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Transitions Between Childlessness and First Birth: Three Generations of U.S. Women

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Transitions Between Childlessness and First Birth: Three Generations of U.S. Women

Data Evaluation and Methods Research

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for Health Statistics

Hyattsville, Maryland
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Abstract

Objective

This report analyzes the patterns of childlessness, and conversely, the first-birth patterns of three birth cohorts of American women. For this report, a cohort refers to women born in the same year. The cohorts compared were women born in 1910, 1935, and 1960—who, consequently, turned 25 during the Great Depression, the Baby Boom, and lastly, the post-Baby Boom period. The purpose of the report is to explore the differences in fertility characteristics of these three generations of women and to consider those differences in light of the social and economic conditions at the time.

Methods

Life table methodology, including the probability of having a first birth, the number of women remaining childless, and the expected number of years to remain childless, was applied to each of the three birth cohorts for comparison. Techniques extended from life table functions were also used and included measures of first-birth concentration as well as comparisons between childlessness and the total fertility rate (TFR). Data were based on the Centers for Disease Control and Prevention's National Center for Health Statistics tables on cohort fertility.

Results

Of the three birth cohorts studied, the women born in 1910 had the highest proportion childless and a low TFR. In contrast, the women born in 1935 had both the lowest proportion childless and the highest TFR. The fertility of women who were born in 1960 is characterized as intermediate to the other cohorts in terms of childlessness, but is distinct with both lowest levels of childbearing and oldest ages of first births. First-time childbearing is more concentrated (that is, least spread out) by age of mother for the 1910 and 1935 cohorts than the 1960 cohort. Finally, data for all U.S. birth cohorts 1910–1960 suggest that the greater the proportion childless in a cohort, the lower the TFR.

Keywords: birth cohorts • cohort fertility • life table methods • zero parity

Transitions Between Childlessness and First Birth: Three Generations of U.S. Women

by Sharon E. Kirmeyer, Ph.D.; and Brady E. Hamilton, Ph.D., Division of Vital Statistics

Introduction

Both the timing of the first birth and the percentage childless have profound consequences for society. These include the demand for schools and housing, as well as the development and utilization of women in the labor force. Moreover, the lives of women who become mothers are significantly different from those who do not. To give birth (and to raise a child) results in a transition to parenthood, with immediate and generally permanent implications (1). In industrialized societies, parenthood affects the acquisition of material goods (such as choice of place of residence, housing type, and consumable goods) (2). When and if women become mothers, they can encounter opportunity costs (for example, those that limit education, the ability to work full-time, the possibility to obtain higher professional attainment, promotions, and higher incomes) (3).

In nonindustrialized societies, rather than material or maternal opportunities, the degree of kin availability—that is the presence of children and the children's spouses—is of great importance for the elderly. Consequently, the proportion of women with *any* offspring is key to the well-being of families in these societies (2).

Childlessness has increasingly become an acceptable lifestyle in North America and Europe. However, lifestyle decisions are only one of the reasons for having a child. Not having a child may be due to postponement of childbearing, rather than early sterility (such as premature menopause). Intervening factors leading to childlessness include partners' availability and intentions, life course events, subfecundity, and unplanned events (1).

This report presents three strongly contrasting patterns of childlessness (and their complement, descriptions of first childbirth) and discusses the context in which these patterns occurred in the United States. In addition, this report discusses previously unknown relationships between individual functions of childlessness and the larger demographic context.

Methods

Data Sources

The patterns of childlessness examined in this report used U.S. birth *cohort* data, not *period* data. A birth cohort for this report is a group of women born in the same year and who share the same general or common experiences, at successive ages, during their reproductive lives.

Within this report, the experiences of three cohorts of women are followed over consecutive years through their respective reproductive lives. In contrast, analysis of period data includes the observation of many cohorts within a given time interval (1 year, for example), with mixed and different experiences of their reproductive lives.

The data for this report come from publications based on U.S. vital statistics data: ''Fertility Tables for Birth Cohorts by Color: United States, 1917–1973'' (4), Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS)

tables from the vital statistics of the United States (5,6), and the recent NCHS Internet release, ''Cohort Fertility Tables for All, White, and Black Women: United States, 1960–2005'' (7).

The selection of these three birth cohorts was based on several criteria. The cohorts chosen experienced their prime childbearing years under differing social, economic, and demographic conditions, and were evenly spaced from each other. The birth cohorts selected were 1910, 1935, and 1960, which are spaced 25 years apart. This spacing is close to the mean length of a generation, which empirically has a mode of 27–28 years (8). Moreover, these cohorts had data for essentially their complete reproductive lives; that is, ages 15–49. Note that the data for the 1960 cohort are only available through age 45. However, this was deemed acceptable because the cohort had essentially completed its childbearing.

In essence, the data represent three generations of women who experienced markedly different conditions. The earliest cohort of women spent their prime childbearing years (ages 20–35) during the Great Depression (1929 to the start of World War II), the second during the post-World War II economic recovery and the ''Baby Boom'' years (1946–1964), and the third during a period of social and economic liberalization (which began in the late 1960s) with relatively low and definitely delayed fertility (1973–2005).

Data for the 1910 and 1935 cohorts were taken from earlier sources (4–6) and data for the 1960 cohort were from the most recent source (7).

Data Quality

Note that the data in this report encompass a period where birth registration completeness improved to become effectively universal. Three nationwide tests of birth registration completeness estimated that of all births occurring in the United States, 92.5 percent in 1940, 97.9 percent in 1950, and 99.2 percent in 1964–1968 were registered (9). Accordingly, births for earlier data years were adjusted for underregistration. The quality (as well as classification) of live birth order and age of mother also improved, with relatively few births imputed for live birth order and age of mother not stated. For a detailed discussion on the adjustment of births and imputation of missing data, see references 4 and 7.

Analytic Methods

The life table method is most commonly applied to mortality data to analyze the probability of dying in a particular time period such as 1 year and to estimate a variety of statistics such as the average expectation of life at birth. However, life tables can also be used to study how long it takes for any event to happen. Some examples of reproductive health applications include: estimating the average time to conceive (10), gauging pregnancy outcomes (11), measuring the mean duration of breastfeeding (12), evaluating contraceptive use duration (13), cumulating birth probabilities within first marriages (14), and measuring the duration of cohabitation, marriage, divorce, and remarriage (15). This is the first time, the authors believe, that life tables have been used to formally examine and compare patterns of childlessness. The tabular data (4–7) produce functions that relate to both childlessness and first birth; as such, the tables are referred to in this report as ''maternity tables.''

Several maternity table functions that are used in the analysis are briefly discussed in the next section. The complete maternity tables are included as Tables 1–3. Unlike standard life tables, which range from birth to the oldest measureable age, the maternity table starts at age 15 and ends at age 49. These ages typically represent the beginning and end points of the reproductive period. As seen in Tables 1–3, less than 1 percent of first births occur after age 45 (i.e., column b_x, births).

Measures

As noted earlier, the life table method is most commonly applied to mortality data to analyze the probability of dying within a given time interval and to estimate other duration functions. Its applications are common in survival analysis, medical trials, and a number of reproductive health topics. The life table—or in this case, the ''maternity table''—functions were calculated in a spreadsheet format using Excel, wherein the calculations from one table column become the basis for the next. The following describes the most basic functions.

Size of maternity table's initial cohort, or "radix"—For purposes of comparison, each cohort in the maternity table is standardized to 100,000 at age 15 (expressed as l_{15} in formal terms).

Probability of having a first birth at age x (the q_x values)—Represent the probability or chance that a woman who is childless on her xth birthday will have a child before reaching her xth + 1 birthday.

Number of first births occurring at age x (the b_x values)—Represent the number of first births who are born to a woman at age x.

Number of childless women at age x (the l_x values)—Represent the number of women who are still childless on their xth birthday.

Cumulative probability of having a first birth by age x—Derived by subtracting the l_x value from the radix and dividing that difference by the radix to obtain a cumulative indicator of the probability of first births in a cohort.

Number of years expected to remain childless from a given age to age 50 (the e_x values)—Represent the average time remaining in a woman's reproductive life that she would expect to be childless. It has a well-known counterpart in life tables: the expectation of life.

A more detailed description of the functions is provided in the ''Technical Notes.'' Two other related functions are described below.

Indicators of dispersion (Gini Concentration Ratio and Duncan Index of Concentration)—Represent two measures of spread (or dispersion) in volume and timing of childbearing. Both depend on the Lorenz curve of cumulative dependent variables. While most known for indicating economic and geographic inequality, they have also been used to reflect maternal and

child health inequality (16,17). Both measures indicate the concentrations of first births by age of mother. The differences in the two indices are discussed below.

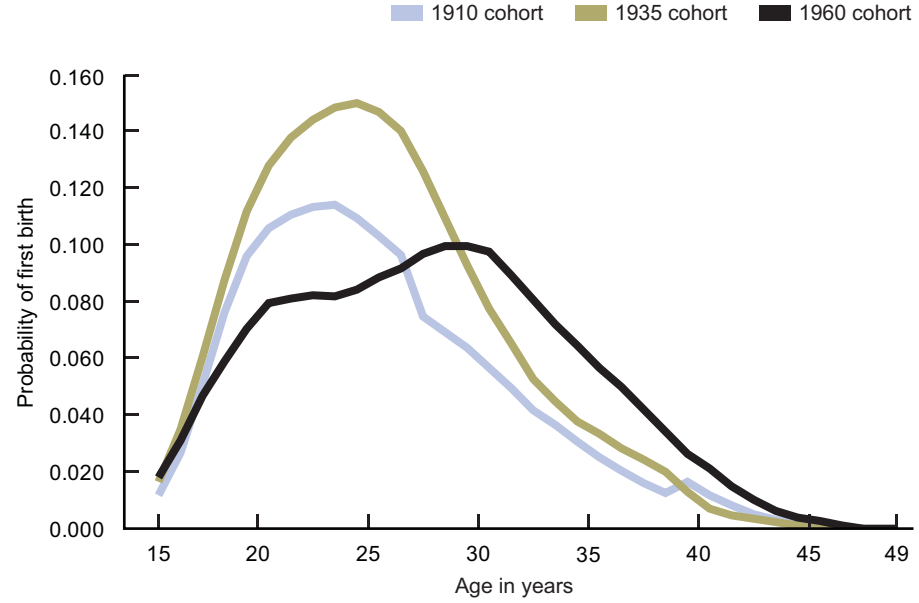
Lifetime total fertility rate by birth cohort (TFR)—The age-cohort-specific central fertility rates (f_x) are summed over a cohort's 35-year reproductive period to provide the completed fertility rate for that birth cohort, expressed as number of births per 1,000 women (aged 15–50).

