

Technical Appendix to the Cohort Fertility Tables for All, White, and Black Women: United States, 1960–2005

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Contents

Introduction	3
Births and Method of Estimating Number of Births.....	4
Source	4
Method of estimating number of births.....	4
Populations and Method of Estimating Number of Women.....	7
Sources.....	8
Method of adjustment	9
Cohort Fertility Measures and Method of Computation.....	10
Central birth rates	10
Cumulative birth rates	11
Parity distribution	12
Birth probabilities	14
Standards of reliability and precision	16
References.....	17
List of Cohort Fertility Measure Tables.....	19

Introduction

Fertility data are presented in tables for age groups or cohorts of women as they pass through their childbearing years, ages 14 through 49 years. The tables contain data for calendar years 1960–2005. These data have been prepared as a revision and extension of the cohort fertility measures published in *Fertility Tables for Birth Cohorts by Color: United States, 1917–1973* and *Vital Statistics of the United States* (VSUS) from 1974 through 1999 (1–3). Measures in the tables have been revised to include race of mother (white and black); previously, measures were by race of child. The measures also have been extended to include data for 2000–2005.

Birth and fertility measures routinely published by the National Center for Health Statistics (NCHS), such as the general fertility rate, age-specific birth rates, and total fertility rate, focus on the number of births to women of a given age in a given year (4). These measures evaluate the current condition of fertility in the United States and are generally referred to as period rates. Cohort analysis is the study of the fertility of the same women at successive ages, the cumulative effect of this fertility at successive ages, and the completed family size of the women in a cohort (4). A cohort initially consists of female babies born during a 12-month period centered on January 1; subsequently, it consists of the survivors of these babies. A cohort is identified by the year of the date on which the birth was centered. For example, women born from July 1, 1939, through June 30, 1940, centering on January 1, 1940, constitute the cohort of 1940. Because these women retain this designation throughout their childbearing years, the relationship is fixed among the cohort identification year, the age of the member of the cohort, and the calendar or data year to which the fertility measure refers—by knowing any two of these factors, the third can be derived. The relationship is identification or cohort year plus age equals calendar or data year of the fertility measure, or:

$$\text{Calendar year} = \text{Cohort year} + \text{age}$$

Central birth rates have been computed using the number of births and the number of women (see section on “Cohort Fertility Measures and Method of Computation—Central Birth Rates”):

$$\frac{\text{Number of births}}{\text{Number of women}} \times 1,000.0$$

The number of births have been adjusted for underregistration for 1960–1979, and the number of women have been adjusted for misstatement of age for all years (1960–2005); see sections on “Births and Method of Estimating Number of Births—Adjustment for underregistration of births” and “Populations and Method of Estimating Number of Women—Method of adjustment.” These rates differ from the cohort fertility rates shown in *Fertility Tables for Birth Cohorts by Color: United States, 1917–1973* and VSUS, which were adjusted for underregistration of births, underenumeration of the number of women (based on different population estimates), and misstatement of age for all years through the end of the series (1999) (1–3). The rates in this release also differ from the age-specific birth (period) rates shown in VSUS, which have not been adjusted for underregistration of births for any years after 1959 or for misstatement of age for any years (3). In addition, the cohort fertility rates by race in both of the earlier reports cited are based on race of child; the rates by race in this release are based on race of mother.

Measures presented in the tables are intended to represent a general model of fertility trends over time, and the numbers should not be taken as precise values. Small differences and fluctuations may not represent real changes because of the estimations required to obtain the births and female populations for all years (such as the adjustment for underregistration and the imputation of missing birth-order data for Massachusetts and missing race data for New Jersey; see following discussion). Comparisons of these measures with earlier cohort measures for all women in *Fertility Tables for Birth Cohorts by Color: United States, 1917–1973* and VSUS 1974–1999 have been made, and they appear consistent across age and birth order over time. **However, data users analyzing cohort fertility patterns since 1960**

should use the measures released in these tables exclusively, and not combine these measures with those in *Fertility Tables for Birth Cohorts by Color: United States, 1917–1973* and *VSUS 1974–1999*.

The cohort fertility tables will be updated annually beginning with the 2006 data year. In addition, cohort fertility measures for other race and Hispanic origin groups (such as American Indian or Alaska Native (AIAN), Asian or Pacific Islander (API), non-Hispanic white, and non-Hispanic black) will be included.

Births and Method of Estimating Number of Births

Source

Since 1985, the number of births for all states and the District of Columbia has been based on information received in electronic files of individual records processed by the states and provided to NCHS through the Vital Statistics Cooperative Program. NCHS receives these files from the registration offices of all states, the District of Columbia, and New York City.

Births for 1960–1966 and 1968–1971 are based on 50 percent samples of records filed. During the processing of 1967 data, the sampling rate was reduced from 50 percent to 20 percent; for details of this procedure and its consequences for 1967 data, see VSUS 1967 (5). From 1972 through 1984, births are based on all records filed in states submitting computer tapes and on a 50 percent sample of records in all other states (6,7).

U.S. natality data are limited to births occurring within the United States, including those occurring to U.S. residents and nonresidents. Births to nonresidents of the United States have been excluded from all tabulations by place of residence beginning in 1970. Births occurring to U.S. citizens outside the United States are not included in any tables.

