Population and Economics

Population and Economics 8(4): 138–149
DOI 10.3897/popecon8.e135073

DATA PAPER

Russian Fertility Database

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Received 4 September 2024 ♦ **Accepted** 4 October 2024 ♦ **Published** 31 December 2024

Citation: Churilova EV, Andreev EM, Chertenkov KO, Kishenin PA, Rodina OA, Sokolova VV (2024) Russian Fertility Database. Population and Economics 8(4):138-149. https://doi.org/10.3897/popecon.8.e135073

Abstract

The Russian Fertility Database contains a series of fertility indicators by birth order for Russia from 1946 to 2022, cohort fertility tables by birth order, and fertility rates by birth order for Russian women born between 1932 and 1988. All fertility indicators are calculated using data from official population statistics provided by the Federal State Statistics Service.

The article describes the structure of the database, the source data, and the methodology of calculating period and cohort fertility rates, as well as cohort fertility tables by birth order.

The Russian Fertility Database can be used for research, analytical materials, reports, presentations, as well as for educational purposes. The data allow us to analyze changes in the age profiles of fertility, the mean age at birth, the dynamics of the total fertility rate as period and cohort indicator for all birth orders combined and by birth order, parity distribution of women with specific number of children ever born and parity progression ratios. The data are in .xlsx format and are available on the web page: https://demogr.hse.ru/RFD.

Keywords

demographic database, cohort fertility, fertility rates, fertility tables

JEL codes: J10, J13

Introduction

Demographic analysis of fertility indicators in modern developed countries is essential for both understanding past and current changes in the intensity and timing of childbearing and for predicting future demographic trends. Currently, certain fertility indicators for Russia are presented in the Unified Interdepartmental Information and Statistical System (EMISS) of Rosstat, in the Russian Fertility and Mortality Database (RusFMD) of the

Center for Demographic Research of the New Economic School, and in the international Human Fertility Database (HFD). However, EMISS contains fertility indicators (absolute numbers of births and total fertility rate) for the period from 1990 to the present and numbers of births by age of mother and birth order for 2018-2021, while RusFMD contains only age-specific fertility rates by 1-year and 5-year groups of age of mother and birth order for the period from 1959 to the present. The HFD database for Russia presents absolute and relative fertility indicators for the calendar period from 1959 to 2018 and aggregate fertility indicators for female cohorts born in 1944-1978, including cohort fertility tables for women born in 1953-1993. To construct the latter, data from the 1979, 1989, 2002, and 2010 Population Censuses were used (Andreev et al. 2020).

Analyzing past and current fertility trends, researchers most often use period fertility rates, thereby not examining the cohort fertility. While one-year age-specific fertility rates exclude the influence of the age structure and best reflect the age pattern of fertility, which makes it possible to trace the rejuvenation of fertility over time or its shift to older ages, the use of the total fertility rate can lead to false conclusions, especially if it is used to assess the effectiveness of demographic policy (Sobotka and Lutz 2011), since this indicator, although not affected by the age structure of the female population, is still sensitive to the influence of the conjuncture, i.e. it is still dependent on changes in the timing of births, decreasing in conditions of mass postponement of births and increasing in periods of shorter intergenetic intervals.

Period fertility indicators are used for rapid assessment of changes, while fertility rates for cohorts depend neither on the age structure nor on the socioeconomic context and show the final fertility of women of different generations. Since reliable and high-quality data on fertility and sex-age structure of the population refer to the period starting from 1959, accurate calculations of the completed fertility rate are possible for generations starting from the generation born in 1944. In the literature there are estimates of fertility rates for both earlier calendar periods and cohorts (Vishnevsky 2006; Zakharov 2008, 2023; Kishenin 2023a, 2023b; Andreev 2024).

