer data tapes coded by the States and provided to the NCHS).</p>
<p>Definitions and treatment of births by vitality</p>	<p>In the Vital Statistics reports for the United States, the distribution of deliveries by plurality is available annually from 1915 until 1958. From 1959 onwards, information on the plurality of births available in those reports correspond to babies (not deliveries).</p> <p>US data on multiple births concern mainly the live births. Nevertheless, for some years, the distribution of fetal deaths by plurality is also available, but there are some quality issues for those data, as explained further below.</p> <p>Data on live births available in the Vital Statistics reports come from the Certificate of Live Birth. By law, birth registration falls under the responsibility of the professional attendant at birth (i.e., a physician or a midwife). If no professional attendant is available, the parents of the child are responsible for the report. Certificates must be filled with the local registrar of the district where the birth occurred, following the reporting requirements of the State (these vary from State to State).</p> <p>According to the Vital Statistics report for the year 1965 – the first report that includes a definition for a live birth –, the United States follows the definition set forth by the World Health Organization (WHO), namely:</p> <p style="padding-left: 40px;">“Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such birth is considered live-born” (p. 4-3) .</p> <p>This definition was revised in 1988 by a working group formed by the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists. That revision recommended adding the following precisions to the above definition: “Heartbeats are to be distinguished from transient cardiac contractions; respirations are to be distinguished from fleeting respiratory efforts or gasps”².</p> <p>Annual publication of statistics on fetal deaths started in 1922 for the birth-registration area, which expanded to cover the entire United States in 1933 (see Coverage and Completeness). Until 1939, the nationally recommended procedure for registering a fetal death required to fill both a live-birth and a death certificate. However, as this procedure was not always completed, a separate, single Standard Certificate of Stillbirth (fetal death) was created in 1939. This certificate was later revised. By 1959, separate certificates of fetal deaths were in use in all States, but in some of them fetal death registration</p>

² NCHS. 1997. *State Definitions and Reporting Requirements for Live Births, Fetal Deaths, and Induced Terminations of Pregnancy, 1997 Revision*, Hyattsville, Maryland.

	<p>was recommended but not mandatory. In 1978, the Standard Certificate of Fetal Death was replaced by the Standard Report of Fetal Death. This report has also been revised since its first version.</p> <p>As for the definitions used, the Vital Statistics reports underline the difficulty to produce comparable statistics for the entire territory, as each State used its own definitions of a live-birth and a stillbirth. For example, the criteria to declare a fetal death were clearly indicated in some States while they were not in others, and the minimum gestational age for a dead fetus to be registered as a stillbirth varied between States (in some States, no such age was even defined). Nevertheless, until 1950, the nationally recommended definition of a fetal death for registration purposes was: “A fetus showing no evidence of life after complete birth (no action of heart, breathing, or movement of voluntary muscle), if the 20th week of gestation has been reached”. Another important issue mentioned in the Vital Statistics reports is the underreporting of fetal deaths and the heterogeneity between States regarding the completeness of fetal death registration, which persists in 2020 (see Coverage and Completeness). Because of these issues, interpretation of stillbirth statistics for the US must be conducted with caution.</p> <p>In an effort to introduce consistency in terminology, the national Vital Statistics office adopted the definition of a fetal death proposed by the WHO in 1950, namely: “Fetal death is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation, the fetus does not breath or show any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles”. The use of the term “fetal death” was also highlighted, to avoid confusion from the use of other terms such as miscarriage, stillbirth, spontaneous abortion, and induced termination of pregnancy.³ Despite becoming the nationally recommended standard, it took some time before some States started using it for the production of statistics on fetal deaths. By 1959, only 21 States had adopted the definition of a fetal death proposed by the WHO. Out of those 21 States, a minimum gestation period was specified in only three. According to the Vital Statistics report for the year 1959, it is possible that some live-born infants who died shortly after birth were erroneously reported as fetal deaths, especially those born prematurely. Nevertheless, starting in 1945, in an effort to produce comparable statistics, the Vital Statistics reports provide the number of fetal deaths according to certain characteristics, including only those fetal deaths with a stated or presumed gestational age of 20 weeks or more.</p> <p>Due to changes in the reporting practices of births by plurality, there are three series in HMBD’s input data file for the United States:</p> <ul style="list-style-type: none"> • “Mixed” treatment of fetal deaths in the statistics (i.e., years with values <i>Stillbirths</i> = 2 in the input data file) from 1915 to 1958. In this series, the number of deliveries by plurality (columns <i>Singletons</i>, <i>Twin_deliveries</i>, <i>Triplet_deliveries</i>, <i>Quadruplet_plus_deliveries</i>, <i>Multiple_deliveries</i>, and <i>Total_deliveries</i>) include only those cases
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³ In the HMBD, the terms stillbirth and fetal death are used as synonyms.

