

Reproduction Rates for 1990–2002 and Intrinsic Rates for 2000–2001: United States

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Abstract

Objective—This report presents revised rates of reproduction for 1990–93, reproduction rates for 1994–2002, and intrinsic rates for 2000–2001. The revised rates for 1991–93 are based on populations consistent with the April 1, 2000, census, as are the rates for 1994–2002.

Methods—Tabular and graphic data on the reproduction and intrinsic rates by race and Hispanic origin of mother are presented and described.

Results—Rates of reproduction (total fertility, gross reproduction, and net reproduction rates), the intrinsic rate of natural increase, and the intrinsic birth rate were lower in 2001 (and 2002) than 1990. Among the race and Hispanic subgroups, the reproduction rates were lower for all groups except Cubans and whites (total). The overall intrinsic death rate increased between 1990 and 2001 with the rate declining for whites (total) but increasing for blacks (total).

Keywords: total fertility rate • gross reproduction rate • net reproduction rate • intrinsic rate of natural increase • intrinsic birth rate • intrinsic death rate

Introduction

This report provides information on fertility patterns critical to understanding population growth and change in the United States. The rates of reproduction and intrinsic rates are intended as useful adjuncts to the birth and fertility rates published by the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS). Whereas birth and fertility rates measure the fertility of women in a given year, the rates of reproduction summarize the fertility of women over a generation, that is, the total or average number of births expected for a group of women during their lifetime given particular fertility and mortality rates. This distinction can be better understood in terms of the annual increase in the number of people versus generational replacement of persons. A general fertility rate of 70.0, for example, means that a population accrued 70 people for every 1,000 women aged 15–44 years for a given year, whereas

a total fertility rate of 2,129.0 means that there will be enough children born, if conditions continue, to replace a group of 1,000 women and their partners. The intrinsic rates summarize the birth, death, and growth rates of a population, which would be expected to prevail given particular fertility and mortality rates. (Life expectancy at birth is based on the same idea.) The intrinsic rates reflect the growth, fertility, and mortality of a population apart from the effect of the age structure (and excluding migration). These rates are annual measures similar to the crude rate of natural increase, crude birth rate, and crude death rate (see "Intrinsic rates").

This report presents revised gross reproduction rates for 1991–93 and newly released rates for 1994–2002. This report also presents net reproduction and intrinsic rates for 2000–2001. Revised total fertility rates consistent with the report "Births: Final Data for 2002" are also included (1). All rates in this report are consistent with the April 1, 2000, census. Consequently, the revised gross reproduction rates for 1991–93 may differ from those previously published, which were based on populations projected from the 1990 census (2). The gross reproduction rates for 1994–2002 and the net reproduction and intrinsic rates for 2000–2001 are published for the first time in this report. The net reproduction and intrinsic rates are presented by race of mother. The gross reproduction rate is presented by race and Hispanic origin of mother, as is the total fertility rate. To place the rates in context, and to provide an overall indication of the trends over the past four decades, the reproduction and intrinsic rates are shown since 1960.

Acknowledgments

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Methods

The rates of reproduction and intrinsic rates shown in this report are computed from the revised total fertility and age-specific birth rates published in "Births: Final Data for 2002" (1). For formulas and method of computation, see "Technical Notes." The rates are based on 100 percent of the birth certificates registered in all States and the District of Columbia. More than 99 percent of births occurring in the United States are registered (3). The data are provided to NCHS through the Vital Statistics Cooperative Program (VSCP). The VSCP includes all States, the District of Columbia, and territories (Puerto Rico, Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Marianas). However, data for the territories are not included in this report.

Race and Hispanic origin are reported independently on the birth certificate. In tabulations of birth data by race and Hispanic origin of mother, data for Hispanic persons are not further classified by race because the majority of women of Hispanic origin report themselves as white. This report shows rates for the following categories: white total, non-Hispanic white, black total, non-Hispanic black, American Indian total, Asian or Pacific Islander (API) total, and Hispanic. Rates for American Indian and API populations are not shown separately by Hispanic origin.

The total fertility and age-specific birth rates for 1991–2002 were computed using populations produced under a cooperative agreement with the U.S. Census Bureau and are based on the 2000 census. The revised gross reproduction rates for 1991–93 therefore may differ from those published in volume I of *Vital Statistics of the United States*, 1993 (2).

Reflecting the new standards issued in 1997 by the Office of Management and Budget (OMB), the 2000 census included an option for individuals to report more than one race as appropriate for themselves and household members (4); see "Technical Notes." The 1997 OMB standards also provided for the separate reporting of Asians from Native Hawaiians or Other Pacific Islanders. Under the prior OMB standards (issued in 1977), data for Asian or Pacific Islander (API) were collected as a single group (5). Birth certificates currently collect only one race for the mother (and father) in the categories specified in the 1977 Directive (that is, the certificates do not report Asian separately from native Hawaiian or other Pacific Islander). Birth data by race are thus currently incompatible with the population data collected in the 2000 census. To produce fertility rates for 2000–2002, and revised intercensal rates for 1991–99, it was necessary to "bridge" the population data for persons who reported being members of more than one race (multiple-race persons) back to single-race categories. In addition the 2000 census counts were modified to be consistent with the 1977 OMB race categories, that is, to report the data for Asian and Native Hawaiian or Other Pacific Islander as a combined category: Asian or Pacific Islander (6). The procedures used to produce the "bridged" populations are described elsewhere (7,8).