Method of estimating number of births

To compute central birth rates, which are the basic rates from which cumulative birth rates, parity distributions, and birth probabilities are derived, the number of births in each year from 1960 through 2005 was corrected for underregistration and classified by age of mother (single years of age from 14 through 49), live-birth order (each order through the seventh, and eighth and higher orders combined), and race of mother (white and black). The number of registered births tabulated by age, birth order, and race were adjusted to:

- Distribute births to women under age 14 and over age 49.
- Distribute births of unknown live-birth order and adjust according to age of mother.
- Impute race data for New Jersey for 1962 and 1963.
- Account for underregistration of births.

These adjustments were made separately for births to all, white, and black women. The methods for making these adjustments are described in following sections.

Age of mother

Beginning in 1964, birth records with date of birth of mother or age of mother *not stated* have had age imputed according to the age of mother from the previous birth record of the same race and total birth order (total of fetal deaths and live births). In 1963, birth records with age not stated were allocated

according to the age appearing on the record previously processed for a mother of identical race and parity (number of live births). For 1960–1962, not-stated ages were distributed in proportion to the known ages for each racial group.

Beginning in 1989, a “date of birth” item on the birth certificate replaced the “age (at time of this birth)” item. Not all states revised this item; therefore, the age of mother is either derived from the reported month and year of birth or coded as stated on the certificate. From 1960 through 1963, births were reported to occur to mothers aged over 49 (“50 years and over”). From 1964 through 1996, births reported to occur to mothers under age 10 or over age 49 had age imputed according to the age of mother from the previous record with the same race and total birth order (total of live births and fetal deaths). Beginning in 1997, age of mother is imputed for ages 9 and under and 55 and over.

Births to women under age 14 are included with births to women aged 14—the lower end of the age range—for computing central birth rates for women aged 14. Eighty-one percent of births to women under age 15 in 2005 were to women aged 14 compared with 77 percent in 1960. Births to women aged over 49 are included with births to women aged 49—the upper end of the age range—for computing central birth rates for women aged 49 from 1997 through 1999; starting in 2000, births to women aged over 49 are “rolled back,” with births to women aged 50 assigned to women aged 45, births to women aged 51 assigned to women aged 46, births to women aged 52 assigned to women aged 47, births to women aged 53 assigned to women aged 48, and births to women aged 54 assigned to women aged 49.

Live-birth order and parity

Live-birth order indicates the number represented by the present birth; for example, a baby born to a mother who has had two previous live births (even if one or both are not now living) has a live-birth order of three. Parity indicates how many live births a mother has had. Before delivery, a mother having her first baby has a parity of zero, and a mother having her third baby has a parity of two. After delivery, the mother of a baby who is a first live birth has a parity of one, and the mother of a baby who is a third live birth has a parity of three.

Live-birth order and parity are determined from two items on the birth certificate, “live births now living” and “live births now dead” (fetal deaths are excluded). Before 1969, if both of these items were blank, the birth was considered a first birth. Beginning in 1969, births for which the items on pregnancy history were not completed have been tabulated as live-birth order not stated. As a result of this revised procedure, 22,686 births in 1969 that would have been assigned to the “first birth order” category under the old rules were assigned to the “not stated” category.

In computing central birth rates by live-birth order, births tabulated as birth order not stated are distributed in the same proportion as births of known live-birth orders of the corresponding age group.

A small percentage of birth records in all states omit information on birth order. Before 1963, however, birth order was not coded or tabulated for births occurring in Massachusetts (8). Partial reporting of the item “total number of children born alive previous to this birth” on the Massachusetts live birth certificate began in 1961. The reporting was about 76 percent complete by 1963 and judged to be sufficient for coding and tabulation. To obtain birth-order and parity-specific rates for the entire United States, estimates were included for Massachusetts. Births for 1960 through 1963, tabulated as birth order not stated (which includes those births in Massachusetts), were accordingly distributed in the same proportion as births of known live-birth orders of the corresponding age group for the United States as a whole. (The exact procedure for estimating the number of births was not documented when the birth files were originally prepared and was inferred by an examination of the birth data for Massachusetts.) The estimates were made so that the time series of the cohort fertility measures would be continuous for all years from 1960 through 2005.

Finally, births for higher birth orders are adjusted according to age of mother for women under age 20. For women aged 14, second- through fourth-order births are assigned to women aged 15. Fifth- and higher-order births for women aged 14 are allocated to women aged 20. Fifth- and higher-order births for

women aged 15–19 are allocated to women aged 20. This follows the procedure used in the Heuser and VSUS tables (1–3).

Race

Cohort fertility measures published in *Fertility Tables for Birth Cohorts by Color: United States, 1917–1973* and VSUS from 1974 through 1999 were by race of child, whereas measures in the new tables referenced here have been revised and are based on race of mother (white and black) (1–3). In these tables, all women (including Hispanic women) are classified only according to their race. The general tabulation of birth data by race of mother began with the 1989 data year. In 1988 and prior years, the race shown in tabulations was that of the child. [For details on this change, see *Technical Appendix From Vital Statistics of the United States, 1999* (9).] After the change in tabulation to race of mother in 1989, trends in births and birth and fertility (period) rates by race (but not the cohort rates) were retabulated by race of mother for 1980–1988 to facilitate time series analysis.

Not-stated race of mother—Prior to 1964, all births for which race was not stated were classified as white. From 1964 through 1968, the race of the mother was assigned to white if the race on the preceding record was white; otherwise, the assignment was to black. Beginning in 1969, the race of mother has been allocated according to the specific race of the mother on the preceding record. Consequently, some of the not-stated frequencies that had previously been assigned to the black category may now be assigned to one of the other race categories (for example, Guamanian, American Indian, Chinese, Japanese, Hawaiian, or Filipino). Beginning in 1989, the procedures for allocating race when race is not stated were slightly modified. If the race of the mother is not defined or not consistent with the categories used in the classification and the race of the father is known, the race of the father is assigned to the mother. Where information on race for both parents is missing, the race of the mother is allocated according to the specific race of the mother on the preceding record with a known race of mother.