	<p>where at least one baby was born alive. For example, a twin pregnancy resulting in one stillbirth and one live-born baby is counted as one case, whereas a twin pregnancy resulting in two stillbirths is not counted. In this series, the values in the column <i>Multiple_children</i> correspond to the number of babies born alive from plural deliveries, as it is calculated as the difference between the total number of children and the number of singletons. The column <i>Total_children</i> (in the input data file) shows the total number of live-born babies of all pluralities reported for a given year.</p> <ul style="list-style-type: none"> • Stillbirths excluded (i.e., years with values <i>Stillbirths</i> = 0 in the input data file). This series starts in 1959 and goes until the most recent year with available data. Here, only the live births are included, as the units are not deliveries but babies according to plurality. For example, the number of twins (in the column <i>Twin_children</i> in the input data file) is the number of babies born alive from a pregnancy involving twins. However, in HMBD's pooled data file, the variable <i>Stillbirths</i> = 2 for this series (i.e., mixed treatment of stillbirths), as estimates on deliveries by plurality take into consideration the stillbirths in those cases where there is at least one baby born alive. This is because the number of deliveries by plurality is calculated by dividing the number of babies by the corresponding plurality (for example, the number of twin deliveries is approximated as the number of twin children divided by two). Nevertheless, when there are too many fetal deaths, this approach may result in an underestimation of the number of twin and other multiple deliveries. • Stillbirths included (i.e., years with values <i>Stillbirths</i> = 1 in the input data file). This series starts in 1931 and goes until 2020. However, due to limited availability, data for the following periods are missing: 1969-1970, 1994-2002, 2007-2012, and 2014-2018. In addition, due to data quality issues up until 1988 (explained below) as well as limited availability of good quality data since 2005, this series is only included in the input data file of the United States, but it is excluded from HMBD's pooled data file. <p>In this series, all births are included, regardless of vitality at birth. Thus, the column <i>Total_children</i> (in the input data file) shows the sum of fetal deaths and live births reported for any given year. Until 1944, the stillbirths included in this series are all reported stillbirths, regardless of gestational age. From 1945 onwards, only the fetal deaths with a gestational age of at least 5 months (20 weeks) are included, as well as all those for which the period of gestation was not stated. From 1969, the latter include only the fetal deaths of unknown gestational age in those States requiring registration at 20 weeks or more, as well as the fetal deaths with a stated birth weight of 500 grams or more in those States requiring registration of "all products of conception" regardless of gestation period. Live-birth and stillbirth registration improved over time (see also Coverage and completeness).</p>
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	<p>For the production of national statistics on fetal deaths by plurality, cases with non-stated plurality are assumed to be single births, for the areas that report plurality of fetal deaths. Until 1988, data on fetal deaths from the State of Louisiana were erroneously converted to a plurality of one (i.e., single birth) and included in the totals for the United States. However, the State of Louisiana does not report plurality of fetal deaths. For this reason, from 1989 until 1993, national statistics on fetal deaths by plurality exclude the State of Louisiana.⁴ In HMBD's input data file for the United States, the live births from Louisiana are also excluded from 1989 until 1993 in the series <i>Stillbirths</i> = 1.</p>
Footnotes⁵	<p>1 - Up until (and including) 1932, data correspond to the national birth registration area only. Coverage of the national birth registration area reached 100% of the continental US in 1933 (Alaska and Hawaii were included later, when they became States). Since 1959, data include all 50 States and the District of Columbia. In addition to the expansion of the national birth registration area, there were improvements in birth registration over time. Under-registration of live births persisted until 1959; after that year, registration of live births can be considered complete (see Coverage and completeness).</p> <p>2 - While registration of live births is complete since 1960, some issues persist with the registration of fetal deaths due to differences between the States regarding reporting requirements (see Coverage and completeness). Moreover, before 1989, there are mistakes in the series that includes the fetal deaths (i.e., the series with <i>Stillbirths</i> = 1 in the input data file), as data from Louisiana were treated erroneously. Due to those issues, Louisiana is excluded from that series between 1989 and 1993 (see Definitions and treatment of births by vitality).</p> <p>3 - From 1947 to 1958, the number of deliveries by plurality (columns <i>Twin_deliveries</i>, <i>Triplet_deliveries</i> and <i>Quadruplet_plus_deliveries</i>) exclude incomplete cases, i.e., cases where not all babies from a plural set were reported (for example, cases where only one baby from a plural birth was reported, but there are no matching transcripts for the other babies from the same pregnancy). The number of such incomplete cases varied from year to year, between 229 and 694 (twins), 6 and 33 (triplets), and 1-2 (quadruplets).</p> <p>4 - Data from 1951 to 1971 come from a 50% sample by State. Data from 1972 to 1984 come from a combination of total birth records for some States and a 50% sample for the rest (see Coverage and completeness).</p> <p>5 - For the years 1951, 1954, 1957 and 1958, the total number of deliveries reported in the original sources is larger than the sum of singleton and multiple deliveries. The original data was retained in the HMBD, as it is not possible to distinguish the source of those discrepancies (i.e., whether they originate from the number of singleton, multiple or total deliveries).</p>