Results and Discussion

The birth cohort of 1910 turned 25 in 1935, during the Great Depression. At that time, many marriages were delayed due to the lack of employment opportunities for men. The average age of marriage increased and a record number of women never married (18). Women at age 25 remained childless for more years than did those in the other cohorts during comparatively better economic times; they expected 14 years of future childlessness compared with 11 years for women born in 1935 and 1960.

The birth cohort of 1935 turned 25 in 1960, at the height of the prosperity that contributed in part to the Baby Boom. At this post-World War II time, the economy had grown rapidly and headed to full employment and high wages. Men with only a high school education could earn enough money to support a family (19). Prior to World War II, few attained higher levels of education. Post-World War II, the G.I. Bill assisted veterans in both obtaining higher education and supporting a family. At the same time, women were staying at home, having at least two children. This was due both to their husbands functioning as the sole provider in the household and to social and workplace discrimination, which curtailed the employment of married women and, particularly, mothers (19).

The birth cohort of 1960 turned 25 in 1985, during a period of increasing educational attainment and sustained labor force participation for women. There were legally enforced improvements in opportunities for women. Also at this time, there were changes in the service sector in the U.S. economy (especially for professional, managerial, sales, and technical services) (20), which favored the employment of women. Just as importantly during this time, modern methods of contraception became widely available (21,22).



SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 1. Probability of having a first birth, by age and birth cohort of mother: United States, 1910, 1935, and 1960

Patterns of First-birth Probabilities (q_x)

During each year of a childless woman's reproductive life, there is some probability that she will give birth. If she does not, she remains childless and has the opportunity in the succeeding year to have a birth. The shapes of first-birth probabilities differ greatly among the three cohorts. They are distinguished by overall magnitude of the first-birth curve, its symmetry, and the peak age to give birth (Figure 1).

Of the three cohorts, the 1910 cohort's attainment of motherhood was the lowest. The greatest probability or likelihood to have a first birth at a given age was 114 births per 1,000 (or 6,126 of 53,737 childless women). This peak of first births occurred at age 23 (Table 1). Put another way, 11.4 percent of childless women born in 1910 had a first birth at age 23. The greatest number of first births occurred early in the reproductive period. The probabilities for first births dropped rapidly after age 25. This is not unexpected given that the United States was deep into the Great Depression at this time.

The birth cohort of 1935 entered prime childbearing years during the economic prosperity of the late 1950s and early 1960s. This cohort had the highest overall fertility and lowest level of childlessness. The highest first-birth probability occurred at age 24 when about 15 percent of women still childless had their first child (Table 2). The probability curve was similar to that of the 1910 cohort, but first-birth probabilities were higher than those of the 1910 cohort until age 39.

The initial slope of first-birth probabilities for the 1960 cohort (to age 20) was not as steep as those of the previous cohorts. After age 20, the probabilities remained fairly constant for 10 years. The cohort's highest probability of having a first child occurred comparatively late, at age 29, with the chance that 1 out of 10 childless women would have their first child (Table 3). Overall, the

Table A. Cumulative probability of first birth, by selected age and birth cohort of women: United States, 1910, 1935, and 1960

Age of women in years	Birth cohort		
	1910	1935	1960
	Cumulative probability of first birth		
18	0.087	0.108	0.093
22	0.397	0.457	0.329
25	0.576	0.663	0.482
30	0.723	0.825	0.686
35	0.778	0.869	0.794
49	0.803	0.886	0.844

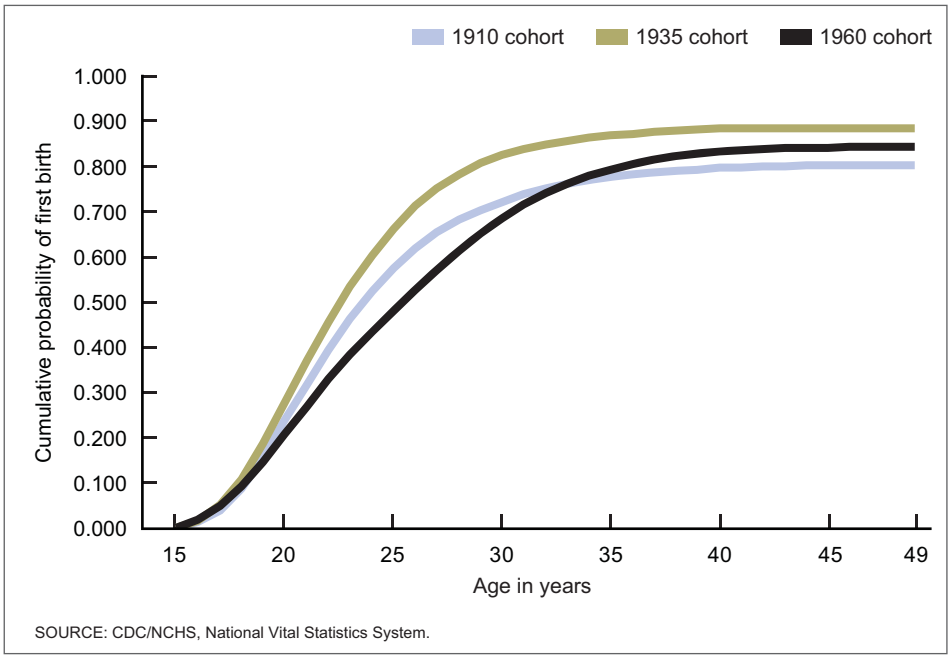


Figure 2. Cumulative probability of having a first birth, by age and birth cohort of mother: United States, 1910, 1935, and 1960

first-birth probability curve for the 1960 cohort shifted considerably to the older ages relative to those of the earlier cohorts.

Table A compares the cumulative first-birth probabilities at important ages. Among them are: age 18, when high school is generally completed; age 22, when college is completed; and age 35, when motherhood has essentially been initiated. For these three ages, the 1935 cumulative birth probabilities were the highest (0.108 at age 18 and 0.869 at age 35). The 1960 cohort's cumulative probability was relatively high at age 18 (0.093), but quickly dropped below those of other cohorts at age 25. However, at age 35, women born in 1960 had a higher probability of having had a first birth than the 1910 cohort (Figure 2).

Number in Cohort Remaining Childless, by Age (l_x)

Because the size of the initial cohort is set at 100,000, the number of women in column l_x (Tables 1–3) at age 49 represents the number out of the original 100,000 who remain childless at that age.

As illustrated in the inset of Figure 3, about 19,700 out of the 100,000 women of the 1910 cohort remained childless at the end of their reproductive period. That is, 0.197 of that cohort were still childless at age 49. For the 1935 cohort, the relative proportion was 0.114, and for the most recent cohort, 1960, it was 0.156. These figures correspond well with the proportions childless found in the National Fertility Survey (23) and the National Surveys of Family Growth (3).

In the last 10 years of their reproductive periods, the proportions childless in the three cohorts were approximately equally spaced (Figure 3). This was not true at earlier ages. Due to the postponement of first births by the women in the 1960 cohort, a relatively large number of the 1960 cohort were childless at younger ages. It was not until women in the 1960 cohort were aged 33 that they crossed under the "survival curve" of the women in the 1910 cohort. From that age forward, a relatively larger proportion of the 1910 cohort than the 1960 cohort was childless at each age (Figure 3 and Table B).

Distribution of First Births by Mother's Age (b_x)

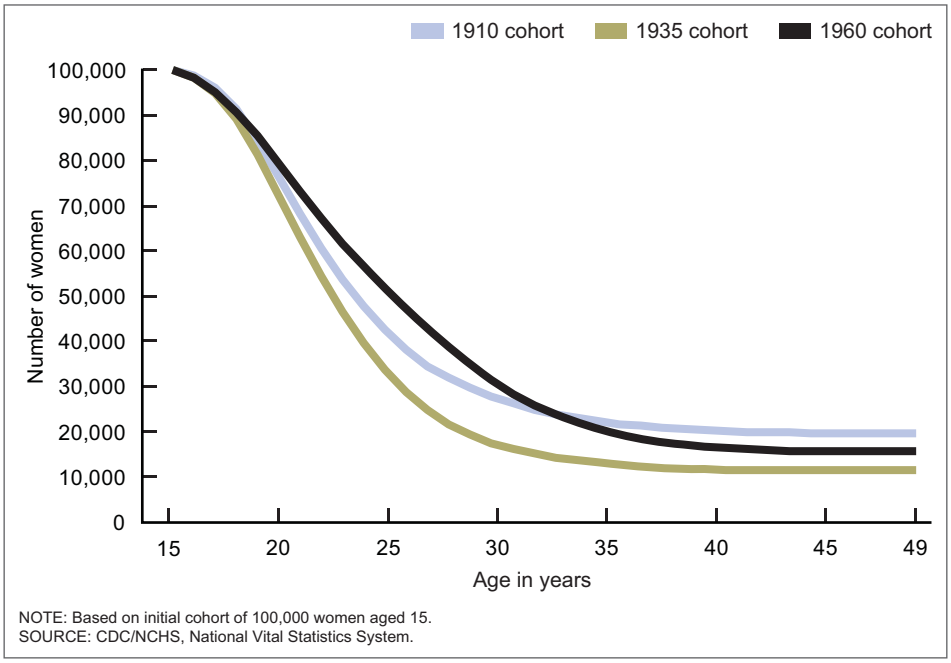
As shown in Table B, a substantial number of women did not have children by the time they concluded their reproductive years. However, approximately 80 percent to 90 percent of the women in all three cohorts did have at least one birth. The distributions of first births vary by peak, shape, and overall magnitude of first births for these three cohorts of 100,000 women. These differences are shown in Figure 4 and Table C.

The fewest first births were born to women in the 1910 cohort. For each 100,000 women who entered their reproductive period in 1925, 80,300 became mothers between ages 15 and 49 (Table A). It was at age 19 that the greatest numbers of births occurred; that is, 81 births per 1,000 women (or 8,100 per the original 100,000 women born in 1910). Of the 1910 cohort, one-half of the first births were born to women before age 21.1 and the other one-half at later years (Tables A and C).

Many more first births occurred to women in the 1935 cohort than in the 1910 cohort: approximately 88,600 of the 100,000 women in the 1935 cohort within their 35-year reproductive period. This level is 10 percent higher than that of the 1910 birth cohort. It was at age

20, the peak age for first births, when 92 births per 1,000 took place for women born in 1935. One-half were born before age 20.8 for the 1935 cohort and the other one-half at later years (Tables A and C).