Race data for New Jersey in 1962 and 1963—Birth certificates used in New Jersey in 1962 and 1963 did not include an item on race (10). Nearly all statistics by race for the United States as a whole in 1962 and 1963 were affected by the lack of information for New Jersey. Period birth and fertility rates by race for those years are computed on a population base that excluded New Jersey. For the cohort fertility measures, however, to obtain rates by race for the entire United States, the numbers of births to white and black mothers occurring in New Jersey were estimated. Births for 1962 and 1963 were distributed (i.e., imputed) in the same proportion by race of mother as births in the combined years 1961 and 1964, according to the age and live-birth order of mother. (The specific procedure for estimating the number of births was not documented when the birth files were originally prepared and was inferred by an examination of the birth data for New Jersey.) The estimates allow the time series of the cohort fertility measures to be continuous for all years from 1960 through 2005.

Office of Management and Budget standards for classifying data on race—In 1997, the Office of Management and Budget (OMB) issued “Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity,” which revised the “1977 Statistical Policy Directive 15, Race and Ethnic Standards for Federal Statistics and Administrative Reporting” (11,12). These documents stipulate the requirements for the collection, tabulation, and presentation of race and ethnicity data within the federal statistical system. The 1997 revised standards incorporate two major changes designed to reflect the changing racial profile of the United States. First, the revision increased from four (AIAN, API, black, and white) to five (AIAN, Asian, black or African American, Native Hawaiian or Other Pacific Islander (NHOPI), and white) the minimum set of categories to be used by federal agencies for identification of race. Asians are now reported separately from NHOPI. The revised standards also require federal data collection programs to allow respondents to select *one or more race categories*.

The U.S. Census Bureau collected race data in the 2000 decennial census in accordance with the 1997 revised standards. However, the National Vital Statistics System, which is based on data collected by the states, is not fully compliant with the new standards because all of the states have not revised their birth certificates to reflect the new standards (13). Thus, beginning with the 2000 data year, the numerators (births) for birth rates are incompatible with the denominators (populations) (14). From 2003 through

2005, the multiple-race reporting states varied, with 6 states reporting more than one race in 2003, 15 in 2004, and 19 in 2005; these multiple-race reporting states include several states that have not revised their birth certificates but have implemented the collection of multiple-race data (14–16). To provide uniformity and comparability, compute rates, and maintain trend data, it is necessary to “bridge” birth data, as well as population data, for multiple-race persons to single-race categories. Multiple race is imputed to a single race (AIAN, API, black, or white) according to the combination of races, Hispanic origin, sex, and age indicated on the birth certificate of the mother or father; the imputation procedure is detailed elsewhere (17–20). This process has been followed for birth rates by race presented in this report.

Adjustment for underregistration of births

Three nationwide tests of birth registration completeness (BRTs) have been conducted, in 1940, 1950, and 1964–1968. The last two tests are the basis for estimating the completeness of registration in later years.

The 1950 BRT provided detailed results by place of delivery (in or out of hospital) for each state and by age of mother and live-birth order for the United States overall. The 1964–1968 BRT, however, based on a sample, provided only limited estimates of registration completeness, including births occurring in and out of hospitals for the United States by race but not by state or by age of mother and live-birth order. Results from the 1950 BRT may be found in *Vital Statistics of the United States, 1950, Volume I, Chapter 6* (21). The 1964–1968 BRT is described and the results shown in “Test of Birth Registration Completeness 1964 to 1968,” *Census of Population and Housing, 1970, Evaluation and Research Program, PHC(E)–2* (22). Descriptions of the method of estimating registration completeness and the number of births adjusted for underregistration follow.

Births were first adjusted for underregistration based on the 1950 BRT by age of mother, race, and live-birth order; see Table 6.53 of *Vital Statistics of the United States, 1950, Volume I, Chapter 6* (21). After distributing births to women under age 14 and over age 49 and to unknown live-birth order, control totals for 1960 through 1979 were obtained using national estimates of registration completeness for births in and out of hospital from the 1950 and 1964–1968 BRTs. Percentages of registration completeness for 1960–1966 were obtained by linear interpolation (based on Aitken’s iterative procedure, 2 point) between the test results (4). The 1964–1968 test results were assumed to apply for 1966, the midpoint of the test period, and for later years up to 1979, when the adjustment for underregistration of births was discontinued due to the complete registration of births. The number of births occurring in and out of hospital from 1960 through 1979 was adjusted separately based on the (interpolated) estimates of registration completeness, and the adjusted numbers were summed to obtain the control total. The numbers of births by age of mother and live-birth order for each race group were then adjusted by dividing the number of births by age of mother and live-birth order for each race group by the ratio of the total number of births to the control total; their sum equals the control total. Births for 1980 through 2005 are not adjusted for underregistration because registration completeness was effectively universal during that period.

Populations and Method of Estimating Number of Women

The population of females by single years of age, 14 through 49, and by race (all races, white and black) for 1960 through 2006 are based on census counts and estimates of the U.S. residential population, excluding Armed Forces abroad, provided by the U.S. Census Bureau. The counts and estimates are consistent within cohorts and from year to year. (These populations represent the denominator base of the published period rates for 1960–2005.) The sources of the population estimates are summarized and the method of adjustment to obtain appropriate denominators for central birth rates is described in following sections.