Readers should keep in mind that the population data used to compile the reproduction and intrinsic rates by race and ethnicity shown in this report are based on special estimation procedures. These populations are not true counts. This is the case even for the 2000 populations that are based on the 2000 census. The estimation procedures used to develop these populations may contain some measurement errors. Smaller populations, for example, American Indians, are likely to be affected much more than larger populations by these

measurement errors (7). While the nature and magnitude of these errors are unknown, the potential for error should be kept in mind when evaluating trends and differentials.

The age-specific birth rates used to calculate the rates of reproduction, 1991–2002, and the intrinsic rates, 2000–2001, in this report, as well as the probability of survival, determined from the life tables for 2000 and 2001, also used to calculate the net reproduction and intrinsic rates, are based on intercensal and postcensal population estimates consistent with the 2000 census. Life tables for 1991–99 for the United States, consistent with the 2000 census, were not available at the time this report was prepared, and therefore revised and new net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates could not be calculated for 1991–99. The Internet release of this report will be updated to include the revised and new rates for these years when revised life tables become available.

Net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates for American Indian, API, and Hispanic origin subgroups cannot be computed because the necessary life tables are not available (9,10) (see "Technical Notes"). The life tables for these groups will not be produced with the revised life tables.

Text statements have been tested for statistical significance, and a statement that a given rate is higher or lower than another rate indicates that the rates are significantly different. Information on the method used to test for statistical significance is presented in the "Technical Notes."

Results and Discussion

Rates of reproduction

Total fertility rate—The total fertility rate (TFR) shows the potential impact of current fertility patterns on reproduction, that is, completed family size. The TFR indicates the average number of births to a hypothetical cohort of 1,000 women, if they experienced throughout their childbearing years the age-specific birth rates observed in a given year. The TFR is thus a rate of reproduction and is included in this report. (The revised total fertility rates have been published elsewhere (1).) Because it is based on age-specific birth rates, the TFR is not affected by changes over time in the age composition of a population and can be used to compare populations over time or between different groups.

The TFR fell 3 percent between 1990 and 2002, from 2,081 per 1,000 women to 2,013 (table 1 and figures 1 and 2). The rate fell steadily from 1990 to 1997 (1,971), accounting for most of the total decline (1). From 1997 to 2000, the rate increased moderately (4 percent), but has again declined since 2000. From 1990 to 2002, the TFR never exceeded the rate of "replacement" (2,100 per 1,000 women). The "replacement" rate is considered the value at which a given generation can exactly replace itself. The TFR has not exceeded "replacement" since 1971.

The TFR differed substantially by race and Hispanic origin. Rates for Hispanic women from 1990 to 2002 exceeded "replacement" for every year, whereas the rates for non-Hispanic white and API women were consistently below "replacement" during that time (table 2). For the remaining groups, the TFRs varied considerably. Nevertheless, while the TFRs for these groups were quite different, the TFR declined for most groups, except Cuban and white (total) women, between 1990 and 2002.

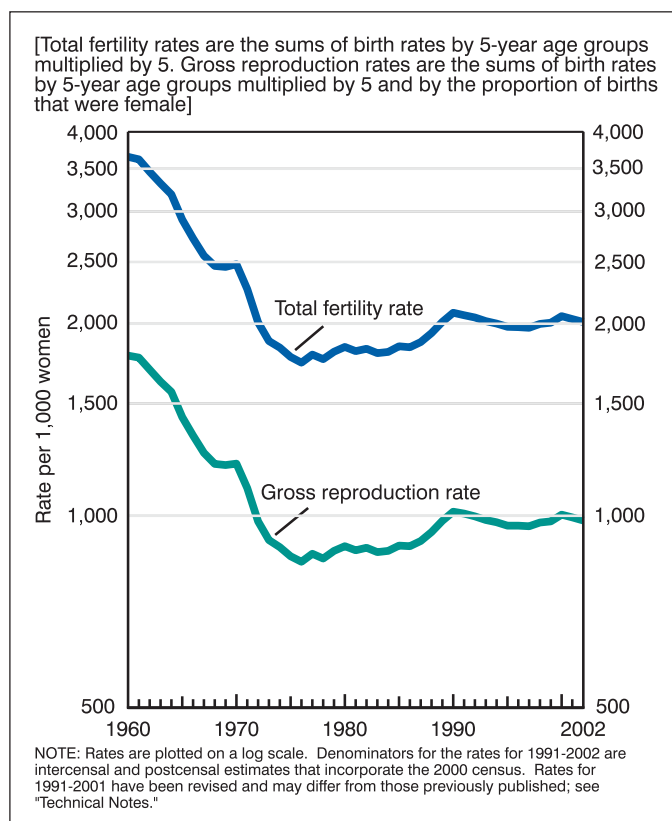


Figure 1. Total fertility rates and gross reproduction rates: United States, 1960–2002

Gross reproduction rate—Another important measure used to summarize reproduction is the gross reproduction rate (GRR). This rate represents the average number of daughters born to a hypothetical cohort of 1,000 women if they experienced the age-specific birth rates observed in a given year throughout their childbearing years, and if none of the cohort was to die during her childbearing years. The GRR is similar to the TFR except that it measures only female births, since reproduction is largely dependent on the number of females in a given population. Moreover, like the TFR, the GRR is age adjusted and thus rates can be compared over time or between different groups.

The **GRR** in 2002 was 983 female births per 1,000 women ([table 1](#)). The rate decreased 1 percent from 2001 (994) and 2 percent between 1990 (1,015) and 2001. Due to the narrow variability of the number of female births relative to male births, the GRR has closely paralleled the TFR: decreasing steadily from 1990 to 1997; increasing moderately from 1997 to 2000; and then decreasing steadily again to the present ([figures 1 and 2](#)).