The number of first births born to women in the 1960 cohort was intermediate to those in the 1910 and 1935 cohorts (roughly 84,400 women had a first birth compared with 80,300 and 88,600). But the volume of first births is not the only distinguishing characteristic of this cohort. The peak of the distribution is 63 births per 1,000, a peak that is about two-thirds the number of births that occurred in the 1935 cohort table (also at age 20). The shape of this distribution is markedly different as well: the decline in numbers of first births is particularly more attenuated than it was for the earlier cohorts. This moderate level extends into older years. The midpoint is about 2 years older for the 1960 cohort than that of the 1935 cohort (Table C).



NOTE: Based on initial cohort of 100,000 women aged 15.
SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 3. Number of women remaining childless, by age and birth cohort of mother: United States, 1910, 1935, and 1960

Table B. Proportion of women childless, by selected age and birth cohort of women: United States, 1910, 1935, and 1960

Age of women in years	Birth cohort		
	1910	1935	1960
		l_x/100,000	
18	0.913	0.892	0.907
22	0.606	0.543	0.671
25	0.424	0.337	0.518
30	0.277	0.175	0.314
35	0.222	0.131	0.206
49	0.197	0.114	0.156

Expectation of Number of Years to be Childless in the Future (e_x)

A woman may give birth in the first 12 months of her reproductive life—that is, at age 15—or she may have her first birth at the end of the maternity table when she is in her 40s. However, it is most likely that she will have her first birth, if she does become a mother, in her 20s. It is not only of interest whether a woman will or will not become a mother: a discrete outcome. It is additionally of interest to know the average number of years that she remains childless during the period when she could potentially have a child. This is an important statistic because it speaks to the opportunity costs a woman may have in completing her education and job training during years when her childbearing potential is comparatively high.

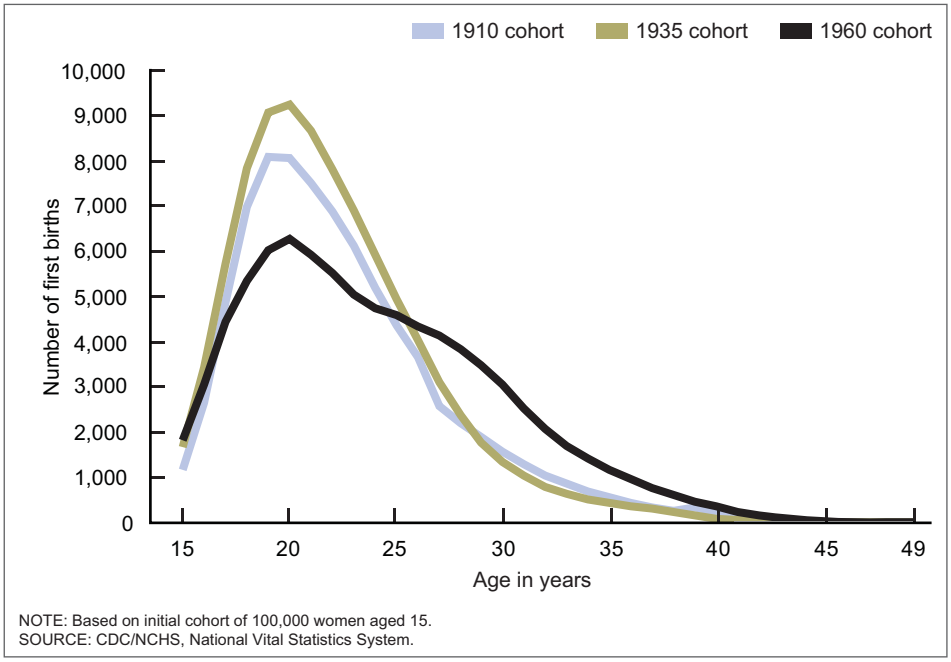
The average number of years a childless woman at a given age is expected to remain childless is shown in Figure 5. This measure is a function of both the birth probabilities at a given age (q_x) and the number of women who remain childless at that age (l_x). The expected childless years begin to decline sharply when the number of childless women remains fairly constant: around age 35 for each of the three cohorts (Figure 3). Thereafter, with each year of life, the expected number of childless years decreased annually by approximately 1 year (Figure 5).

The 1910 cohort had the highest overall level of childlessness and thus the average number of years expected to be childless followed the highest curve of the three cohorts. It reached a high of 15.4 years at age 30 (Table D).

For ages 15–30, the 1935 cohort had substantially lower levels of childlessness compared with the 1910 cohort, although the shapes of the curves were similar (Figure 5).

At age 15, women of the 1910 cohort anticipated being childless for an average of 13.4 years; those of the 1935 cohort, 10.8 years. After age 30, the two curves followed similar patterns.

The childless-years curve remained rather flat for the 1960 cohort as the first-birth probability curve was quite wide (as in Figure 1). As seen earlier in Figure 3, the number of women remaining childless stayed fairly constant up to age 35. This is when the average expected number of childless years dropped constantly with each increasing year of age (Figure 5).



NOTE: Based on initial cohort of 100,000 women aged 15.
SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 4. Distribution of first births, by age and birth cohort of mother: United States, 1910, 1935, and 1960

Table C. Mean, median, modal, and maximum number of first births (b_x), by birth cohort of women: United States, 1910, 1935, and 1960

Summary indicators of first birth, by cohort	Birth cohort		
	1910	1935	1960
Mean age at first birth	22.7	22.1	24.2
Median age at first birth	21.1	20.8	22.7
Modal (most common) age at first birth	19.0	20.0	20.0
Maximum number of first births (b_x) at any age	8,102.0	9,241.0	6,289.0

Degree of Concentration of First Births

Another way to view the distribution of first births relative to age of women is in terms of concentration (2). Concentration analysis generally studies the degree to which a certain proportion of producers (in this case, women of fertile ages) dominate a market (here, first-born children). The greater the degree of concentration (as measured by the Gini or Duncan indices, for example), the greater is the concentration of first births among women in particular age groups.

Lorenz curves provide a visually interpretable basis for comparing these two indicators of concentration. The Lorenz curves in Figure 6 map the cumulative proportion of first births of a cohort to the cumulative proportion of years exposed to childbearing. The points on the Lorenz curve represent statements like "in the first 35 percent of 1935 cohort's reproductive years (that is, by age 27.25), 90 percent of the first births were produced." A 45-degree diagonal line that runs from 0 through 100 percent shows the condition of equal distribution, where the probability distribution of having a first birth holds constant across ages. That is, by age 32.5 (the midpoint between ages 15 and 50), 50 percent of women would have had their first birth.

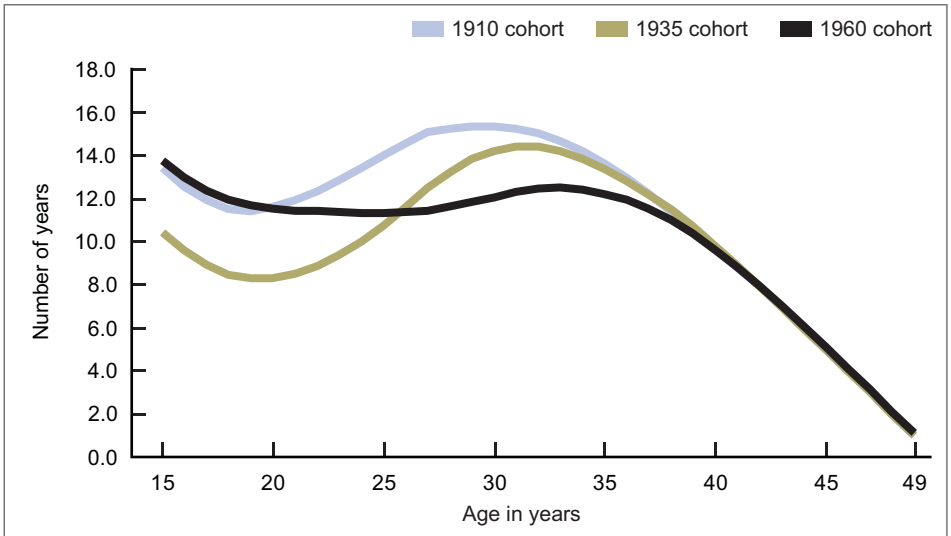
Several Lorenz curves can be mapped on the same graph regardless of the total number of events occurring as the Lorenz curve and its related indicators are independent of scale. Accordingly, Figure 6 plots first-birth concentrations for each of the fertility cohorts even though the cumulative number of first births in the maternity tables is different for each cohort (80.3, 88.6, and 84.4 thousand first births).

To easily compare the information of concentration (or inequality) shown in the Lorenz curves, the Gini ratio can be used. It is the index associated with the proximity of the Lorenz curve to the diagonal line of equality. The Gini concentration quotient is the ratio of the area that lies between the Lorenz curve and the line of equality to the total area below the line of equality (24). The ratio range is 0–1. The higher the coefficient, the greater is the concentration or inequality. Table E shows the ratios for the cohorts of 1910 and 1935 to be similar (0.534 and 0.563, respectively), but the ratio for 1960 is notably lower at 0.447. This lower figure illustrates the greater dispersion in age of first births for the most recent cohort.

As stated earlier, indicators from the Lorenz curves provide concrete information about the pacing of first births. At 50 percent of cumulative years exposed (to age 32.5), the cumulative proportions of first births were fairly similar (in 1910, 95 percent of first births; in 1935, 97 percent; and in 1960, 90 percent). But at a cumulative 25 percent of years exposed (to age 23), the differences in cumulative proportions of first births are markedly different (in 1910, 65 percent; in 1935, 68 percent; and in 1960, 52 percent). This is another way of expressing the lower concentration of first births for the 1960 cohort (Figure 6).

A second indicator of concentration, the Duncan index, is also shown in Figure 6 (25). Geometrically, this index is the maximum vertical distance from the diagonal line to the curve, showing the exact point *where* there are the greatest deviations between the diagonal line and the Lorenz curve. It is calculated by subtracting at each age the value of the diagonal from the value of the Lorenz curve. The greatest difference indicates the age where the concentration is highest.