Populations for the census years 1960, 1970, 1980, 1990, and 2000 are based on (enumerated) census counts of the resident population as of April 1 of each year. Populations for the years between census years (intercensal periods of 1961–1969, 1971–1979, 1981–1989, and 1991–1999) or after the last census year (postcensal period of 2001–2005) are based on national estimates of the resident population as of July 1 of each year. (Population estimates for the intercensal periods have been adjusted for the respective censuses.)

Sources

1960–1979

Populations for 1960 through 1979 were obtained from the Census Bureau publications, “Population Estimates and Projections: Estimates of the Population of the United States, by Age, Sex, and Race: April 1, 1960 to July 1, 1973” and “Population Estimates and Projections: Preliminary Estimates of the Population of the United States, by Age, Sex, and Race: 1979 to 1981” (23,24). These populations, both the census counts as of April 1 and estimates of the resident population as of July 1, are rounded to thousands.

Populations of females by single years of age 45–49 for 1960 through 1970, excluding Armed Forces abroad, were not available from the Census Bureau publications (23,24). These populations were estimated based on the populations of females aged 45–49 (excluding Armed Forces abroad) for 1960 through 1970, distributed by single year of age according to the populations of females by single years of age 45–49 for 1960 through 1970 including Armed Forces abroad (23–25).

1980–1989

Populations for 1980 through 1989 were obtained from the *quarterly intercensal resident population* data set files available from the U.S. Census Bureau population estimates archives (26). These populations, both the census counts as of April 1 and estimates of the resident population as of July 1, are not rounded.

1990–2005

Populations for 1990 through 2005 were produced by the U.S. Census Bureau for NCHS, with support from the National Cancer Institute, and are available from NCHS (27–33). These population “counts” and estimates, which are all based on the 2000 census, have been modified to be consistent with the racial categories stipulated in the 1977 OMB guidelines and historical categories for birth data (see preceding section on “Method of Estimating Number of Births— Race”).

Reflecting the OMB guidelines issued in 1997, the 2000 census included, among several changes, the option for persons to report more than one race as appropriate for themselves and household members (11). However, birth certificates for many states from 2003 through 2005 continued to report only one race for each parent in the categories specified in the 1977 OMB guidelines (12,14–16).

To produce comparable birth certificate data (the numerators for central birth rates) and population data (the denominators for the rates) for 1990 through 2005, the population data for multiple-race persons were bridged to single-race categories. The procedures used to produce the bridged populations are described in separate publications (17,18).

NOTE: The population data used to compile the cohort measures by race shown in the tables are based on special estimation procedures and are not actual counts.

Method of adjustment

Enumerations and estimates of the population of women in single-year age groups (cohorts) were adjusted to represent more adequately the denominators of the central birth rates of cohorts in calendar years (1).

Essentially, the denominator of a central birth rate for age group i in calendar year y is the average population of women who are between exact ages i and $i+1$ (that is, current age i or i last birthday) during year y . To obtain such a denominator, an estimate is made for the population age i on every day of the year and is averaged for the result. The figure shows how to approximate the value (1): The date of birth of three cohorts (1938, 1939, and 1940) is plotted against the date at which age 24 or 25 is attained during 1963. The horizontal distance between the diagonal lines for the 24th and 25th birthdays and the beginning or end of 1963 (shaded portion of figure) is the length of time in 1963 that women born on a particular date (vertical axis) are current age 24. For example, women born on August 24, 1939, were aged 24 for 36 percent of 1963 (red line in figure). Assuming that the survivors of the 1939 cohort (born July 1, 1938–June 30, 1939) were distributed evenly with respect to the date that age 24 was attained, they spent an average 75 percent of 1963 at age 24. In addition, half of the women in the cohorts of 1938 (born July 1, 1937–June 30, 1938) and 1940 (born July 1, 1939–June 30, 1940) were aged 24 during one or more days in 1963 (again assuming an even distribution of birthdays). They spent an average 25 percent of 1963 at current age 24. Because only half of the women in the cohorts of 1938 and 1940 were aged 24 in 1963, the weight applied to them is one-half of 25 percent, or 12.5 percent. Therefore, the denominator for a central birth rate at age i in year y is $0.125 P_{y,i-1} + 0.75 P_{y,i} + 0.125 P_{y,i+1}$, where P represents the female population of the designated single-year age group or cohort on July 1 of year y .