The GRRs also varied considerably by race and Hispanic origin ([table 2](#)). In 2002 the rates ranged from 890 for non-Hispanic white women to 1,413 for Mexican women. Except for Cuban and white (total) women, the rates for 2002 were lower than in 1990. The largest declines were measured for non-Hispanic black and American Indian women (20 and 21 percent, respectively). Rates decreased 1 percent for non-Hispanic white women and increased 34 percent for Cuban women. The trend in the GRRs by race and Hispanic origin generally paralleled the TFRs with changes varying by group.

Net reproduction rate—The net reproduction rate (NRR or R_0) is closely related to the GRR. However, unlike the GRR, the NRR

incorporates the effects of mortality. The NRR represents the average number of daughters who would be born to a hypothetical cohort of 1,000 women, if they passed through their childbearing years conforming to the age-specific fertility and mortality rates of a given year. In contrast, the GRR assumes that all of the women in the cohort survive through their childbearing years.

The NRR for the United States in 2001 was 979 births per 1,000 women, a decrease of 1 percent from 2000 (989). From 1990 to 2000 the rate declined 1 percent, from 997 to 989 ([table 1 and figure 2](#)). Between 1960 and 1990, the NRR dropped 42 percent. It is worth noting that the difference between the GRR and the NRR has been diminishing since 1960. This reflects the decline in the age-specific mortality rates of women in their childbearing years.

As a measure of replacement, an NRR of 1,000 means that a cohort of 1,000 women is having enough daughters to exactly replace itself in the population. A rate of 2,000 means the women would double their numbers in the next generation, whereas a rate of 500 means their numbers would be reduced by half. The NRRs in 1990, 2000, and 2002 were below “replacement.” Since 1972 the rate has not exceeded 1,000. Before 1972, however, the NRR never fell below “replacement” (2).

For white (total) and black (total) women, the two race groups for which data are available, the NRRs were below “replacement” in 2001 ([table 2](#)). However, in 1990 and 2000, the rates for black women were above 1,000, whereas the rates for white women were below. Between 1990 and 2001, the rate for white women was up 2 percent; the rate for black women was down 17 percent. Data are not available for American Indian, API, and Hispanic women; see “[Technical Notes](#).”

Intrinsic rates

The **intrinsic rate of natural increase** (r) measures the rate of population growth that would eventually result from the continuance of the age-specific birth and mortality rates of a given year over a long period of time, assuming no migration. Because it is based on age-specific birth and mortality rates, the intrinsic rate of natural increase is not affected by changes over time in the age composition of a population. A rate that is less than zero (negative) signifies a population decline, whereas a rate greater than zero (positive) denotes population growth. The intrinsic rate of increase for the United States in 2001 was -0.8 ; the rate was -0.4 in 2000 and -0.1 in 1990 ([table 1 and figure 3](#)).

Among the two race groups for which data are available, the intrinsic rates of natural increase for whites (total) and blacks (total) have been markedly different. Whereas the rate for whites in 2001 is comparable to that of blacks, -0.6 per 1,000, the rates in 2000 and 1990 were negative for whites and positive for blacks ([table 2](#)). Compared with 1990, the rate for whites has been reduced by 60 percent, and the rate for blacks has dropped 109 percent. Thus, the rate has remained negative for whites, but the rate for blacks has shifted from increase to decrease.

The decline in the intrinsic rate of natural increase seen between 1990 and 2001 is consistent with recent trends. The rate was negative from 1972 to 1990, indicating population decrease, but, prior to 1972, the rate was positive, indicating population increase ([table 1](#)). The trend of the intrinsic rate of natural increase has closely paralleled that of the NRR since 1960. During the recent period of decrease, however, the rate has fluctuated considerably, decreasing by nearly 300 percent