As illustrated by the lengths of these vertical lines in Table E, the cohorts of 1910 and 1935 have the greater indices of concentration (0.491 and 0.523), and the 1960 cohort index



NOTE: Refers to number of years women may expect to remain childless from current age to end of reproductive period.
SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 5. Average number of years expected to remain childless, by age and birth cohort of mother: United States, 1910, 1935, and 1960

Table D. Expected number of years childless, by selected age interval and birth cohort of women: United States, 1910, 1935, and 1960

Age interval of women in years	Birth cohort		
	1910	1935	1960
		e_x	
15–50	13.4	10.8	13.6
30–50	15.4	14.3	12.0

has the lesser value (0.401). These values may be compared as they are based on the same number of years a woman is exposed to childbearing.

The Duncan calculations reinforce the Gini calculations. The greatest vertical difference for the 1910 cohort has a value of 0.506 out of a maximum of 1.0; the horizontal position is at the cumulative age proportion of 37 percent or 27 years. For 1935, the point of highest concentration is also at age 27, but the vertical measure of concentration is higher, at 0.542. In 1960, it is at age 31 that the vertical distance is the greatest, with a distance of 0.422. In sum, the 1935 cohort has the highest concentration and the 1960 the lowest; additionally, the 1960 cohort has a Duncan index occurring at the oldest age (age 31).

Importance of Childlessness in the Demographic Context of the 20th Century

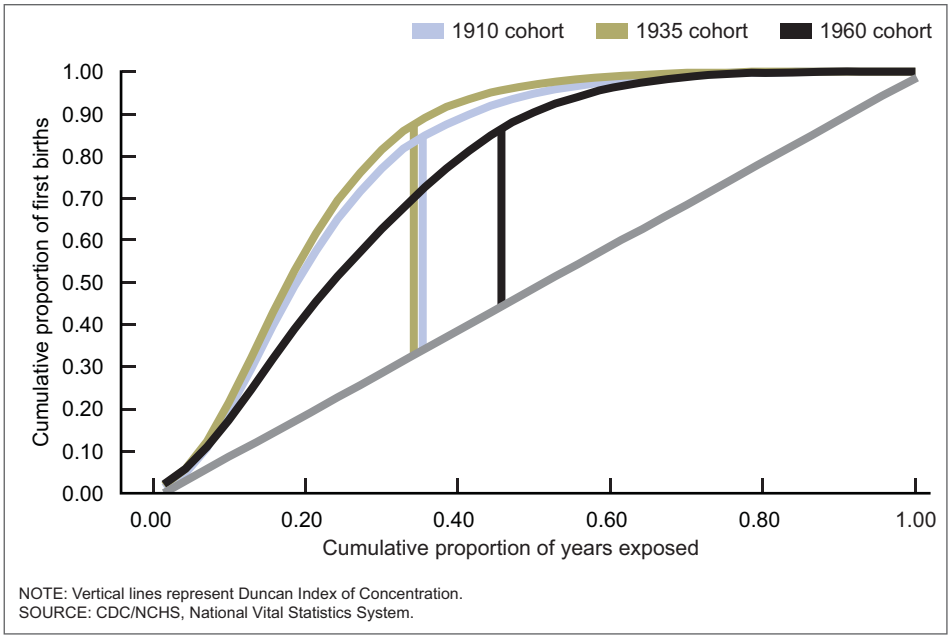
Childlessness is but one aspect of a cohort's fertility behavior. There are, of course, those women who have had one, two, three, four, and even higher parities. It is the totality of the distribution of these parities that produce cohorts' TFRs. Moreover, the TFR at the end of the reproductive period is not the only indicator of concern. The timing of childbearing (whether predominately early or late, concentrated or dispersed) marks broad trends in five decades of childbearing. One interesting illustration of this is the pattern of the TFR with respect to the proportion childless for the cohorts (1910, 1915, 1920, etc.), from 1910 through 1960.

Trends by Parity Distribution in the 20th Century

Figures 7 and 8 show relative frequencies of zero- and higher-order completed parity for all cohorts (Figure 7) and the three cohorts (Figure 8). The low completed fertility of the 1910 cohort shown in Figure 9 was due to the higher proportion of women who had zero, one, or two children. In fact, the proportion childless stayed historically high for women born in 1910–1915. The high TFR of the 1935 cohort was due to a combination of the historically lowest levels of childless and parity-one women and the highest levels of women with four or more children (37 percent), than had been seen in the birth cohorts of 1900–1960. The cohort of 1960 sustained a TFR close to 2.0. This level began before 1995 (Figure 9). It was characterized by distinctively high levels of women with two children (35 percent) and moderate parities of zero, one, and three. The 1960 cohort had historically low levels of completed fertility of four or more children. The percent distribution for the parity for these three cohorts is clearly shown in Figure 8.

Cohort TFRs, 1950–2005

The cohort TFR is measured 50 years after the birth of the cohort when women have essentially completed their childbearing. TFR is the average number of children born to women by the end of their reproductive years. Figure 9 provides the TFRs for the years 1950–2005. During this period of interest, the TFRs of the 1910 and 1960 cohorts were located near two low points in the curve and the 1935 cohort's TFR was near a high point. As noted, childlessness is an important component of the TFR; the high childlessness of 1910 and 1960 and low childlessness of 1935 influence the corresponding TFRs.



NOTE: Vertical lines represent Duncan Index of Concentration.
SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 6. Lorenz curves of first births and Duncan Index of Concentration, by birth cohort: United States, 1910, 1935, and 1960

Table E. Gini Concentration Ratio and Duncan Index of Concentration, by birth cohort of women: United States, 1910, 1935, and 1960

Measures of dispersion	Birth cohort		
	1910	1935	1960
Gini Concentration Ratio	0.534	0.563	0.447
Duncan Index of Concentration	0.491	0.523	0.401

In general terms, the lifetime reproductive experience of women born in 1910 began in 1925, a time only a few years before the beginning of the Great Depression. Due to economic considerations, there was a sudden drop in marriages, down 20 percent in 1932 from that of 1929 (26). The difficult economic circumstances of the Great Depression coupled with the decline in marriage lowered the probabilities that women would normally have a first-, second-, or higher-order birth. World War II affected the mid-childbearing years both in terms of uncertainty and in terms of large numbers of potential fathers being away from home, which further suppressed completed fertility rates. Some demographers concluded that the children who were postponed were, in the end, never born (18).

In contrast, the women of the 1935 cohort started their reproductive ages in 1950. World War II had ended; the members of the Armed Forces and employees of war-related industries had returned home to start or to resume married life, and the economy prospered (19).

There was a dramatic jump in the number of marriages, with a 42-percent increase in 1 year alone (1945–1946) (26). In addition to the rapid growth in the economy, families were aided by the G.I. Bill. This legislation and its supplements were sufficient for Veterans to live singly or married (27). The prosperity that it ensured led to early and nearly universal marriage and parenthood. With such means of support, it was not necessary to postpone family formation.

As shown above, completed parity distributions were markedly different from those of the pre-World War II period. In addition, almost all of the women in the 1935 cohort who had children went on to have a second-, third-, or higher-order birth (Figure 7) (7).

For a variety of reasons, *cohort* fertility fell after 1980, which was reflected in the 1960 cohort's fertility characteristics. Some of these reasons included delaying first births (28), delayed marriage (29), a major decline of completed parity for black women (7), the widespread availability of coitus-independent means of fertility control (21,22), and the substantial numbers of women who entered the labor force (30). Less educated women also became more likely to stay childless (31). It has been observed that women with initial desires to remain childless diverged by educational attainment (32). More educated women found that they could combine motherhood with a professional life.

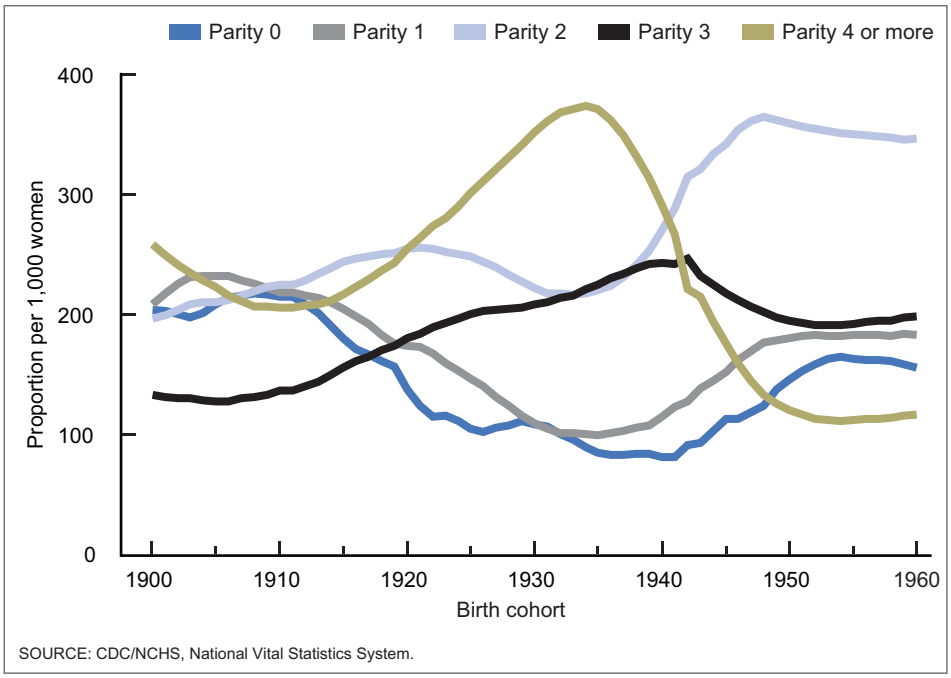
Postponement and Recuperation of Fertility

Cohort fertility analysis provides the ability to study major timing trends in childbearing. The last century showed trends of postponement and then recuperation in timing of births. The terms "postponement" and "recuperation" are dual measures of magnitude and timing of fertility.

Postponement

An essential aspect of trends in low-fertility countries during the past one-half of a century has been postponement of childbearing. Childbearing postponement takes place in the form of a fertility decline among young women, which is a combination of actual postponement as well as a decline in the number of births. What proportion of the fewer births were actually postponed becomes apparent only when the respective generation reaches the end of its childbearing age and it is clear how many of the "postponed" births were born later in the life of these women. For a more detailed discussion of this issue, see section 2.6 in Frejka and Sardon (33).

Postponement of childbearing started among the cohorts of the 1940s of the United States, Canada, and Northern and Western Europe. Table F shows that the average number of children borne by American women prior to their 27th birthday had peaked for the 1940 birth cohort at 1.927. But that number had halved for the 1980



SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 7. Parity distribution at completed fertility of birth cohorts: United States, 1900–1960

birth cohort (i.e., through age 26). The childbearing delay, again shown in Table F, had slowed down among birth cohorts of the 1970s in the United States in both relative and absolute terms.