The Russian Fertility Database of the International Laboratory for Population and Health of the HSE University was developed during the project "Changes in reproductive behavior and the final number of births in generations of Russian women" and contains birth rates for the calendar period from 1946 to 2022 and for female cohorts born between 1932 and 1988 in a user-friendly .xlsx format. The database is primarily designed to fill a gap in the availability of continuous and comparable series of fertility indicators across generations of Russian women. In addition, the database contains cohort fertility tables by birth order. The database of Russian women's fertility rates is aimed at specialists engaged in professional analysis of demographic indicators, and may also be useful to other specialists interested in fertility trends in Russia, including sociologists, economists, political scientists, etc. The format of the data makes it easy to load them into any statistical analysis system.

Data format and availability

The Russian Fertility Database contains fertility rates by birth order for Russia for 1946 to 2022, as well as fertility rates by birth order for female cohorts born between 1932 and 1988, including fertility tables by birth order. All indicators are presented in separate files in .xlsx format.

All indicators are calculated using data provided by the Federal State Statistics Service (Rosstat).

Data are available free of charge and without registration on the website of the International Laboratory for Population and Health of the HSE University (Russian Fertility Database 2024): https://demogr.hse.ru/RFD.

Database structure and description of variables

The database contains the following indicators in separate files.

Fertility rates for the period from 1946 to 2022:

- age-specific fertility rates by 1-year age groups and age-specific fertility rates by 1-year age groups and birth order (1, 2, …, 5+);
- TFR and TFR by birth order (1, 2, …, 5+);
- mean age at birth and mean age at birth by birth order (1, 2, …, 5+).

Fertility rates for women from the 1932-1988 birth cohorts:

- 1-year age-specific fertility rates by birth order (1, 2, …, 5+);
- cumulative cohort fertility rates by age 15, 16, …, 54, 55+ by births order (1, 2, …, 5+);
- cumulative cohort fertility rates by age 40, 45, and 50 by birth order (1, 2, …, 5+);
- mean age at birth by ages 40, 45, and 50 by birth order (1, 2, …, 5+);
- fertility tables by birth order;
- cohort parity progression ratios by ages 40, 45, and 50;
- parity distribution of women with N child(ren) by ages 40, 45, and 50.

The names of the data files for the respective indicators are given in Annexes 1 and 2.

The fertility indicators presented in the Database refer to Russia in the borders up to March 17, 2014 for the purposes of comparability of cohorts and due to incomplete availability and/or lack of source data for the respective territories.

Methodology

Data

The source data for creating the Russian Fertility Database and calculating period and cohort fertility rates were annual numbers of births by age of mother and birth order in 1946-2022 and population data by sex and age in 1959-2023 provided by the Federal State Statistics Service. For 1946-1958, the data on the sex and age structure of the Russian population presented in Andreev et al. (1998) were used.

The numbers of births by age of mother for the period from 1956 to 1958 and the numbers of births by age of mother and birth order for the period from 1955 to 1977 were developed by five-year age groups and were interpolated by one-year age groups using a quadratic spline function. A similar methodology was previously applied in Shkolnikov et al. (2007) and Andreev (2016). The Federal Law of 15.11.1997 No. 143-FZ "On Acts of Civil Status" excluded the order of birth from birth registration acts, and therefore, in 1999-2010 in many regions data on the order of birth were not available. For regions where birth rates by birth order in 1997-2010 were not known, they were distributed by birth order in proportion to the rates in regions with known distributions.

Calculation of age-specific fertility rates

Age-specific fertility rates are the ratio of the number of births among mothers of age x in year y to the number of person-years of life lived in that year by all women of that age:

$$f(x, y) = \frac{B(x,y)}{E(x,y)},$$

where $B(x, y)$ is the number of births among mothers of age x in year y, $E(x,y)$ is the number of person-years of life lived by all women of age x in year y.