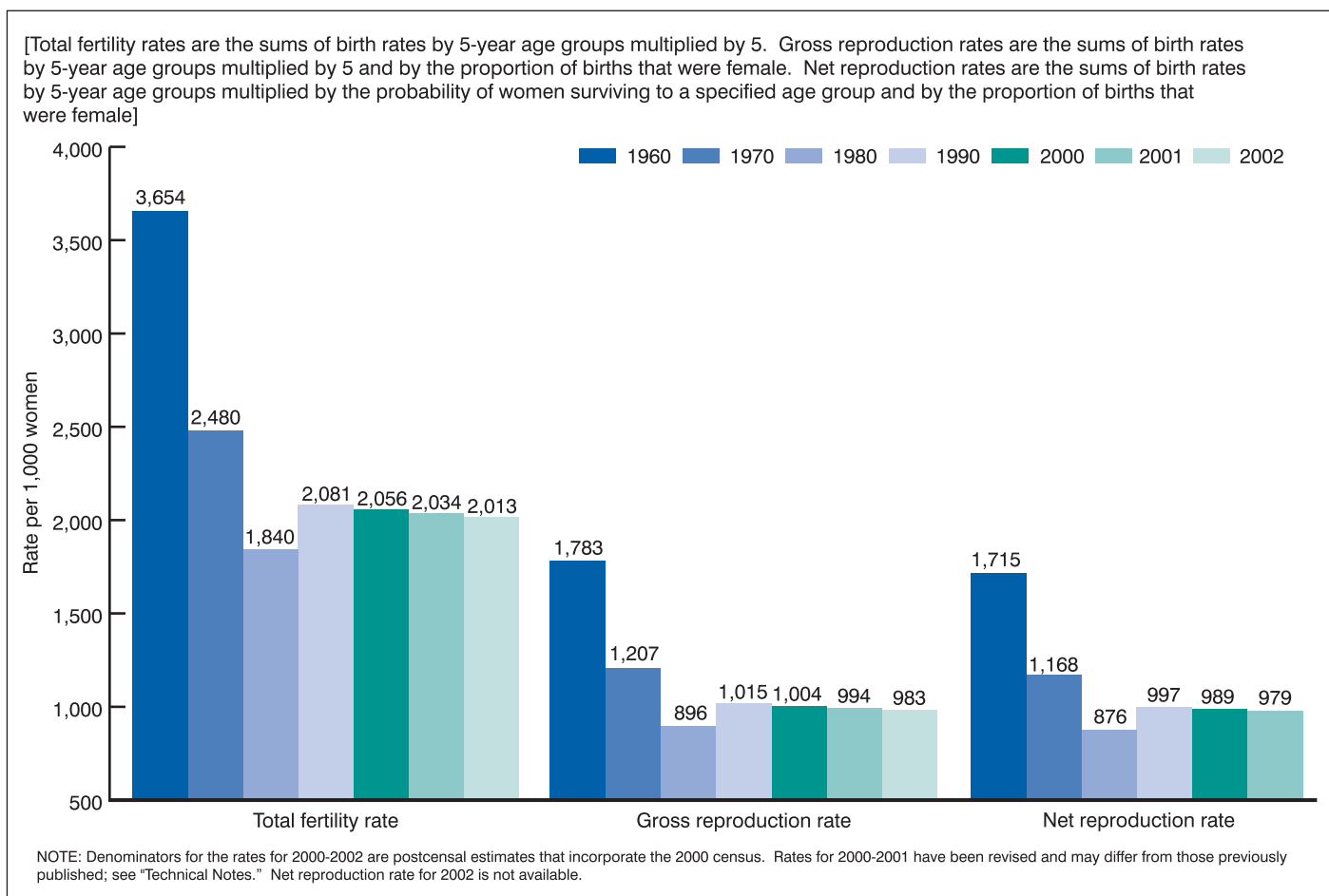


Figure 2. Total fertility rates, gross reproduction rates, and net reproduction rates: United States, 1960, 1970, 1980, 1990, and 2000–2002

between 1972 (–2.0 per 1,000) and 1976 (–7.4). After 1976 the rate of decrease lessened, from –7.4 in 1976 to –0.1 in 1990.

In addition to the influence of the rate of reproduction, the intrinsic rate of natural increase, as an annual rate, is also affected by delayed childbearing. Indeed, the rate is more affected by a delay in childbearing than a change in the reproduction rate. Therefore, when examining the downward trend in the intrinsic rate of natural increase, the increasing number of mothers having children at later ages must be considered (1). Because it is a rate of generational replacement, the NRR is less affected by delayed childbearing.

Most of the decline in the intrinsic rate of natural increase reflects the decline in the intrinsic birth rate. The intrinsic birth rate (b) is the birth rate of a stable population, that is, a hypothetical population that would eventually prevail if the age-specific birth and mortality rates of a given year continued over a long period of time, assuming no migration. This population is stable in terms of its unchanging age structure. The other component of the rate of increase is the intrinsic death rate. The intrinsic death rate (d) is the mortality rate of the stable population. Between 1990 and 2001 the intrinsic birth rate decreased 5 percent, whereas the intrinsic death rate increased nearly 1 percent (table 1). From 1960 to 2001, the intrinsic birth rate fell 54 percent, from 27.4 to 12.6, and the intrinsic death rate more than doubled, from 6.6 to 13.4, although the intrinsic birth rates were lower from 1973 to 1988, and the intrinsic death rates were higher from 1972 to 1989, than these rates in 2001.

The intrinsic birth rates were 12.6 and 13.6, respectively, for whites and blacks in 2001. Between 1990 and 2001, the rate increased by 2 percent for whites and decreased by 26 percent for blacks. However, the intrinsic death rate fell by 5 percent for whites during this period, whereas the rate for blacks increased by 22 percent. Thus, the increase in the intrinsic rate of natural increase for whites is due mostly to the drop in the intrinsic death rate, and the decrease for blacks is due mostly to the drop in the intrinsic birth rate.

It is important to note that the intrinsic death rate is not equivalent to the crude death rate. The difference lies in the age structure of the respective populations used to calculate the rates. The intrinsic death rate is based on a stable population, that is, a hypothetical population with an *unchanging* age structure (and no migration) over time. The crude death rate is based on a real population in which the age structure may change over time. This is also true of the intrinsic rate of natural increase and the intrinsic birth rate as compared with the crude rate of natural increase and the crude birth rate (11).

Conclusion

This report presented revised gross reproduction rates for 1991–93 and newly released gross reproduction rates for 1994–2002. Net reproduction and intrinsic rates for 2000–2001, calculated using recently released intercensal and postcensal population estimates