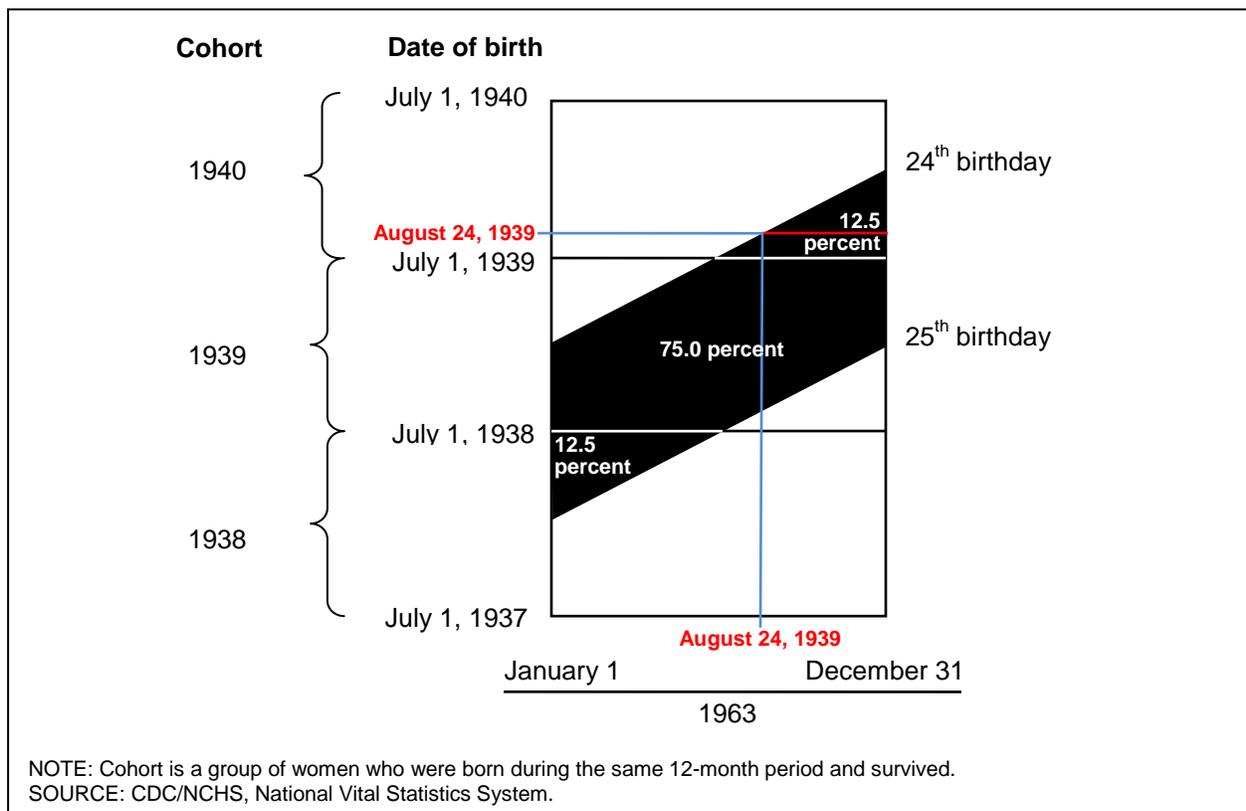


Figure. Date in 1963 on which age 24 or 25 is attained by women in the cohorts of 1938, 1939, and 1940

NOTE: The denominator for central birth rates for ages 14 and 49 in year y —the lower and upper ends of the age range—are adjusted accordingly: $0.875P_{y,14}+0.125 P_{y,15}$ and $0.125 P_{y,48}+0.875P_{y,49}$, where P represents the female population of the designated single-year age group or cohort on July 1 of year y .

Cohort Fertility Measures and Method of Computation

Cohort fertility measures presented in the tables detail births to groups of women, essentially those women born during a 12-month period, as they pass through their childbearing years and experience the same historical conditions at the same time in their reproductive lives. Period fertility measures, such as the general fertility rate and total fertility rate, detail the number of births for women of a given age i in a given year y —the “current” condition (see “Introduction”). Cohort fertility measures indicate the fertility of a cohort of women at particular and successive ages (central birth rates and cumulative birth rates); the cumulative effect of this fertility at successive ages, including the proportion of childless women and the proportion of women bearing at least n children (birth distributions and birth probabilities); and the completed family size of these women (cumulative birth rates).

Central birth rates

Central birth rates represent the number of births occurring to women at age i (see preceding section on “Births and Method of Estimating Number of Births—Method of Estimating Number of Births”) divided by the number of women of age i (see preceding section on “Populations and Method of Estimating Number of Women”) (1). The rates were computed for the major racial groups (all races, white, and black) by single year of age 14–49 by live-birth order, first through eighth and higher order combined, for each calendar year 1960 through 2005 (see Tables 1, 5, and 9–11).

The central birth rates therefore express the number of births of a particular order per 1,000 women of a given age in a given year (similar to the period fertility measures, which are age-specific birth rates). The central birth rates at live-birth order first through eighth and higher are computed according to:

$$C_{en}BR_{iy}^n = \frac{B_{iy}^n}{P_{i,y}} \times 1,000.0$$

where

$C_{en}BR_{iy}^n$ = central birth rate of women for live-birth order n (first through eighth and higher) and single-year current age group i (aged 14–49) in year y per 1,000 women.

B_{iy}^n = number of births of a given live-birth order n (first through eighth and higher) to women of a given single year of age i (aged 14–49) in year y .

$P_{i,y}$ = population of women of a given single year of age i (aged 14–49) in year y without regard to the number of children they have.

Additionally, the central birth rates are adjusted for data heaping by age by averaging the rates of the previous age group, current age group, and following age group for a birth order.

The sum of the central birth rates for all live-birth orders n (first through eighth and higher) for a given age group i equals the total central birth rates for the group:

$$C_{en}BR_{iy}^{Total} = \sum_{n=1st}^{8th \text{ and higher}} C_{en}BR_{iy}^n$$

where

$C_{en}BR_{iy}^{Total}$ = total central birth rate of women for single-year current age group i (aged 14–49) in year y per 1,000 women.

$C_{en}BR_{iy}^n$ = central birth rate of women for live-birth order n (first through eighth and higher) and single-year current age group i (aged 14–49) in year y per 1,000 women.