Age-specific fertility rates by birth order are the ratio of the number of births by birth order i among mothers aged x in year y to the number of person-years of life lived in a given year by all women of a given age:

$$f_i(x, y) = \frac{B_i(x, y)}{E(x, y)}.$$

The Russian Fertility Database presents age-specific fertility rates by 1-year age groups and birth order (1, 2, ..., 5+) for the period from 1946 to 2022.

Age-specific fertility rates can be calculated in cohorts c. Calculations require the distribution of births by age and mother's year of birth, whereas Russian statistics only allows us to obtain the distribution of numbers of births by year of birth and mother's age. In this regard, the method for calculating age-specific fertility rates of female cohorts was used to calculate the age-specific fertility rates of cohorts, as described in Appendix 1 of Andreev (2016), according to which the age-specific fertility rates of a cohort can be calculated as the half-sum of the corresponding fertility rates at a given age in two neighboring calendar years:

$$f(x, c) = \frac{f(x,y)+f(x,y+1)}{2}.$$

A similar calculation can be done to obtain cohort age-specific fertility rates by birth order:

$$f_i(x, c) = \frac{f_i(x,y)+f_i(x,y+1)}{2}.$$

This rather simple calculation methodology nevertheless allows us to obtain fairly accurate values of age-specific fertility rates if the number of person-years lived by a generation at a given age in two neighboring calendar years differs insignificantly.

The Russian Fertility Database presents cohort age-specific fertility rates by 1-year age groups and birth order (1, 2, ..., 5+) for women born in 1932-1988.

Calculation of period total fertility rate, cumulative and completed cohort fertility rates

The total fertility rate (TFR) shows the average number of children that will be born to a woman who reaches reproductive age $x_{min} = 15$ years in a year y if the age-specific fertility rates of the given year y are constant throughout her reproductive period. TFR is calculated as the sum of age-specific fertility rates $f(x)$ in year y:

$$TFR(y) = \sum_{x_{\min}}^{x-1} f(x,y).$$

The total fertility rate can be calculated from the order of births:

$$TFR_i(y) = \sum_{x_{\min}}^{x-1} f_i(x,y).$$

The total fertility rate of a given year can be computed by adding the total fertility rates of the *i*-th birth order of a given year:

$$TFR(y) = TFR_1(y) + TFR_2(y) + \ldots + TFR_{i=\max}(y).$$

The cumulative cohort fertility rate (CCFR) shows the average number of children born to a woman in cohort *c* by age *x* and is calculated as the sum of the age-specific fertility rates of cohort *c* starting at $x_{\min} = 15$ years and ending at age $x - 1$.

$$CCFR(x,c) = \sum_{z=x_{\min}}^{x-1} f(z,c).$$

The cumulative cohort fertility rate by age *x* for *i*-th order births:

$$CCFR_i(x,c) = \sum_{z=x_{\min}}^{x-1} f_i(z,c).$$

A special case of the cumulative cohort fertility rate is the *completed cohort fertility (CCF).* It indicates the average number of children born to a woman in the specified cohort *c* over the entire reproductive period ($x_{\min} = 15$ years, $x_{\max} = 49$ years) and is an analog of the total fertility rate for women cohorts:

$$CCF(c) = \sum_{x=x_{\min}}^{x_{\max}} f(x,c),$$

$$CCF_i(c) = \sum_{x=x_{\min}}^{x_{\max}} f_i(x,c).$$

The Russian Fertility Database presents the cumulative cohort fertility rates by birth order by the ages of 40 years for the cohorts born in 1932-1984, 45 years for the cohorts born in 1932-1978, and the real-generation final fertility rate for the cohorts born in 1932-1974.

Calculation of the mean age at birth

The mean age at birth (MAB), as an integral indicator of the age profile of fertility, is the weighted average of the ages of mothers at the time of the corresponding live births by age *x*. This indicator is calculated as the ratio of the sum of age-specific fertility rates *f(x)* weighted by the half-age interval *x* to the sum of age-specific fertility rates:

$$MAB = \frac{\sum f_{(x)} \times (x+0{,}5)}{\sum f_{(x)}}.$$

The mean age at birth by age *x* as an indicator is applicable to both period and cohort fertility, differing only in the fact that for cohorts the age-specific fertility rates *f(x)* for *age x* in year *y*, for age $x + 1$ in year $y + 1$, etc. are consistently used, while for rime period the values of the age-specific fertility rates are conditionally assumed to be constant over the lifetime of all women composing a given generation.