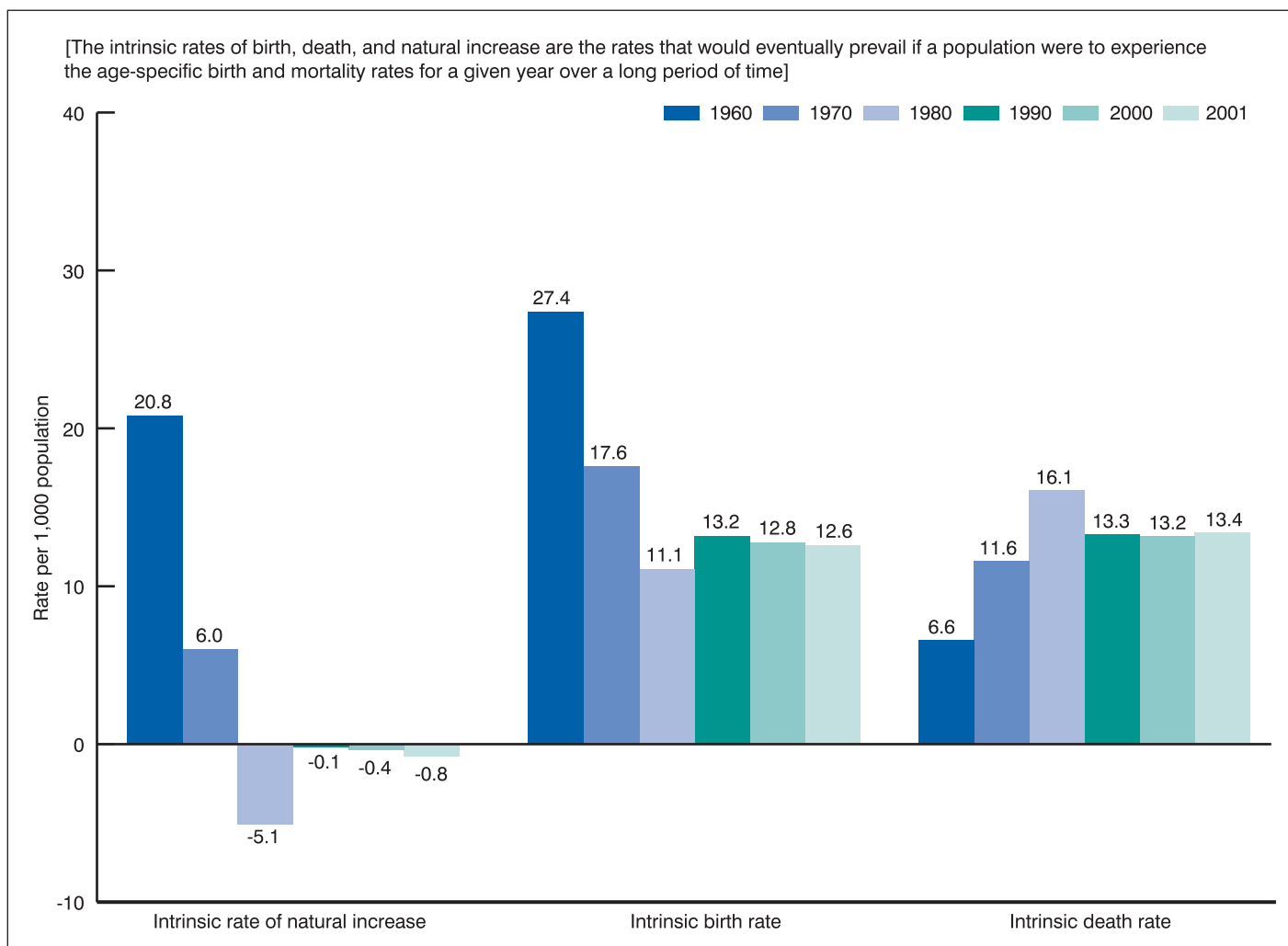


Figure 3. Intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates: United States, 1960, 1970, 1980, 1990, and 2000–2001

consistent with the April 1, 2000, census were also presented in this report for the first time. Revised total fertility rates consistent with “Births: Final Data for 2002” were included as well (1). The population estimates on which the revised and new rates were based were produced for the Centers for Disease Control and Prevention’s National Center for Health Statistics under a collaborative arrangement with the U.S. Census Bureau. The net reproduction and intrinsic rates in this report are presented by race. The gross reproduction rate is presented by race and Hispanic origin, as is the total fertility rate.

The rates of reproduction (total fertility, gross reproduction, and net reproduction rates) have declined since 1990, both overall and for most groups. Moreover, the overall net reproduction rates for 1990 (997 per 1,000 women), 2000 (989), and 2001 (979) were below “replacement” (that is, 1,000 births per 1,000 women). To put these two results in perspective, the rate of population decline has increased from three tenths of a percent in 1990 to 2 percent in 2001. This natural population decline resulted in a negative intrinsic rate of natural increase for those years, with a downward trend from 1990 to 2001. The intrinsic birth rate declined (5 percent) during this period, whereas the intrinsic death rate increased (1 percent). However, births and deaths are only two components of population change. This decline was compensated for by

the considerable net migration into the United States (an excess of over 1 million migrants each year from 2000 to 2002) and by the lagged effect on population growth of the relatively large number of women still in their childbearing years (6,12,13).

The revised gross reproduction rates from 1991 to 1993, based on the intercensal estimates, were lower than previously published rates that were based on postcensal population estimates projected from the 1990 census because the 1990-based populations were underestimated. For 1993 (the last year the 1990-based rates were reported), the revised rates were 1 percent lower than the original rates overall and for whites. This adjustment was expected due to the overestimate of the total fertility and age-specific birth rates based on the 1990 census (14). The revised net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates are likewise expected to be lower than those previously published between 1991 and 1993. When revised life tables for 1991 to 1999 become available, the Internet release of this report (tables 1 and 2) will be updated to include the revised and new rates for these years.