Recuperation

Childbearing recuperation is the phenomenon of increase in age-specific cohort rates in the later childbearing ages of 27 and over. Less attention has been paid in the literature to this phenomenon although there are considerable data. Due to the length of the window in Table F, there are fewer time periods in the overview of recuperation or "catching up." As seen in Table F, the cumulative fertility rates for ages 27–40 for the 1930 birth cohorts dropped below one. For the 1960 birth cohort, there had been a robust recuperation of fertility in the older ages such that the annual rates of change in the preceding decade had been positive: 2 percent.

Relationship of Childlessness to TFRs

As seen earlier, trends in childlessness affect the completed cohort fertility rate, but trends in the distributions of births for other parities affect the completed fertility rate as well. Taken together, these factors produce a shift in the relationship between childlessness (*y* axis in Figure 7) and completed fertility (TFR, *y* axis in Figure 9), with two major segments produced in the observed trends (Figure 10). The first segment is for the 1910–1935 birth cohorts and the second is for the 1935–1960 birth cohorts (the calendar year 1980 is the point of inflection).

The observation has been that an elevated percentage of women who are childless contributes to low levels of completed fertility (34). The proportion childless has been mapped by other authors (35,36), showing that the higher the percentage childless, the lower the TFR. However, these examples used cross-sectional TFRs and proportions childless from numerous countries at various points. The data shown in this report (Figure 10) are less ambiguous than those of other analysts: the data were from one country (the United States) and represent a continuous series of completed fertility from 1950 through 2005.

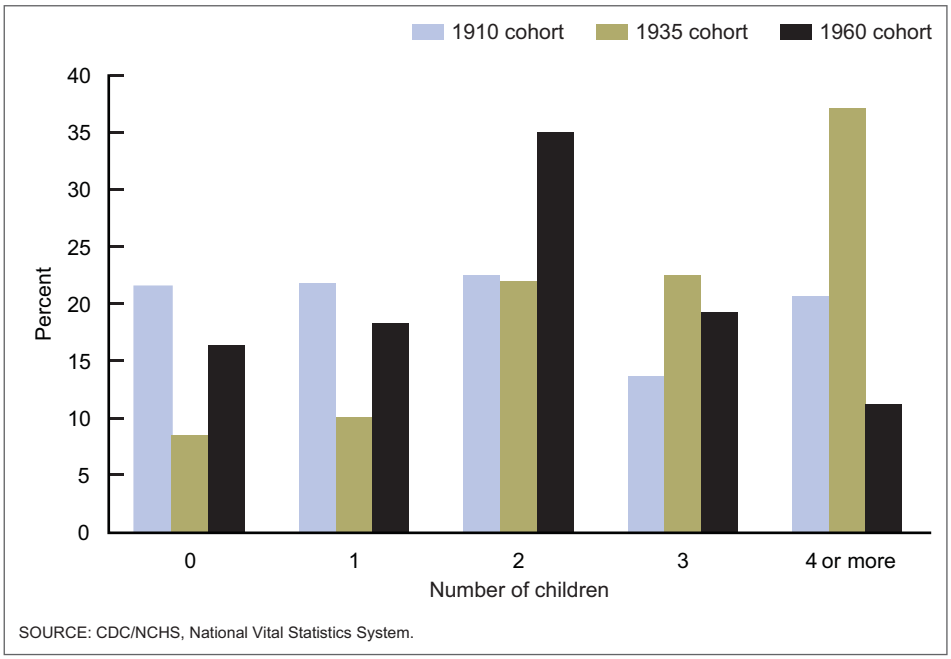
As seen in other publications, there was a general but loose negative relationship between proportion childless and the TFR. When least squares regression was applied to the data in Figure 10, a negative relationship between proportion childless and fertility was also measured. Namely, the TFR declined by one child for a 7.5-percent increase in the proportion of childless women.

Table F. Total fertility rates, by selected age group and birth cohorts of women: United States, 1930, 1940, 1950, 1960, 1970, and 1980

Total fertility rates, by age group and birth cohort	Birth cohort					
	1930	1940	1950	1960	1970	1980
Postponement up to age 26						
Cumulated age-specific cohort rates	1.795	1.927	1.165	0.995	0.978	0.948
Annual rates of change of percent	- - -	0.710	–5.032	–1.577	–0.172	–0.312
Corresponding span of birth cohorts	. . .	1930–1940	1940–1950	1950–1960	1960–1970	1970–1980
Recuperation from 27th to 40th birthday						
Cumulated age-specific cohort rates	1.389	0.849	0.834	0.988	- - -	- - -
Annual rates of change of percent	- - -	–4.923	–0.178	1.694	- - -	- - -
Corresponding span of birth cohorts	. . .	1930–1940	1940–1950	1950–1960	1960–1970	1970–1980

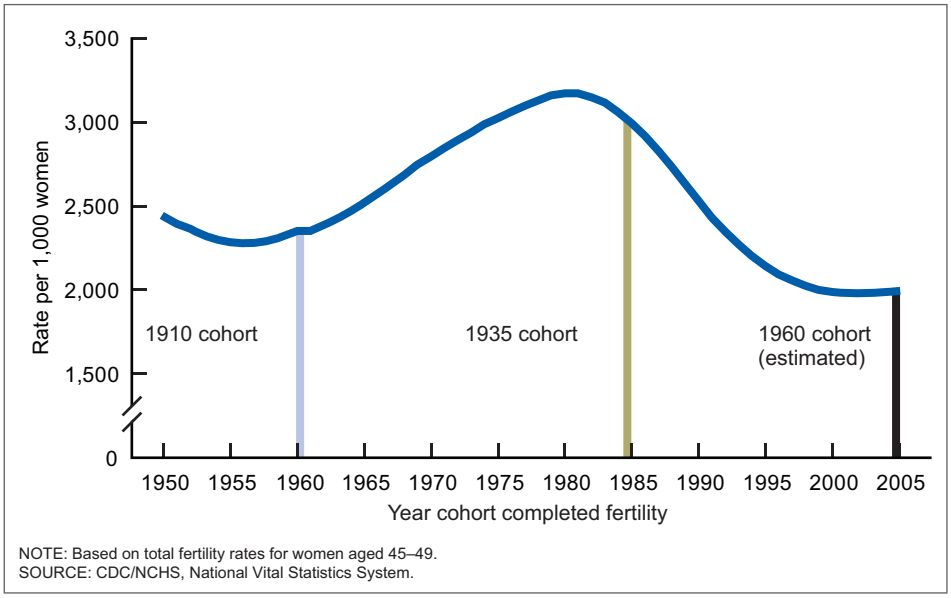
. . . Category not applicable.
- - - Data not available.

SOURCE: SOURCE: Frejka T, Sardon JP. Contemporary childbearing trends in low-fertility countries: A long-term perspective. Marrakech, Morocco: XXVI IUSSP International Population Conference. 2009.



SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 8. Percent distribution of the number of children ever born, by birth cohort of mother: United States, 1910, 1935, and 1960



NOTE: Based on total fertility rates for women aged 45–49.
SOURCE: CDC/NCHS, National Vital Statistics System.

Figure 9. Total fertility rates at completed fertility of birth cohorts: United States, 1950–2005

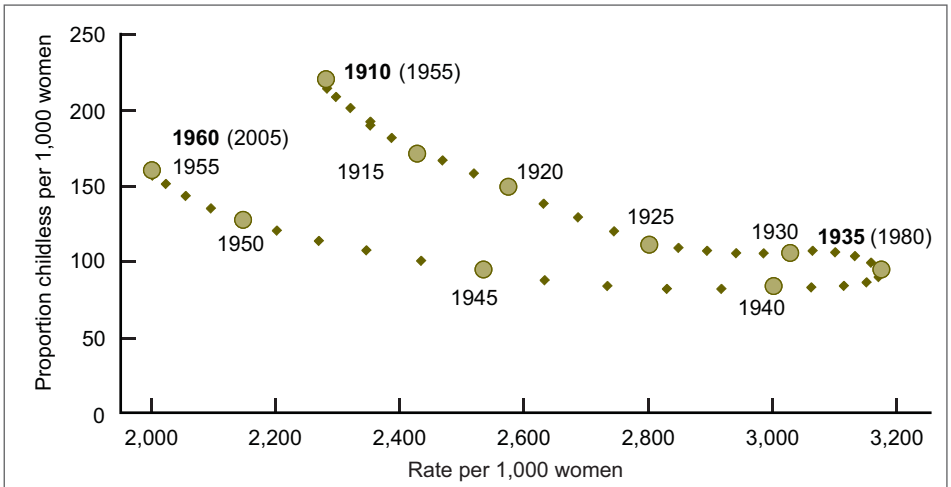
However, given the presence of a continuous series of data points, the outcomes are even more informative. Figure 10 depicts an annual plotting of the proportion of 1,000 women at age 50 who are childless, by the corresponding TFRs. Each point in Figure 10 represents a birth cohort that can also be defined as the year that cohort reaches age 50. The figure shows how the TFR and the percentage childless changes over time.

Starting with the cohort of 1910 for which the TFR was 2.3 and more than 20 percent of the cohort was childless at age 50, each successive cohort through the cohort of 1935 had a higher TFR and lower percentage childless. The cohort of 1935 had a TFR of 3.2 with less than 10 percent of the cohort remaining childless. Cohorts after 1935 had decreasing TFRs and increasing percentages childless with the lowest completed cohort TFR occurring in the 1956 cohort (1.99) with the proportion childless at 16 percent. The horizontal ranges in TFRs are similar; however, the magnitudes of the slopes describing the trends between the cohorts of 1910 and 1935, and 1935 and 1960, are substantially different. The relationship between the TFR and percentage childless is much stronger between the 1910 and 1935 cohorts (slope equals 13 percent) than it is between the 1935 and 1960 cohorts (slope equals 6 percent). Only one-half the change in percentage childless was needed in recent years to produce the same amount of change in the TFR as in earlier years. In other words, the TFR would increase by one child when the proportion childless decreases by 13 percent in the 1910–1935 cohort segment, and for the 1935–1960 cohort segment, the TFR would increase by one child when the proportion childless decreases by 6 percent.

A demographic explanation may be given for these differential slopes. As can be seen in Figures 7 and 8, between the 1910 and 1935 cohorts, the proportion childless dropped greatly as the proportion of women of high parity rose to historically high levels.