Example

Suppose the central birth rates of women aged 20 for first- through eighth- and higher-order births in 1988 are 57.2, 28.9, 8.9, 2.2, 0.5, 0.1, 0.0, and 0.0, then the total central birth rate for these women is:

$$C_{en}BR_{20,1988}^{Total} = 57.2 + 28.9 + 8.9 + 2.2 + 0.5 + 0.1 + 0.0 + 0.0 = 97.8$$

Central birth rates for the selected groups of cohorts (i.e., 5-year age groups, see Table 5) are simple averages of the central birth rates for single cohorts. For example, the single-year cohort central birth rates in 1988 for ages 15–19 were 18.0 (aged 15), 33.0 (aged 16), 51.5 (aged 17), 70.2 (aged 18), and 86.0 (aged 19). Thus, the central birth rate for the 5-year age group of 15–19 in 1988 is 51.7.

Cumulative birth rates

Cumulative birth rates represent the total childbearing experience of women in a cohort up to that (exact) age. These rates *measure* the total number of births of a given order per 1,000 women of a given age in a given year; that is, the continuing accumulation of the central birth rates over successive data years (taking into account the fact that for each successive data year, age of mother increases by one year) (1). To put it another way, for a cohort, cumulative birth rates for a specified age are the sums of the central birth rates for ages 14 forward. The sum of the central birth rates of a cohort during current ages i and under is referred to as the cumulative birth rates by exact ages $i+1$ and is said to relate to January 1 of a given year.

The cumulative birth rate is equivalent to the period fertility measure, or total fertility rate, which *estimates* the number of births that a group of 1,000 women, a “hypothetical cohort,” would have if they experienced throughout their childbearing years the *same age-specific birth rates* observed in a given year. Like the central birth rates, the cumulative birth rates were computed for the major racial groups (all races, white, and black) by age (single year of age 15–50, and 5-year age groups 15–19 through 45–49) by live-birth order (first through eighth and higher order combined), for each calendar year 1960 through 2005, according to:

$$C_{um}BR_{i+1,y+1}^n = C_{en}BR_{iy}^n + C_{um}BR_{iy}^n$$

where

$C_{um}BR_{i+1,y+1}^n$ = cumulative birth rate of women for live-birth order n (first through eighth and higher) and single-year exact age group $i+1$ in year $y+1$ per 1,000 women.

$C_{en}BR_{iy}^n$ = central birth rate of women for live-birth order n (first through eighth and higher) and single-year current age group i in year y per 1,000 women.

$C_{um}BR_{i,y}^n$ = cumulative birth rate of women for live-birth order n (first through eighth and higher) and single-year exact age group i in year y per 1,000 women.

The cumulative birth rate at age 50, assumed to be the end of childbearing, is considered to be the completed fertility rate of a cohort (i.e., the total number of births) and indicates the extent to which a population can reproduce or “replace” itself.

Example

Suppose the central birth rate of women aged 20 for first-order births in 1988 is 57.2 and the cumulative birth rate for these women is 196.8, then the cumulative birth rate for these women at age 21 in 1989 is:

$$C_{um}BR_{21,1989}^1 = 57.2 + 196.8 = 254.0.$$

As with the central birth rates, the sum of the cumulative birth rates for all live-birth orders n (first through eighth and higher) for a given age group i equals the total cumulative birth rates for the group:

$$C_{um}BR_{i,y}^{Total} = \sum_{n=1st}^{8th \text{ and higher}} C_{um}BR_{i,y}^n$$

where

$C_{um}BR_{i,y}^{Total}$ = total cumulative birth rate of women for single-year exact age group i in year y per 1,000 women.

$C_{um}BR_{i,y}^n$ = cumulative birth rate of women for live-birth order n (first through eighth and higher) and single-year exact age group i in year y per 1,000 women.

Example

Suppose the cumulative birth rates of women aged 21 for first- through eighth- and higher-order births in 1989 are 254.0, 77.9, 18.6, 3.7, 0.5, 0.1, 0.0, and 0.0, then the total cumulative birth rate for these women is:

$$C_{um}BR_{21,1989}^{Total} = 254.0 + 77.9 + 18.6 + 3.7 + 0.5 + 0.1 + 0.0 + 0.0 = 354.8.$$

Cumulative birth rates for the selected groups of cohorts (i.e., 5-year age groups, see Table 6) are simple averages of the cumulative birth rates for single cohorts. For example, the single-year cohort cumulative birth rates in 1989 for ages 20–24 were 196.3 (aged 20), 254.0 (aged 21), 310.1 (aged 22), 362.9 (aged 23), and 414.3 (aged 24). Thus, the cumulative birth rate for the 5-year age group 20–24 in 1989 is 307.5. (See Tables 2, 6, and 12–14 for the cumulative birth rates of the single-year and selected groups of cohorts for 1961–2006.)

Cumulative birth rates for January 1, 1960, for the single-year or 5-year exact age groups were obtained from *Fertility Tables for Birth Cohorts by Color: United States, 1917–1973*; cumulative birth rates for subsequent years were obtained by adding central birth rates for 1960 and later years for the single-year age groups and averaging the rates by 5-year age groups to obtain the cumulative birth rates for the selected groups.

Parity distribution

Parity distribution is the distribution of all women in a cohort by the number of children ever born alive to those women up to a specified exact age (1,3). The proportions may be expressed on a per 100 basis (as a percentage) or on a per 1,000 basis (per mille), as in the following formulas and the cohort fertility tables, to show greater precision. The proportions are computed by subtracting the cumulative birth rate for adjacent orders of birth (see following formulas). The cumulative birth rate for birth order n may be interpreted as the proportion of women who have had at least n children (or n or more children). By subtracting the proportion of women who have had $n+1$ or more children from the proportion who have had n or more children, the proportion of women who have exactly n children is ascertained.