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List of Detailed Tables

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2. Total fertility rates and gross reproduction rates, 1990–2002, and net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates, 1990 and 2000–2001, by race and Hispanic origin of mother: United States 8

Table 1. Total fertility rates and gross reproduction rates, 1960–2002, and net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates, 1960–90 and 2000–2001: United States

[Rates per 1,000 population for specified group. Total fertility rates are the sums of birth rates by 5-year age groups multiplied by 5. Gross reproduction rates are the sums of births rates by 5-year age groups multiplied by the proportion of births that were female. Net reproduction rates are the sums of birth rates by 5-year age groups multiplied by the probability of women surviving to a specified age group (as determined from the life table for the year) and by the proportion of births that were female. The gross and net reproduction rates represent the average number of daughters that a hypothetical cohort of 1,000 women would bear if they experienced given sets of age-specific birth and mortality rates. The intrinsic rates of birth, death, and natural increase are the rates that would eventually prevail if a population were to experience the age-specific birth and mortality rates for a given year over a long period of time. For method of computation see "Technical Notes." Population enumerated as of April 1 for 1960, 1970, 1980, 1990, and 2000, and estimated as of July 1 for all other years]

Year	Total fertility rate	Gross reproduction rate	Net reproduction rate	Intrinsic rate of natural increase	Intrinsic birth rate	Intrinsic death rate
2002	2,013.0	983	---	---	---	---
2001	2,034.0	994	979	-0.8	12.6	13.4
2000	2,056.0	1,004	989	-0.4	12.8	13.2
1999	2,007.5	980	---	---	---	---
1998	1,999.0	976	---	---	---	---
1997	1,971.0	963	---	---	---	---
1996	1,976.0	965	---	---	---	---
1995	1,978.0	965	---	---	---	---
1994	2,001.5	977	---	---	---	---
1993	2,019.5	985	---	---	---	---
1992	2,046.0	998	---	---	---	---
1991	2,062.5	1,008	---	---	---	---
1990	2,081.0	1,015	997	-0.1	13.2	13.3
1989	2,014.0	982	964	-1.4	12.6	14.0
1988	1,934.0	943	925	-2.9	11.9	14.8
1987	1,872.0	913	896	-4.1	11.3	15.4
1986	1,837.5	896	879	-4.9	11.0	15.9
1985	1,844.0	898	881	-4.8	11.0	15.8
1984 ¹	1,806.5	881	864	-5.6	10.7	16.2
1983 ¹	1,799.0	877	859	-5.8	10.6	16.4
1982 ¹	1,827.5	891	873	-5.2	10.9	16.1
1981 ¹	1,812.0	883	864	-5.6	10.8	16.3
1980 ¹	1,839.5	896	876	-5.1	11.1	16.1
1979 ¹	1,808.0	881	861	-5.7	10.7	16.5
1978 ¹	1,760.0	857	837	-6.8	10.3	17.1
1977 ¹	1,789.5	872	851	-6.2	10.6	16.8
1976 ¹	1,738.0	847	825	-7.4	10.1	17.5
1975 ¹	1,774.0	864	841	-6.7	10.5	17.2
1974 ¹	1,835.0	893	869	-5.4	11.2	16.6
1973 ¹	1,879.0	916	889	-4.5	11.7	16.2
1972 ¹	2,010.0	980	950	-2.0	13.0	15.0
1971 ²	2,266.5	1,105	1,071	2.6	15.5	12.9
1970 ²	2,480.0	1,207	1,168	6.0	17.6	11.6
1969 ²	2,455.5	1,201	1,161	5.7	17.5	11.7
1968 ²	2,464.2	1,206	1,166	5.9	17.6	11.7
1967 ³	2,557.7	1,255	1,213	7.4	18.5	11.1
1966 ²	2,721.4	1,336	1,288	9.7	20.0	10.4
1965 ²	2,912.6	1,428	1,376	12.1	21.7	9.6
1964 ²	3,190.5	1,564	1,507	15.6	24.2	8.5
1963 ²	3,318.8	1,623	1,564	17.1	24.6	7.5
1962 ²	3,461.3	1,695	1,633	18.8	25.8	7.0
1961 ²	3,620.3	1,770	1,704	20.5	27.1	6.6
1960 ²	3,653.6	1,783	1,715	20.8	27.4	6.6

--- Data not available.

¹Based on 100 percent of births in selected States and on a 50-percent sample of births in all other States; see "Technical Notes."

²Based on a 50-percent sample of births; see "Technical Notes."

³Based on a 20- to 50-percent sample of births; see "Technical Notes."

NOTE: Some rates cannot be computed because the necessary revised life tables are not available; see "Technical Notes." Denominators for the rates for 1991–2002 are intercensal and postcensal estimates that incorporate the 2000 census. Rates for 1991–2001 have been revised and may differ from those previously published; see "Technical Notes."

Table 2. Total fertility rates and gross reproduction rates, 1990–2002, and net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates, 1990 and 2000–2001, by race and Hispanic origin of mother: United States

[Rates per 1,000 population for specified group. Total fertility rates are the sums of birth rates by 5-year age groups multiplied by 5. Gross reproduction rates are the sums of birth rates by 5-year age groups multiplied by 5 and by the proportion of births that were female. Net reproduction rates are the sums of birth rates by 5-year age groups multiplied by the probability of women surviving to a specified age group (as determined from the life table for the year) and by the proportion of births that were female. The gross and net reproduction rates represent the average number of daughters that a hypothetical cohort of 1,000 women would bear if they experienced given sets of age-specific birth and mortality rates. The intrinsic rates of birth, death, and natural increase are the rates that would eventually prevail if a population were to experience the age-specific birth and mortality rates for a given year over a long period of time. For method of computation see "Technical Notes." Population enumerated as of April 1 for 1990 and 2000, and estimated as of July 1 for all other years]