While the 1960 cohort had lower completed fertility than did the 1910 cohort, the percentage childless was lower. The differences in final levels were greatly affected by achieved parities of four or more, so that the overall fertility of women in these earlier cohorts with their greater family size was less affected by the proportion of childless women than the later cohorts with their smaller family size. Hence, in these series, the TFR depends not only on the percentage childlessness, but on the entire fertility distribution.

There is little variation in data points around the long-term trends represented by the long segments in Figure 10. The amount of variation explained by the least squares equations linking childlessness and completed cohort fertility is quite high: 82 percent for the more recent segment of years and 92 percent for the previous ones. These tight relationships imply strict trends in U.S. demographic history that were reversed when a series of events related to post-World War II prosperity



NOTES: Year cohort completed fertility in parentheses. Based on proportion childless and total fertility rate for women aged 45–49.
SOURCES: CDC/NCHS, National Vital Statistics System and Table 186 of reference 7.

Figure 10. Proportion childless and total fertility rate at completed fertility, by birth cohorts: United States, 1910–1960

reversed the decline in fertility that had been occurring for decades.

An economic interpretation for the childlessness–TFR relationship has been noted. Once a family has a child, it may go on to have more children because any goods are substitutable. For example, goods can be passed on from one child to the next, a car can hold three children as well as it can hold one, two children may share a house as easily as may one, etc. (2). It has been further observed that in recent times, once having had one child, the probabilities to have additional ones have remained fairly high (1).

Conclusion

Current low and late fertility and increased childlessness has been observed in all of Europe and in much of North America. This ''second demographic transition'' (37) is consistent with an observed increase in individual autonomy and a growth in gender equality. At the same time, there is the increase in socioeconomic activities competitive with childbearing. In the United States, education and career have been reported as important factors in women's decisions to delay marriage and motherhood. From 1970 to 2005, the female labor force participation rate increased by 37 percent and the percentage of women having completed four or more years of college had more than tripled (38). Studies (1,3) found that older women are childless for both voluntary and involuntary reasons; age is the primary explanatory variable for involuntary childlessness for older women due to subfecundability and decreased partner availability. In the United States, childlessness may have plateaued (3) or may continue to rise as this country adopts more of the demographic and social attributes recently seen in Europe (39).

In sum, the various indicators for the transitions to first birth for the 1910, 1935, and 1960 birth cohorts are closely tied to the social, economic, and historical features of the periods during which these women spent their childbearing years. The 1910 cohort passed the important portion of its childbearing years during the Great Depression. Average age of marriage increased while a record number of women never married. Of the three cohorts, the 1910 cohort had the largest proportion of women who did not have children. As well, the largest proportion of these women had only one birth, contributing to the low TFR of 2.35.

The 1935 cohort passed its principal reproductive years during the prosperous post-World War II era. Men were often sole bread earners and many factors kept women in the home with their roles circumscribed to motherhood. These women married young, began their childbearing young, and were the cohort among the three to have the least childlessness.

The 1960 birth cohort moved through a very different socioeconomic era. The obstacles to educational and employment opportunities were eliminated. Along with the availability of modern contraception, ''choice'' in whether and when to become mothers is shown by the first-birth probability curve. This concentration curve is far flatter than that of the other two cohorts. The proportion of women who had first births is intermediate and the concentration measures of first births are the lowest. The TFR of the 1960 cohort (2.00) is among the century's lowest.

What will the future hold for the next generation, the birth cohort of 1985? It began its childbearing years in a society socially divided on means and financing of fertility regulation. Childbearing outside of marriage has increased significantly (40): the percentage of births occurring outside of marriage has increased from 33.2 percent in 2000 when the cohort was aged 15, to 41 percent in 2009. The cohort moved into its key childbearing years during a significant recession; fertility dropped in 2009 to replacement levels (40). A repeat of the current study could be made in 10 years, using similar measures, providing better insight on the socioeconomic factors affecting the first-birth transitions of the 1985 cohort.

References

1. Testa MR, Toulemon L. Family formulation in France: Individual preferences and subsequent outcomes. Vienna Yearb Popul Res 41–75. 2006.
2. Lutz W. Comparative analysis of completed parity distributions: A global WFS perspective. Popul Bull UN 28:25–57. 1989.
3. Abma JC, Martinez GM. Childlessness among older women in the United States: Trends and profiles. J Marriage Fam 68(4):1045–56. 2006.
4. Heuser RL. Fertility tables for birth cohorts by color: United States, 1917–1973. DHEW Publication No. 76–1152. Rockville, MD: National Center for Health Statistics. 1976.

5. National Center for Health Statistics. Vital statistics of the United States, 1974. Volume 1, Natality. 1978.
6. National Center for Health Statistics. Vital statistics of the United States, 1999. Volume 1, Natality. 2001.
7. Hamilton BE, Cosgrove CM. Cohort fertility tables for all, white, and black women: United States, 1960–2005. Internet tables. Hyattsville, MD: National Center for Health Statistics. 2010. Available from: http://www.cdc.gov/nchs/nvss/cohort_fertility_tables.htm.
8. Preston SH, Heuveline P, Guillot M. Demography: Measuring and modeling population processes. Oxford, UK: Blackwell Publishers Ltd. 2001.
9. U.S. Census Bureau. Test of birth registration completeness 1964 to 1968. 1970 Census of Population and Housing PHC(E) No. 2. Evaluation and Research Program. Washington, DC: U.S. Department of Commerce. 1973.
10. Sheps MC, Menken JA. Mathematical models of conception and birth. Chicago, IL: The University of Chicago Press. 1973.
11. French FE, Bierman JM. Probabilities of fetal mortality. Public Health Rep 77:835–47. 1962.
12. Lesthaeghe R, Page H. Breastfeeding patterns in Nepal. An illustrative analysis. World Fertility Survey. London. 1980.
13. Jain A, Sivin I. Life table analysis of IUDs: Problems and recommendations. Stud Fam Plann 8(2):25–47. 1977.
14. Ford K. Socioeconomic differentials and trends in the timing of births. National Center for Health Statistics. Vital Health Stat 23(6). 1982.
15. Bramlett MD, Mosher WD. Cohabitation, marriage, divorce, and remarriage in the United States. National Center for Health Statistics. Vital Health Stat 23(22). 2002.
16. Schneider MC, Castillo-Salgado C, Loyola-Elizondo E, Bacallao J, Mujica OJ, Vidaurre M, Alleyne GA. Trends in infant mortality inequalities in the Americas: 1955–1995. J Epidemiol Community Health 56(7):538–41. 2002.
17. Schneider MC, Castillo-Salgado C, Bacallao J, Loyola E, Mujica OJ, Vidaurre M, Roca A. Methods for measuring health inequalities (part III). Epidemiol Bull 26(2):12–5. 2005.
18. Glick PC. A demographer looks at American families. J Marriage Fam 37(1):15–26. 1975.
19. Casper LM, Bianchi SM. Continuity and change in the American family. Thousand Oaks, CA: Sage Publications, Inc. 2001.
20. Wyatt ID, Hecker DE. Occupational changes during the 20th century. Mon Labor Rev 129(3):35–57. 2006.
21. Mosher WD, Westoff CF. Trends in contraceptive practice: United States, 1965–76. National Center for Health Statistics. Vital Health Stat 23(10). 1982.
22. Abma JC, Chandra A, Mosher WD, et al. Fertility, family planning, and women's health: New data from the 1995 National Survey of Family Growth. National Center for Health Statistics. Vital Health Stat 23(19). 1997.
23. Ryder NB, Westoff CF. Reproduction in the United States 1965. Princeton, NJ: Princeton University Press. 1971.
24. Lorenz MO. Methods of measuring the concentration of wealth. Publications of the American Statistical Association 9(70):209–19. 1905.
25. Duncan OD. The measurement of population distribution. Popul Stud 11(1):27–45. 1957.
26. U.S. Census Bureau. Historical statistics of the United States, colonial times to 1957. Washington, DC: U.S. Department of Commerce. 1960.
27. Petersen W. Population, 3rd edition. London, UK: Macmillan Publishing Company, Inc. 1975.
28. Ventura SJ. Trends and variations in first births to older women, 1970–86. National Center for Health Statistics. Vital Health Stat 21(47). 1989.
29. Lesthaeghe R. The second demographic transition in Western countries: An interpretation. In: Oppenheim-Mason K, Jensen AM (eds.). Gender and family change in industrialized countries. Oxford, UK: Clarendon Press. 1995.
30. Bureau of Labor Statistics. Changes in men's and women's labor force participation rates. The Editor's Desk. Washington, DC: U.S. Department of Labor. 2007.
31. Williams L, Abma J, Piccinino LJ. The correspondence between intention to avoid childbearing and subsequent fertility: A prospective analysis. Fam Plann Perspect 31(5):220–7. 1999.
32. Martin SP. Diverging fertility among U.S. women who delay childbearing past age 30. Demography 37(4):523–33. 2000.
33. Frejka T, Sardon JP. The postponement of childbearing. In: Childbearing trends and prospects in low-fertility countries: A cohort analysis. Dordrecht, NL: Kluwer Academic Publishers. 2004.
34. Feeny G, Lutz W. Distribution analysis of period fertility. In: Lutz W (ed.). Future demographic trends in Europe and North America: What can we assume today? London, UK: Academic Press. 1991.
35. Barkalov NB. The fertility decline in Russia, 1989–1996: A view with period parity-progression ratios. Genus 55(3–4):11–60. 1999.
36. Barkalov NB, Dorbritz J. European parity-progression-patterns: Results of the Fertility and Family Survey. Z Bevolkerungswiss 30(2–3):175–218. 2005.
37. Billari FC, Liefbroer AC, Philipov D. The postponement of childbearing in Europe: Driving forces and implications. Vienna Yearb Popul Res 1–17. 2006.
38. U.S. Census Bureau. CPS historical time series tables. Table A-1. Washington, DC: U.S. Department of Commerce. 2010.
39. Philipov D, Liefbroer AC, Billari FC (eds). Postponement of childbearing in Europe. Special edition. Vienna Yearb Popul Res. 2006.
40. Hamilton BE, Martin JA, Ventura SJ. Births: Preliminary data for 2009. National vital statistics reports; vol 59 no 3. Hyattsville, MD: National Center for Health Statistics. 2010.
41. Hamilton BE, Cosgrove CM. Technical appendix to the cohort fertility tables for all, white, and black women: United States, 1960–2005. Internet tables. Hyattsville, MD: National Center for Health Statistics. 2010. Available from: http://www.cdc.gov/nchs/nvss/cohort_fertility_tables.htm.
42. Whelpton PK. Cohort fertility: Native white American women in the United States. Princeton, NJ: Princeton University Press. 1954.