The proportion of women at parities one through six are found according to (1,3):

$$PD_{i,y}^n = C_{um}BR_{i,y}^n - C_{um}BR_{i,y}^{n+1}$$

where

$PD_{i,y}^n$ = parity distribution of women for parity n (one through six) and single-year or 5-year exact age group i in year y .

$C_{um}BR_{i,y}^n$ = cumulative birth rate of women for live-birth order n (first through fifth) and single-year or 5-year exact age group i in year y per 1,000 women.

$C_{um}BR_{i,y}^{n+1}$ = cumulative birth rate of women for live-birth order $n+1$ (second through sixth) and single-year or 5-year exact age group i in year y per 1,000 women.

Example

Suppose the cumulative birth rate of women aged 21 in 1989 for first-order births is 254.0 and for second-order births, 77.9, then the proportion of women at parity one is:

$$PD_{21,1989}^1 = 254.0 - 77.9 = 176.1 \text{ or } 17.61 \text{ percent.}$$

The proportion of zero-parity (childless) women is found by subtracting the cumulative first birth rate from 1,000 (3):

$$PD_{i,y}^0 = 1,000.0 - C_{um}BR_{i,y}^1$$

where

$PD_{i,y}^0$ = proportion of childless women for single-year or 5-year exact age group i in year y .

$C_{um}BR_{i,y}^1$ = cumulative first birth rate of women for single-year or 5-year exact age group i in year y .

Example

Suppose the cumulative birth rate of women aged 50 for first-order births in 1989 is 916.0, then the proportion of women at zero parity is:

$$PD_{50,1989}^0 = 1,000.0 - 916.0 = 84.0 \text{ or } 8.4 \text{ percent.}$$

Finally, the proportion of women at parity seven and higher is the cumulative birth rate of women for seventh-order births (3):

$$PD_{i,y}^{7 \text{ and higher}} = C_{um}BR_{i,y}^7$$

where

$PD_{i,y}^{7 \text{ and higher}}$ = parity distribution of women for parity seven and higher and single-year or 5-year exact age group i in year y .

$C_{um}BR_{i,y}^7$ = cumulative birth rate of women for seventh-order live births and single-year or 5-year exact age group i in year y per 1,000 women.

Example

Suppose the cumulative birth rate of women aged 50 for seventh- and higher-order births in 1989 is 42.4, then the proportion of women at parity seven and higher is:

$$PD_{50,1989}^{7 \text{ and higher}} = 42.4 \text{ or } 4.24 \text{ percent.}$$

The sum of the proportion of women at parities zero through seven and higher for a given age group i equals 1,000:

$$1,000.0 = \sum_{n=1st}^{7th \text{ and higher}} PD_{i,y}^n$$

where

$PD_{i,y}^n$ = parity distribution of women for parity n (one through seven and higher) and single-year or 5-year exact age group i in year y .

NOTE: Proportions in the tables may not add exactly to 1,000.0 due to rounding.

Parity distributions for selected groups of cohorts are computed in the same manner as parity distributions for single cohorts. See Tables 3 and 7 for the parity distributions of the single-year and selected groups of cohorts for 1961 through 2006.

Birth probabilities

Birth probability shows the likelihood that a woman who has attained parity n by exact age i at the beginning of year y will have another birth ($n+1$) during age i (1,3). The rates are thus specific for women “at risk” of having a given birth in a specific year. The birth probabilities are computed using the central birth rates and the parity distributions. The formula for birth probability is (1):

$$BP_{i,y}^n = \frac{C_{sn}BR_{i,y}^{n+1}}{PD_{i,y}^n} \times 1,000.0$$

or

$$BP_{i,y}^n = \frac{C_{sn}BR_{i,y}^{n+1}}{C_{um}BR_{i,y}^n - C_{um}BR_{i,y}^{n+1}} \times 1,000.0$$

where

$BP_{i,y}^n$ = probability of a woman for single-year or 5-year exact age group i having parity n birth in year y .

$C_{sn}BR_{i,y}^{n+1}$ = central birth rate of women for live-birth order $n+1$ (first through eighth and higher) and single-year or 5-year current age group i in year y per 1,000 women.

$PD_{i,y}^n$ = parity distribution of women by parity n (one through seven and higher) and single-year or 5-year exact age group i in year y .

$C_{um}BR_{i,y}^n$ = cumulative birth rate of women for live-birth order n (first through seventh) and single-year or 5-year exact age group i in year y per 1,000 women.

$C_{um}BR_{i,y}^{n+1}$ = cumulative birth rate of women for live-birth order $n+1$ (second through eighth and higher) and single-year or 5-year exact age group i in year y per 1,000 women.

Example

Suppose the central birth rate of women aged 20 for second-order births in 1988 is 28.9 and the proportion of these women at parity one is 147.8, then the probability of these women having a second birth is:

$$BP_{20,1988}^2 = \frac{28.9}{147.8} \times 1,000.0 = 195.5.$$

Birth probabilities for zero-parity women having a birth are found according to:

$$BP_{i,y}^0 = \frac{C_{sn}BR_{i,y}^1}{PD_{i,y}^0} \times 1,000.0$$

or

$$BP_{i,y}^0 = \frac{C_{sn}BR_{i,y}^1}{1,000.0 - C_{um}BR_{i,y}^1} \times 1,000.0$$

where

$BP_{i,y}^0$ = probability of a childless woman for single-year or 5-year exact age group i having a live birth in year y .

$C_{sn}BR_{i,y}^1$ = central birth rate of women for first-order births and single-year or 5-year current age group i in year y per 1,000 women.