The mean age at birth by age *x* can be calculated both for all children and for children of a particular birth order:

$$MAB_i = \frac{\sum f_{i(x)} \times (x+0{,}5)}{\sum f_{i(x)}}.$$

Considering mean age at birth by birth order is particularly important in the case of analyzing the dynamics of *mean age at first birth (MAB$_i$)*, because the dynamics of mean age at birth for all birth orders combined during the demographic transition in fertility can be misleading because of the rapid decline in fertility combined with the extinction of high-order births.

The mean age at birth by birth order and the mean age at birth are related as (Preston et al. 2001):

$$MAB = \sum MAB_i \times \omega_i,$$

where ω_i is the share of birth order i in the total number of births for the corresponding birth year of the mother for real generations or calendar year for conditional generations.

Calculating the parity progression ratio

The parity progression ratio (PPR) shows the probability that a woman will have one more child ($i + 1$) if she has a child of the i-th order. The probability of having the first child is calculated using the following formula:

$$PPR_{0\to1}(c) = CCF_1(c).$$

The PPR of higher order births is calculated as:

$$PPR_{i-1\to i}(c) = \frac{CCF_i(c)}{CCF_{i-1}(c)}.$$

It should be noted that this probability calculated for the transition from third-order births to fourth-order births ($PPR_{3\to4}$) turns out to be somewhat higher than the real value, since the data on the highest birth order combine not only fourth but also later births into one group, thus limiting the table in terms of the number of orders used for the convenience of users and better harmonization with similar international databases.

Calculation of cohort fertility tables

For each cohort c, all cohort fertility table functions are computed from age-specific fertility rates by birth order $f_i(x,c)$.

The base of the birth rates of Russian women contains the following indicators in columns: x, $b_i(x)$, $l_{i-1}(x)$, $q_i(x)$, $m_i(x)$, $Sb_i(x)$, $chi(x)$.

The size of the fertility table (l_0) is 10000 women, tabulated number of births by birth order for each age x:

$$b_i(x) = 10000 \times f_i(x,c),$$

where $f_i(x,c)$ is the age-specific birth rate of a given birth order i of cohort c.

In this formula, birth is considered as a repeated event. This means that the total number of women in the table, which is 10000, remains constant at any age. However, the order of births increases for women.

At each age x, the cohort of women in the fertility table with size 10000 is divided into sub-cohorts according to birth order, $l_i(x)$. The cohort changes by age and birth order, starting from childless status at the minimum childbearing age x_{min}, as follows:

$$l_0(x_{min}) = 10000 \text{ (size of the table)};$$

$$l_i(x_{\min}) = 0 \text{ for } i = 1, 2, 3, 4;$$

$$l_i(x) = l_i(x-1) - b_{i+1}(x-1) \text{ for } i = 0;$$

$$l_{i+}(x) = l_i(x-1) + b_i(x-1) - b_{i+1}(x-1) \text{ for } i = 1, 2, 3;$$

$$l_{i+}(x) = l_i(x-1) + b_i(x-1) \text{ for } i = 4$$

(*i refers to women with birth order i and above*).

Age-specific fertility rates by birth order from the fertility table for women aged x with birth order i are obtained by relating birth order i at age x to person-years lived at that age with birth order $i - 1$:

$$m_i(x) = \frac{b_i(x)}{l_{i-1}(x) - a(x) \times b_i(x) + (1 - a(x)) \times b_{i-1}(x)} \; for \; i = 2, 3, 4;$$

$$m_i(x) = \frac{b_i(x)}{l_{i-1}(x) + (1 - a(x)) \times b_{i-1}(x)} \; for \; i = 5+,$$

where $a(x)$ is the average time at age $[x; x + 1)$, lived before the birth of the child. It is assumed that $a_i(x) = 0{,}5$ for any age x and birth order i.