Table 1. Maternity table for the 1910 birth cohort, by age of mother

Age of woman in years	Probability of giving birth to first child at age *x*	Number of childless women at age *x*	Number of first births occuring to women at age *x*	Number of childless person-years lived at age *x*	Number of childless person-years lived from age *x* to age 50	Number of years expected to remain childless from age *x* to age 50
x	q_x	l_x	b_x	L_x	T_x	e_x
15	0.0118	100,000	1,180	99,410	1,343,336	13.43
16	0.0269	98,820	2,658	97,491	1,243,926	12.59
17	0.0507	96,162	4,875	93,724	1,146,435	11.92
18	0.0765	91,286	6,983	87,795	1,052,711	11.53
19	0.0961	84,303	8,102	80,252	964,917	11.45
20	0.1059	76,201	8,070	72,167	884,664	11.61
21	0.1104	68,132	7,522	64,371	812,498	11.93
22	0.1134	60,610	6,873	57,173	748,127	12.34
23	0.1140	53,737	6,126	50,674	690,954	12.86
24	0.1092	47,611	5,199	45,011	640,280	13.45
25	0.1030	42,412	4,368	40,227	595,269	14.04
26	0.0963	38,043	3,664	36,212	555,041	14.59
27	0.0747	34,380	2,568	33,096	518,830	15.09
28	0.0692	31,812	2,201	30,711	485,734	15.27
29	0.0638	29,610	1,889	28,666	455,023	15.37
30	0.0568	27,721	1,575	26,934	426,357	15.38
31	0.0494	26,147	1,292	25,501	399,424	15.28
32	0.0417	24,855	1,036	24,337	373,923	15.04
33	0.0366	23,818	872	23,383	349,586	14.68
34	0.0305	22,947	700	22,597	326,204	14.22
35	0.0252	22,247	561	21,966	303,607	13.65
36	0.0203	21,686	440	21,466	281,641	12.99
37	0.0162	21,246	344	21,074	260,174	12.25
38	0.0126	20,902	263	20,770	239,101	11.44
39	0.0164	20,638	338	20,469	218,331	10.58
40	0.0117	20,300	238	20,181	197,861	9.75
41	0.0081	20,062	163	19,981	177,680	8.86
42	0.0050	19,900	99	19,850	157,699	7.92
43	0.0033	19,800	65	19,768	137,849	6.96
44	0.0019	19,735	37	19,716	118,081	5.98
45	0.0010	19,698	20	19,688	98,365	4.99
46	0.0005	19,678	10	19,673	78,677	4.00
47	0.0000	19,668	0	19,668	59,004	3.00
48	0.0000	19,668	0	19,668	39,336	2.00
49	0.0000	19,668	0	19,668	19,668	1.00

0.0000 Quantity more than zero but less than 0.00005.

Table 2. Maternity table for the 1935 birth cohort, by age of mother

Age of woman in years	Probability of giving birth to first child at age x	Number of childless women at age x	Number of first births occuring to women at age x	Number of childless person-years lived at age x	Number of childless person-years lived from age x to age 50	Number of years expected to remain childless from age x to age 50
x	q_x	l_x	b_x	L_x	T_x	e_x
15	0.0167	100,000	1,670	99,165	1,075,746	10.76
16	0.0349	98,330	3,432	96,614	976,581	9.93
17	0.0604	94,898	5,732	92,032	879,967	9.27
18	0.0879	89,166	7,838	85,248	787,934	8.84
19	0.1116	81,329	9,076	76,791	702,687	8.64
20	0.1279	72,252	9,241	67,632	625,896	8.66
21	0.1376	63,011	8,670	58,676	558,264	8.86
22	0.1440	54,341	7,825	50,428	499,588	9.19
23	0.1483	46,516	6,898	43,067	449,160	9.66
24	0.1497	39,618	5,931	36,652	406,093	10.25
25	0.1469	33,687	4,949	31,213	369,441	10.97
26	0.1401	28,738	4,026	26,725	338,228	11.77
27	0.1257	24,712	3,106	23,159	311,503	12.61
28	0.1095	21,606	2,366	20,423	288,344	13.35
29	0.0927	19,240	1,784	18,348	267,922	13.93
30	0.0776	17,456	1,355	16,779	249,573	14.30
31	0.0652	16,102	1,050	15,577	232,794	14.46
32	0.0529	15,052	796	14,654	217,218	14.43
33	0.0449	14,256	640	13,936	202,564	14.21
34	0.0379	13,616	516	13,358	188,628	13.85
35	0.0336	13,100	440	12,879	175,271	13.38
36	0.0285	12,659	361	12,479	162,391	12.83
37	0.0245	12,299	301	12,148	149,912	12.19
38	0.0200	11,997	240	11,877	137,764	11.48
39	0.0131	11,757	154	11,680	125,887	10.71
40	0.0072	11,603	84	11,562	114,207	9.84
41	0.0048	11,520	55	11,492	102,645	8.91
42	0.0036	11,464	41	11,444	91,153	7.95
43	0.0024	11,423	27	11,410	79,709	6.98
44	0.0012	11,396	14	11,389	68,300	5.99
45	0.0000	11,382	0	11,382	56,911	5.00
46	0.0000	11,382	0	11,382	45,528	4.00
47	0.0000	11,382	0	11,382	34,146	3.00
48	0.0000	11,382	0	11,382	22,764	2.00
49	0.0000	11,382	0	11,382	11,382	1.00

0.0000 Quantity more than zero but less than 0.00005.

Table 3. Maternity table for the 1960 birth cohort, by age of mother

Age of woman in years	Probability of giving birth to first child at age *x*	Number of childless women at age *x*	Number of first births occuring to women at age *x*	Number of childless person-years lived at age *x*	Number of childless person-years lived from age *x* to age 50	Number of years expected to remain childless from age *x* to age 50
x	q_x	l_x	b_x	L_x	T_x	e_x
15	0.0181	100,000	1,810	99,095	1,363,438	13.63
16	0.0312	98,190	3,064	96,658	1,264,343	12.88
17	0.0467	95,126	4,442	92,905	1,167,685	12.28
18	0.0591	90,684	5,359	88,004	1,074,779	11.85
19	0.0706	85,325	6,024	82,313	986,775	11.56
20	0.0793	79,301	6,289	76,156	904,462	11.41
21	0.0810	73,012	5,914	70,055	828,306	11.34
22	0.0824	67,098	5,529	64,334	758,251	11.30
23	0.0820	61,569	5,049	59,045	693,917	11.27
24	0.0841	56,521	4,753	54,144	634,872	11.23
25	0.0885	51,767	4,581	49,477	580,728	11.22
26	0.0918	47,186	4,332	45,020	531,252	11.26
27	0.0966	42,854	4,140	40,784	486,232	11.35
28	0.0994	38,714	3,848	36,790	445,447	11.51
29	0.0997	34,866	3,476	33,128	408,657	11.72
30	0.0975	31,390	3,061	29,860	375,529	11.96
31	0.0892	28,330	2,527	27,066	345,669	12.20
32	0.0808	25,803	2,085	24,760	318,603	12.35
33	0.0718	23,718	1,703	22,866	293,843	12.39
34	0.0645	22,015	1,420	21,305	270,976	12.31
35	0.0567	20,595	1,168	20,011	249,672	12.12
36	0.0498	19,427	967	18,943	229,661	11.82
37	0.0420	18,460	775	18,072	210,717	11.42
38	0.0342	17,684	605	17,382	192,645	10.89
39	0.0265	17,080	453	16,853	175,263	10.26
40	0.0212	16,627	352	16,451	158,410	9.53
41	0.0149	16,274	242	16,153	141,960	8.72
42	0.0101	16,032	162	15,951	125,806	7.85
43	0.0063	15,870	100	15,820	109,855	6.92
44	0.0038	15,770	60	15,740	94,035	5.96
45	0.0026	15,710	41	15,690	78,295	4.98
46	0.0013	15,669	20	15,659	62,606	4.00
47	0.0000	15,649	0	15,649	46,947	3.00
48	0.0000	15,649	0	15,649	31,298	2.00
49	0.0000	15,649	0	15,649	15,649	1.00

0.0000 Quantity more than zero but less than 0.00005.

Appendix. Technical Notes

Sources of Data

The birth probabilities shown in this report were obtained from ''Cohort Fertility Tables for All, White, and Black Women: United States, 1960–2005'' (7), ''Fertility Tables for Birth Cohorts by Color, United States, 1917–1973'' (4), and ''Vital Statistics of the United States, 1974'' and for 1999 (5,6).

The ''Cohort Fertility Tables for All, White, and Black Women: United States, 1960–2005'' (7) were recently released as a revision and extension of the cohort fertility measures (central birth rates, cumulative birth rates, parity distributions, and birth probabilities) published in the other, older reports. Detailed information on the computation of birth probabilities and the other measures may be found in the ''Technical Appendix to the Cohort Fertility Tables for All, White, and Black Women: United States, 1960–2005'' (41).

Description of Life Table Functions

Age of woman (x)—Identifies the cohort with the year of the date on which the woman's birth occurred. Because these women retain this designation throughout their childbearing years, there is a fixed relationship between the cohort identification year, the age of the member of the cohort (column *x*), and the calendar or data year to which the fertility measure refers.

Probability of giving birth to a first child at age x—Indicates the probability or chance that a childless woman changes her status to being a mother within a specific year and is the single most important function in the maternity table. The transition from being childless to being a mother is the first and, obviously, most important step in a woman's fertility career (31), affecting nearly all social, economic, and emotional aspects of a woman's life.

The year begins exactly at a woman's birthday and concludes when she reaches her next birthday (Figure 1 and Tables 1–3, column q_x). These probabilities permit the calculation of the other functions in the maternity tables.

Cumulative percentage of having a first birth at age x—Calculated by subtracting the number of women who have had a first birth and dividing the difference by 100,000 (using column l_x in Tables 1–3). This function is fundamental in the development of cohort fertility analysis. Whelpton (42) relied on this function for short- to medium-range fertility projections. Cumulative percentage of first births at ages 18, 22, and 40 provided robust estimates of final childlessness.

As noted, not all women have a first birth in their lifetimes. Accordingly, the cumulative probability of having had at least one (first) birth by the end of the reproductive period is approximately 80 percent to 90 percent (Figure 2).