⁴ For the years with available data on the plurality of fetal deaths after 1993 there is no mention of Louisiana being excluded.

⁵ Number indicated in the variable *Footnotes*.

	<p>Nevertheless, the Twinning and Multiple rates are only slightly affected by this issue (from or after the third decimal), regardless of the number used in the denominator, i.e., the reported number of total deliveries or the sum of singleton and multiple deliveries.</p> <p>6 - For the years concerned by this note, (i.e., 1961-1988 in the series with values <i>Stillbirths</i> = 0 in the input data file, and 1959-1993, 2003-2006, 2013, and 2019-2020 in the series with values <i>Stillbirths</i> = 1 in the input data file), the number of triplets, quadruplets, and more children is aggregated in the column <i>Triplet_children</i>, as it is not possible to distinguish between them in the original data sources. See also note 10 in this section.</p> <p>7 - From 1970 onwards, births to nonresidents of the United States are excluded from tabulations on births in the Vital Statistics (see Coverage and completeness).</p> <p>8 - For the years 2003 and 2004, the values in the columns <i>Singletons</i>, <i>Twin_children</i>, and <i>Triplet_children</i> in the series with values <i>Stillbirths</i> = 1 are approximations, as the number of fetal deaths reported in the Vital Statistics for those years was later corrected. The number of fetal deaths originally reported and the corrections (in parentheses) are the following: 2003: 25653 (26004), 2004: 25655 (26001). Only the totals by State are published in the corrections, not their distributions by plurality.⁶ In HMBD's input data file for the United States, the corrected totals by year are used to calculate the number of children (column <i>Total_children</i>) and the number of children by plurality are approximated using the originally reported data as weights.</p> <p>9 - By the time of the last data update (January 2022), data for the year 2021 are provisional, as they come from a special issue focused on twin births from 2019 to 2021 (Horon and Martin 2022; see References). For this reason, data for triplets and other multiple births are missing in the input data file. In the pooled database, the number of triples and more for the year 2021 are calculated as the difference between the total number of live births, the number of singletons, and the number of twins. Then, disaggregated estimates for the number of triplets and the number of quadruplets and more are obtained using the procedure described in note 10 of this section. Based on those estimates, we obtain the number of deliveries by plurality (e.g., the number of triplet deliveries is the estimated number of triplet children divided by 3) as well as the total number of deliveries. The latter number is the denominator for the twinning and the multiple rates.</p> <p>10 - As explained in note 6 of this section, for certain years, the number of triplets, quadruplets and more is aggregated in the original sources and</p>
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⁶ NCHS. "Notice of error in the 2003 and 2004 Fetal Death Data files and reports, and instructions for correcting data file error", URL: <https://www.cdc.gov/nchs/data/dvs/fetaldeath0304problems.pdf> (accessed: 06/01/2023).

	<p>therefore in the input data file too. In an effort to disaggregate those data in the pooled database, we estimated the number of triplets and the number of quadruplets and more for the period 1961-1988 and for the year 2021 using linear interpolation of the proportion of quadruplet births, based on years for which that information is disaggregated and available. First, we estimated the proportion of quadruplet births among the births of triplets and more children for the years 1915-1960 and 1989-2020. Then we used linear interpolation to obtain approximations of the missing proportions for the years 1961-1988 and 2021. To obtain those estimates, we used the 'na_interpolation' function of the R-package 'imputeTS'.⁷ Finally, for any year t from 1961 to 1988 and 2021, we applied the estimated annual proportions of quadruplets and more ($p_quadruplets_{(t)}$) as weights, in order to disaggregate the number of quadruplets and more ($Quadruplets_{+ (t)}$) from the number of triplets and more children ($Triplets_{+ (t)}$), i.e.:</p> $Triplets_{(t)} = (1 - p_quadruplets_{(t)}) * Triplets_{+ (t)}$ $Quadruplets_{+ (t)} = p_quadruplets_{(t)} * Triplets_{+ (t)}.$
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⁷ Moritz et al. R-package 'imputeTS': *Time Series Missing Value Imputation*, version 3.3, 08/30/2022.