The probability of having the i-th child at age x for a woman with birth order $i - 1$ is expressed as follows:

$$q_i(x) = \frac{b_i(x)}{l_{i-1}(x)} \; for \; i = 1, 2, 3, 4+.$$

The cumulative number of births by age x and birth order i is computed through the sum of the tabulated numbers of births of order i at all ages up to $x - 1$:

$$Sb_i(x) = \sum_{z=x_{\min}}^{x-1} b_i(z) \; for \; i = 1,2,3,4+.$$

Average number of children born to a woman with maximum birth order 4+ by the time she reaches age x:

$$chi(x) = \frac{4 \times l_4(x) + \sum_{z=x_{\min}}^{x-1} b_{5+}(z)}{l_4(x)}.$$

Calculation of the parity distribution of women by number of children born

The parity distribution of women by number of children born by age x represents the shares of women in the total female cohort at age x who have given birth to a child of a particular birth order i.

The final distribution of women by age x by number of children born is calculated for childless women as:

$$\omega_0 = \frac{l_0(x)}{l_0(x_{\min})}.$$

The value of the final distribution of women by number of children born for childless women (at $i = 0$) is related to the probability of having a first-order child:

$$\omega_0 = 1 - {}_{i}PPR_{0 \to 1}.$$

In this case, the proportion of women who have given birth to at least one child (when $i = 1$):

$$\omega_1 = PPR_{\underset{i}{0\to1}}.$$

For women who have given birth to at least two children (when $i = 2$):

$$\omega_2 = PPR_{\underset{i}{0\to1}} \times PPR_{\underset{i}{1\to2}}.$$

For women who have given birth to at least three children (when $i = 3$):

$$\omega_3 = PPR_{\underset{i}{0\to1}} \times PPR_{\underset{i}{1\to2}} \times PPR_{\underset{i}{2\to3}}.$$

For women with four or more children (when $i = 4+$):

$$\omega_{4+} = PPR_{\underset{i}{0\to1}} \times PPR_{\underset{i}{1\to2}} \times PPR_{\underset{i}{2\to3}} \times PPR_{\underset{i}{3\to4+}}.$$

In addition to the parity distribution of women by number of children born, it is possible to calculate the share of those who had a child of no higher birth order than $i_{\max,}$ i.e. *the parity distribution of women by the maximum number of children* born by age x or $\omega_{i=\max}$.

Then the shares of childless and those who had maximum 4 or more children will remain the same, and the shares of those who had maximum only one, two or three children ($i = 1, 2, 3$) will be equal:

$$\omega_{i_{\max}} = \omega_i - \omega_{i+1}.$$

Applications of the data

The Russian Fertility Database is aimed at demographers engaged in the analysis of fertility, and can be useful to sociologists, economists, political scientists, geographers, other specialists and experts interested in the analysis of fertility of the Russian population. The Russian Fertility Database can be used in fundamental or applied scientific research, in the preparation of analytical materials, reports, presentations, for educational purposes, and may be in demand by executive and legislative authorities engaged in the development of public policy in the field of demography and its enforcement at both federal and regional levels.

The Russian Fertility Database contains aggregated fertility indicators and birth calendar indicators both without and with regard to birth order for the period from 1946 to 2022, as well as similar fertility indicators and birth calendar indicators, fertility tables and the final distribution by number of births for female cohorts, starting from the cohort born in 1932, which will make it possible to conduct new research on the impact of socio-economic factors, parenting support policies and fertility stimulation of Russian women.