Year	All races ¹	White	Black	American Indian ²	Asian or Pacific Islander	Hispanic					Non-Hispanic		
						Total	Mexican	Puerto Rican	Cuban	Other Hispanic	Total ³	White	Black
Total fertility rate													
2002	2,013.0	2,027.5	1,991.0	1,735.0	1,819.5	2,718.0	2,879.5	1,947.5	1,940.5	2,610.5	1,877.0	1,828.5	2,047.0
2001	2,034.0	2,040.0	2,051.0	1,746.5	1,840.0	2,748.5	2,928.5	2,165.0	1,792.5	2,519.5	1,898.5	1,843.0	2,104.5
2000	2,056.0	2,051.0	2,129.0	1,772.5	1,892.0	2,730.0	2,906.5	2,178.5	1,528.0	2,563.5	1,931.5	1,866.0	2,178.5
1999	2,007.5	2,007.5	2,082.5	1,783.5	1,754.5	2,649.0	2,823.0	2,104.5	1,388.5	2,517.0	1,894.0	1,838.5	2,134.0
1998	1,999.0	1,991.0	2,111.5	1,851.0	1,731.5	2,652.5	2,878.0	2,043.5	1,402.5	2,448.5	1,887.5	1,825.0	2,164.0
1997	1,971.0	1,955.0	2,091.5	1,834.5	1,757.5	2,680.5	2,957.0	1,931.5	1,619.5	2,376.5	1,853.0	1,785.5	2,137.5
1996	1,976.0	1,960.5	2,088.5	1,855.0	1,787.0	2,772.0	3,052.0	1,965.0	1,617.0	2,516.5	1,852.0	1,781.0	2,140.0
1995	1,978.0	1,954.5	2,127.5	1,878.5	1,795.5	2,798.5	3,033.5	2,078.0	1,584.0	2,629.5	1,856.5	1,777.5	2,186.5
1994	2,001.5	1,957.5	2,258.5	1,950.0	1,834.0	2,839.0	3,024.0	2,341.5	1,587.0	2,693.0	1,883.5	1,782.5	2,314.5
1993	2,019.5	1,961.5	2,351.0	2,048.5	1,841.5	2,894.5	3,041.5	2,416.0	1,570.0	2,914.5	1,901.5	1,786.0	2,412.5
1992 ⁴	2,046.0	1,978.0	2,416.0	2,135.5	1,894.5	2,957.5	3,107.0	2,568.5	1,453.5	2,989.0	1,929.0	1,803.5	2,482.5
1991 ⁴	2,062.5	1,988.0	2,462.0	2,142.5	1,928.0	2,963.5	3,103.5	2,573.5	1,352.5	3,064.5	1,953.0	1,822.5	2,532.0
1990 ⁵	2,081.0	2,003.0	2,480.0	2,184.5	2,002.5	2,959.5	3,214.0	2,301.0	1,459.5	2,877.0	1,979.5	1,850.5	2,547.5
Gross reproduction rate													
2002	983	989	980	858	881	1,332	1,413	945	944	1,279	916	890	1,007
2001	994	996	1,009	863	890	1,349	1,438	1,055	882	1,236	927	899	1,036
2000	1,004	1,000	1,048	871	915	1,336	1,423	1,062	745	1,254	943	909	1,072
1999	980	979	1,025	879	850	1,298	1,384	1,036	681	1,229	924	895	1,050
1998	976	972	1,038	908	840	1,300	1,413	1,000	666	1,198	921	889	1,064
1997	963	954	1,030	901	848	1,314	1,451	943	793	1,164	904	870	1,052
1996	965	956	1,030	913	867	1,358	1,497	965	791	1,228	904	867	1,056
1995	965	953	1,048	921	868	1,371	1,487	1,011	772	1,290	905	865	1,077
1994	977	954	1,114	960	888	1,391	1,482	1,147	785	1,319	919	868	1,141
1993	985	955	1,159	1,006	891	1,416	1,489	1,176	761	1,427	927	868	1,190
1992 ⁴	998	964	1,187	1,050	917	1,449	1,523	1,249	699	1,468	940	877	1,220
1991 ⁴	1,008	970	1,212	1,063	934	1,454	1,521	1,275	653	1,504	954	889	1,247
1990 ⁵	1,015	976	1,222	1,080	970	1,449	1,574	1,126	703	1,407	965	900	1,255
Net reproduction rate													
2001	979	983	986	---	---	---	---	---	---	---	---	---	---
2000	989	987	1,023	---	---	---	---	---	---	---	---	---	---
1990	997	961	1,185	---	---	---	---	---	---	---	---	---	---
Intrinsic rate of natural increase													
2001	-0.8	-0.6	-0.6	---	---	---	---	---	---	---	---	---	---
2000	-0.4	-0.5	0.9	---	---	---	---	---	---	---	---	---	---
1990	-0.1	-1.5	6.9	---	---	---	---	---	---	---	---	---	---
Intrinsic birth rate													
2001	12.6	12.6	13.6	---	---	---	---	---	---	---	---	---	---
2000	12.8	12.7	14.4	---	---	---	---	---	---	---	---	---	---
1990	13.2	12.4	18.5	---	---	---	---	---	---	---	---	---	---
Intrinsic death rate													
2001	13.4	13.2	14.2	---	---	---	---	---	---	---	---	---	---
2000	13.2	13.2	13.5	---	---	---	---	---	---	---	---	---	---
1990	13.3	13.9	11.6	---	---	---	---	---	---	---	---	---	---

--- Data not available.

¹For 1990–1991 includes births to races not shown separately.

²Includes birth to Aleuts and Eskimos.