Number of the birth cohort remaining childless—Focuses on how long a cohort of women stay in the state of childlessness. The maternity tables in this report use a standard 100,000 as the number of childless women who enter the table at the beginning of their reproductive lives. Each year some women give birth, which decreases the size of the remaining childless cohort. This function depicts the size of the childless population at any given age (up to age 50). As noted, not all women give birth in their lifetimes. Related to the complement of the previous measure, 10 percent to 20 percent of women in the birth cohorts remained childless (Figure 3 and Tables 1–3, column l_x).

Number of first births occurring to women at age x—Shows the number of first births occurring within a given age interval. The number of first births is influenced by the size of the pool of childless women, the percentage of women in a sexual relationship in that pool, and the probability of giving birth to a first child for members of that age class at risk of childbearing (Figure 4 and Tables 1–3, column b_x).

Number of years expected to remain childless from age x to the end of the reproductive period—Is parallel to the ''life expectancy'' function in a mortality-oriented life table. However, instead of average number of years of life expected to live in the future, this function estimates the average number of years a woman expects to remain childless from a specific age to the end of her reproductive period. For example, the women at age 15 in the 1910 birth cohort may expect, on the average, to remain childless for 13.4 years; that is, a woman can expect to have her first birth by age 28.4. While some women will remain childless to the end of their reproductive period, the majority will give birth before then (Figure 5 and Tables 1–3, column e_x).

The Lorenz (concentration) curve—Included to show the concentration of first births by age. The graph illustrates the dispersion of first births over the range of the reproductive lives of women rather than the central tendency of first births over the range (e.g., the average age of first birth). In this, the Lorenz curve permits the measure of skewness or ''tilt'' of the first-birth curve. The women in the 1935 cohort were considered to be young when they had their first births, whereas the members of the 1960 cohort, by comparison, were much older.

Figure 6 shows Lorenz curves in addition to a diagonal line at 45 degrees, which indicates an even distribution of births by age. The further the Lorenz curve deviates from the 45-degree diagonal line, the more concentrated is the age distribution of first births. If the number of first births was equal in each age group—that is, the distribution curve lies on the diagonal line—the distribution curve would represent a complete lack of concentration. If all first births took place in a single age interval, the distribution curve would represent the maximum, or 100 percent, concentration of births at one age. Two measures of concentration related to the Lorenz curve discussed in this report are the Gini Concentration Ratio and the

Duncan Index of Concentration. Numerically, the Duncan index is different from the Gini index as the Duncan is affected by the number of age classes.

Distribution of children ever born, or parity, by birth cohort—Refers to a distribution of all women in a cohort by the number of children ever born alive to those women up to a specified age—generally up to age 49. The proportions may be expressed on a per 1,000 basis (per mille, for greater precision) (Figure 7), or as a percentage (Figure 8) (4,7). This measure is important to describe the household, which may be large or small, and to describe at what ages women give birth and in which various orders.

Cohort total fertility rate (TFR)—Refers to the average completed fertility of women in a cohort (Figure 9). It takes into account the cumulative fertility rates over *all* ages, not just the rate of first births. This summary indicator is not included in the maternity table, but is used in this report to show the impact of childlessness relative to completed fertility of a cohort (4,7). The TFR based on the cohort fertility data is considered to be the "truer" measure of fertility than the TFR based on period data; the latter is complicated by the overlap in timing of cohort rates.

General Probability of Birth ($_nq_x$)

The probability of birth estimates the likelihood that a woman who has attained parity n (either zero, one, two, three, four, five, six, seven, or higher) by age i will have another $(n + 1)$th birth before reaching the end of that age interval; that is, before age $i + 1$. The birth probabilities are computed using the central birth rates and the parity distributions (41).

The formula for the probability of zero parity—that is, women having their first birth—is:

$$BP^0_{i,y} = BR^1_{i,y} / PD^0_{i,y} \bullet 1{,}000.0,$$

where

$BP^0_{i,y}$ = probability of a childless woman at age i having a live birth in year y,

$BR^1_{i,y}$ = first-order central birth rate of women at age i in year y,

and

$PD^0_{i,y}$ = proportion of childless women at age i in year y.

The formulae for computing the birth probabilities of higher parities (one, two, three, four, five, six, seven, or higher), as well as the computed probabilities, are available elsewhere (41).

Note that the probabilities shown in Tables 1–3 are specific to those women born in 1910, 1935, and 1960 "at risk" of having their first birth. As mentioned, the probabilities show the likelihood of first birth between the beginning of an age interval and before reaching the end of that age interval. For example, the probability of a first birth for women in the 1960 cohort in the age interval 20–21 is 0.0793 (Table 3). This means that for every 1,000 women who reach their 20th birthday without having given birth, 79.3 of them will give birth before reaching their 21st birthday.

It is assumed that births are evenly distributed across the single-year age interval under consideration. Across age, the probability of first birth rises with age of mother, peaking sometime in the 20s, and then declines. The probability of dying, in comparison, generally increases with age. This is an important distinction for the final age group in the life tables. With traditional mortality-related life tables, everybody within this age group dies; that is, the probability of dying equals one ($_nq_x = 1.000$). However, the probability of first birth for the final age group of the birth cohort is less than one, so that some women remain childless throughout their lives.

Short Definitions of Life Table Functions and Formulae

Age- and cohort-specific, parity zero, birth probabilities for women at ages 15–49—Refers to the probability or chance that a childless woman, at age i, will have a first birth within the year.

$$q^0_{i,y},$$

where

q^0 = probability that a first birth occurs within 1 year,

i = age of woman,

and

y = year

(See general formula for probability of birth, $_nq_i$, above.)

Age- and cohort-specific number of childless women at ages 15–49—Refers to the number of women at age i from the original cohort who have yet to have any children at the beginning of year y.

$$l^0_{i,y},$$

where

l^0 = the number of women who have not had any children,

i = age of woman,

and

y = year.

$$l^0_{i+l,y} = l^0_{i,y} \bullet q^0_{i+l,y}$$

(Often the cohort is set to have an initial magnitude like 100,000.)

Age- and cohort-specific number of first-born children for women at ages 15–49—Refers to the number of first births occurring to women, at age i, within year y.

$$b^0_{i,y},$$

where

b^0 = the number of first-born children,

i = age of woman,

and

y = year.

$$b^0_{i,y} = q^0_{i,y} \bullet l^0_{i,y}$$

Age- and cohort-specific number of childless years for women at ages 15–49—Refers to the number of childless years lived by women at age i in year y, taking into account the decrease of childless women as the cohort ages in the year.

$$L^0_{i,y},$$

where

$L^0_{i,y}$ = the number of childless years lived by childless women at age i

and

$L^0_{i,y}$ = is calculated for all ages for each cohort.

$$L^0_{i,y} = (0.5) \bullet l^0_{i,y} + (0.5) \bullet l^0_{i+l,y}$$

Cohort-specific number of years childless from current age to age 50—Refers to the number of childless years from age *i* to the end of reproductive period.

$$T^0_{i,y}$$

where

$T^0_{i,y}$ = the total number of childless years lived over exact age *i* by women in the cohort

and

$T^0_{i,y}$ = $\Sigma^{50}_{i=x} L_{x,y}$, that is, the sum of childless women-years from age *x* to age 50.

Age- and cohort-specific expected number of years to be childless for women at ages 15–49—Refers to the average number of years a woman at age *i* in year *y* expects to remain childless.

$$e^0_{i,y},$$

where

e^0 = the average number of years expected to remain childless between ages *x* and 50,

i = the age of woman *x*,

and

y = year.

$$e^0_{i,y} = T^0_{i,y} / l^0_{i,y}$$

Cohort TFR—Refers to the average completed fertility of women in a given birth cohort at the end of their reproductive period.

$$TFR_y,$$

where

TFR = the average completed fertility of women in a cohort at age 50

and

$TFR_y = \Sigma^{8+}_{n=1} CumBR_{i,y}$ is the sum of cumulative birth rates from parity one to eight or higher.

Cumulative birth rates—Refers to the sum of central fertility rates from age 15 to the current age.

$$CumBR,$$

where

$$CumBR^n_{i+1,y+1} = CenBR^n_{i,y} + CumBR^n_{i,y}$$

i = age,

y = year,

and

n = parity.

To repeat, the TFR takes into account the cumulative fertility rates for *all* parities, not just the rate for a birth order one. (With the TFR, the emphasis is usually on rates for all ages.)

Indicators of Concentration

Lorenz curve—Is a graphical representation of various types of inequality, where the *x* axis represents the cumulative proportion of an independent variable such as time, population, etc., and the cumulative proportion on the *y* axis of a dependent variable, such as income or, for this report, first births. The curve is convex, and is graphed between 0.0 and 1.0. As an example, it could be said that a curve may show that 45 percent of the women in the population had 70 percent of its children.

Gini Concentration Ratio—The graph containing the Lorenz curve also holds a diagonal line at 45 degrees; that is, where $x = y$. This line is called the ''line of perfect equality.'' If the Lorenz curve lies precisely on the diagonal line, then all members of the horizontal axis have an equal distribution on the *y* axis. A perfectly unequal distribution would be one in which one person has the entire amount of the item measured and everyone else has none.

Theoretically, the Gini ratio (*G*) is a ratio of areas that lies between the line of perfect equality and the Lorenz curve to total area under the line of equality.

$$G = A/B,$$

where

A = the area between the line of perfect equality and the Lorenz curve

and

B = the area under the line of equality.

If the function is known, the ratio may be easily found with integration.

However, as when working with discrete points, the ratio can be approximated as follows:

$$G = 1 - \Sigma^n_{k=1} (X_k - X_{k-1}) \bullet (Y_k + Y_{k-1}),$$

where

X_k = horizontal point,

Y_k = vertical point,

and

k = sequence of each point.

Duncan Index of Concentration—Refers, geometrically, to the maximum vertical distance from the diagonal line of equality to the Lorenz curve.

Algebraically, the index is simply the sum of values of

$$|X_k - Y_k|.$$

As such, it is equivalent to the Index of Dissimilarity, which is the sum of the positive differences between the two percent distributions. The value of the concentration index depends upon the size of the set of geographic units used.

Δ = Duncan Index of Concentration

and

$$\Delta = \tfrac{1}{2}\Sigma^n_{k=1} |X_k - Y_k|,$$

where

X_k = horizontal point,

Y_k = vertical point,

and

k = sequence of each point.

The computation of the Duncan index provides the point where the concentration is greatest. It is calculated by subtracting the individual values between the line of equality from the Lorenz curve. Its largest value indicates the age at greatest concentration.

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