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Acknowlegments

This paper follows from Strategic Project «Social Policy for Sustainable Development and Inclusive Economic Growth», which is part of HSE University development program under the «Priority 2030» academic leadership initiative. The «Priority 2030» initiative is run by Russia's Ministry of Science and Higher Education as part of National Project «Science and Universities».

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Appendix 1

Table A1. Fertility indicators for calendar years and their corresponding files in the database

Indicator	Calendar years	Filename
Age-specific fertility rates by one-year age groups and birth order (1,2,...,5+)	1946-2022	Rus_ASFR1946-2022.xlsx
Total fertility rate by birth order (1,2,...,5+)	1946-2022	Rus_TFR1946-2022.xlsx
Mean age at birth by birth order (1,2,...,5+)	1946-2022	Rus_MAB1946-2022.xlsx

Appendix 2

Table A2. Cohort fertility indicators and their corresponding files in the database

Indicator	Cohorts	Filename
Age-specific fertility rates by one-year age groups and birth order (1, 2, ..., ..., 5+)	1932-1988	Rus_CASFR 1932-1988.xlsx
Cumulative fertility rates by birth order (1, 2, ..., ..., 5+)	1932-1988	Rus_CFR 1932-1984.xlsx
Completed cohort fertility by age 40, 45, and 50 by birth order (1, 2, ..., ..., 5+)	1932-1984	Rus_CCF 1932-1984.xlsx
Mean age at birth by age 40, 45, and 50 years by birth order (1, 2, ..., 5+)	1932-1984	Rus_CMAB 1932-1984.xlsx
Cohort parity progression ratios by age 40, 45, and 50 years	1932-1984	Rus_PPR 1932-1984.xlsx
Cohort fertility tables by birth order	1932-1988	Rus_CFT 1932-1988.xlsx
Parity distribution by age 40, 45 and 50 years	1932-1984	Rus_cohort proportion of women with N children.xlsx

Appendix 3

Table A3. Description of data files

Indicator	Description
Age-specific fertility rates by one-year age groups and birth order (1,2,...,5+)	Calendar year. All births, data by age: 15, 16, ..., 54, 55 and older. First births, age data: 15, 16, ..., 54, 55 and older, etc. Fifth and next births, data by age: 15, 16, ..., 54, 55 and older.
Total fertility rate by birth order (1,2,...,5+)	Calendar year. All births. First births. Second births. Third births. Fourth births. Fifth and next births.
Mean age at birth by birth order (1,2,...,5+)	Calendar year. All births. First births. Second births. Third births. Fourth births. Fifth and next births.
Age-specific fertility rates by one-year age groups and birth order (1, 2, ..., ..., 5+)	Cohort. All births, data by age: 15, 16, ..., 54, 55 and over. First births, data by age: 15, 16, ..., 54, 55 and older, etc. Fifth and next births, data by age: 15, 16, ..., 54, 55 and over.
Cumulative fertility rates by birth order (1, 2, ..., ..., 5+)	Cohort. Age. All births by age 15, 16, ..., 54, 55 and older. First births by age 15, 16, ..., 54, 55 and older. Fifth and next births by age 15, 16, ..., ..., 54, 55 and over.
Completed cohort fertility by age 40, 45, and 50 by birth order (1, 2, ..., ..., 5+)	Cohort. All births, completed (cumulative) fertility by age 40, 45, 50. First births, completed (cumulative) fertility by age 40, 45, 50, etc. Fifth births, completed (cumulative) fertility by age 40, 45, 50.
Mean age at birth by age 40, 45, and 50 years by birth order (1, 2, ..., 5+)	Cohort. All births, mean age at birth by age 40, 45, 50. First births, mean age at birth of child by age 40, 45, 50. etc. Fifth and next births, mean age at birth by age 40, 45, 50.
Cohort parity progression ratios by age 40, 45, and 50 years	Cohort. Probability of having a first child. Probability of having a second child. Probability of having a third child. Probability of having a fourth and next children.