$PD_{i,y}^0$ = proportion of childless women for single-year or 5-year exact age group i in year y .

$C_{um}BR_{i,y}^1$ = cumulative birth rate of women for first-order births and single-year or 5-year exact age group i in year y per 1,000 women.

Example

Suppose the central birth rate of women aged 20 for first-order births in 1988 is 57.2 and the proportion of these women at zero parity is 803.2, then the probability of a childless woman giving birth is:

$$BP_{20,1988}^0 = \frac{57.2}{803.2} \times 1,000.0 = 71.2.$$

Finally, birth probabilities for women having their seventh- and higher-order birth are found according to:

$$BP_{i,y}^{7 \text{ and higher}} = \frac{C_{en}BR_{i,y}^{8 \text{ and higher}}}{PD_{i,y}^{7 \text{ and higher}}} \times 1,000.0$$

or

$$BP_{i,y}^{7 \text{ and higher}} = \frac{C_{en}BR_{i,y}^{8 \text{ and higher}}}{C_{um}BR_{i,y}^7} \times 1,000.0$$

where

$BP_{i,y}^{7 \text{ and higher}}$ = probability of a woman for single-year or 5-year exact age group i having a parity seven and higher birth in year y .

$C_{en}BR_{i,y}^{8 \text{ and higher}}$ = central birth rate of women for eighth- and higher-order birth and single-year or 5-year current age group i in year y per 1,000 women.

$PD_{i,y}^{7 \text{ and higher}}$ = parity distribution of women for parity seven and higher and single-year or 5-year exact age group i in year y .

$C_{um}BR_{i,y}^7$ = cumulative birth rate of women for seventh-order birth and single-year or 5-year exact age group i in year y per 1,000 women.

Example

Suppose the central birth rate of women aged 44 for eighth- and higher-order births in 1988 is 0.2, and the proportion of these women at parity seven and higher is 17.7, then the probability of a woman having a seventh- and higher-order birth is:

$$BP_{44,1988}^{7 \text{ and higher}} = \frac{0.2}{17.7} \times 1,000.0 = 11.3.$$

Note: Birth probabilities differ from central birth rates in that the denominator for birth probabilities is specific for parity as well as for age (3).

Birth probabilities for selected groups of cohorts are computed in the same manner as birth probabilities for single cohorts. See Tables 4, 8, and 15–17 for the birth probabilities of single-year and selected groups of cohorts for 1960 through 2005.

Standards of reliability and precision

An asterisk (*) is shown in place of any central birth rate based on fewer than 20 births in the numerator. Moreover, no central birth rates are computed (an asterisk is shown) for second- and higher-order births for women aged 14, or for fifth- and higher-order births for women aged 15–19, due to the unreliability of the number of births for these groups. As a result, no cumulative birth rates are computed for second- and

higher-order births for women aged 15, or for fifth- and higher-order births for women aged 16–20. Consequently, no parity distributions or birth probabilities are computed for second- and higher-order births for women aged 15, or for fifth- and higher-order births for women aged 16–20. In addition, no proportion is computed if the cumulative birth rate for a particular birth order is less than the rate for the next higher birth order, and no birth probability is computed if the proportion of women in an age-parity group is less than 10.0 per 1,000.

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List of Cohort Fertility Measure Tables

Table 1. Central birth rates, by live-birth order, current age, and race of women in each cohort from 1911 through 1991: United States, 1960–2005

Table 2. Cumulative birth rates, by live-birth order, exact age, and race of women in each cohort from 1911 through 1991: United States, 1961–2006

Table 3. Distribution of women, by parity, exact age, and race of women in each cohort from 1911 through 1991: United States, 1961–2006

Table 4. Birth probabilities, by parity, exact age, and race of women in each cohort from 1911 through 1990: United States, 1960–2005

Table 5. Central birth rates, by live-birth order, current age, and race of women in selected groups of cohorts from 1911–1915 through 1986–1990: United States, 1960–2005

Table 6. Cumulative birth rates, by live-birth order, exact age, and race of women in selected groups of cohorts from 1912–1916 through 1987–1991: United States, 1961–2006

Table 7. Distribution of women, by parity, exact age, and race of women in selected groups of cohorts from 1912–1916 through 1987–1991: United States, 1961–2006

Table 8. Birth probabilities, by parity, exact age, and race of women in selected groups of cohorts from 1911–1915 through 1986–1990: United States, 1960–2006

Table 9. Central birth rates, by live-birth order and current age of all women in each cohort from 1911 through 1991: United States, 1960–2005

Table 10. Central birth rates, by live-birth order and current age of white women in each cohort from 1911 through 1991: United States, 1960–2005

Table 11. Central birth rates, by live-birth order and current age of black women in each cohort from 1911 through 1991: United States, 1960–2005

Table 12. Cumulative birth rates, by live-birth order and exact age of all women in each cohort from 1910 through 1990: United States, 1961–2006

Table 13. Cumulative birth rates, by live-birth order and exact age of white women in each cohort from 1910 through 1990: United States, 1961–2006

Table 14. Cumulative birth rates, by live-birth order and exact age of black women in each cohort from 1910 through 1990: United States, 1961–2006

Table 15. Birth probabilities, by parity and exact age of all women in each cohort from 1911 through 1990: United States, 1960–2005

Table 16. Birth probabilities, by parity and exact age of white women in each cohort from 1911 through 1990: United States, 1960–2005

Table 17. Birth probabilities, by parity and exact age of black women in each cohort from 1911 through 1990: United States, 1960–2005