³Includes races other than white and black.

⁴Excludes data for New Hampshire, which did not report Hispanic origin.

⁵Excludes data for New Hampshire and Oklahoma, which did not report Hispanic origin.

NOTES: Race and Hispanic origin are reported separately on birth certificates. Race categories are consistent with the 1977 Office of Management and Budget Directive; see "Technical Notes." Data for persons of Hispanic origin are included in the data for each race group according to the mother's reported race. Some rates cannot be computed for American Indian, Asian or Pacific Islander, and Hispanic because the necessary life tables are not available; see "Technical Notes." Denominators for the rates for 1991–2002 are intercensal and postcensal estimates that incorporate the 2000 census. Rates for 1991–2001 have been revised and may differ from those previously published; see "Technical Notes."

Technical Notes

Source of data

The natality data presented in this report are based on information reported on birth certificates filed for all births in the United States. Data are provided to the National Center for Health Statistics (NCHS) through the Vital Statistics Cooperative Program (VSCP). In 1984 and earlier years, the VSCP included varying numbers of States that provided data based on 100 percent of their birth certificates. Data for States not in the VSCP were based on a 50-percent sample of birth certificates filed in those States. During the processing of the 1967 data, the sampling rate was reduced from 50 percent to 20 percent. For details of this procedure and its consequences for the 1967 data see volume I of *Vital Statistics of the United States, 1967* (15). Detailed information on data collected from the birth certificate file is presented in the natality “Technical Appendix” (3,16).

The mortality data for the life tables used in this report are based on information from all death certificates filed in the United States, coded by the States and provided to NCHS through the VSCP, and from copies of original certificates received by NCHS from State registration offices (17).

Race and Hispanic origin

Race and Hispanic origin are reported separately on the birth certificate. Beginning with the 1989 data year, NCHS started tabulating birth data primarily by race of the mother. In 1988 and prior years, births were tabulated by race of the child, which was determined from the race of the parents as entered on the birth certificate.

Trend data by race shown in this report are by race of mother for all years. The text discussions of data by race are based on tabulations by race of mother. Factors influencing the decision to tabulate births by race of the mother are presented in detail elsewhere (18). These include the 1989 revision of the birth certificate, which includes many more health questions that are directly associated with the mother. In these instances, it is more appropriate to tabulate births by the mother’s race. A second factor has been the increasing incidence of interracial parentage. Since 1980, births to parents of different races have more than doubled, from 1.9 in 1980 to 5.4 in 2002. A third factor influencing the decision to tabulate births by race of mother is the large proportion of births with race of father not reported (14 percent in 2002). Although this proportion declined slightly in the 1990s, it is still higher than in 1980, 11 percent. The high proportion of records with father’s race not reported reflects the increase in the proportion of births to unmarried women; in many such cases, no information is reported on the father. These births are assigned the race of the mother. Tabulating all births by race of mother, therefore, provides for a more uniform approach, rather than a necessarily arbitrary combination of parental races.

Race of mother is reported by all registration areas in eight categories: White, Black, American Indian, Chinese, Japanese, Hawaiian, Filipino, and “other” Asian or Pacific Islander (API). In addition, 11 States (California, Hawaii, Illinois, Minnesota, Missouri, New Jersey, New York, Texas, Virginia, Washington, and West Virginia) report data on API subgroups included in the “other” API category (Vietnamese, Asian Indian, Korean, Samoan, Guamanian, and remaining API).

In cases where race of mother was not reported, the race of the father was assigned, if known. When information was not available for either parent, the race of the mother was imputed according to the specific race of the mother on the preceding record with a known race of mother.

Hispanic origin and race are reported independently on the birth certificate, as noted previously. Data for Hispanic subgroups are shown in most cases for four groups: Mexican, Puerto Rican, Cuban, and other Hispanic (which includes Central and South American with other and unknown Hispanic). In tabulations of birth data by race only, data for persons of Hispanic origin are included in the data for each race group according to the mother’s reported race. In tabulations of birth data by race and Hispanic origin, data for persons of Hispanic origin are not further classified by race because the vast majority of births to Hispanic women are reported as white. In these tabulations, data for non-Hispanic persons are classified according to the race of the mother, because there are substantial differences in fertility and reproduction between Hispanic and non-Hispanic white women.

Items asking for the Hispanic origin of the mother have been included on the birth certificates of all States and the District of Columbia since 1993 (19). In 1991 and 1992, New Hampshire did not ask for information on Hispanic origin and in 1990, neither New Hampshire nor Oklahoma collected this information.

Computation of rates

In computing total fertility and gross reproduction rates for the Hispanic populations, births with origin of mother not stated are included with non-Hispanic births rather than being distributed. Thus, rates for the U.S. Hispanic population are underestimates of the true rates to the extent that the births with origin of mother not stated were actually to Hispanic mothers. In computing the rates, the census-based populations with origin not stated are imputed. The effect on the rates is believed to be small.

The age-specific birth rates used to calculate the rates of reproduction, 1991–2002, and the intrinsic rates, 2000–2001, in this report, as well as the probability of survival, determined from the life tables for the year, used to calculate the net reproduction and intrinsic rates, are based on intercensal and postcensal population estimates consistent with the 2000 census (1,9,10). (The revised number of life table person-years lived for women and men, ${}_5L_i^F$ and ${}_5L_i^M$, for 2000, based on the 2000 census, are unpublished.) At the time the report was prepared, life tables for 1991–99 for the United States based on the 2000 census were not available, because revised intercensal populations, consistent with the 2000 census, were not yet available by single year of age from 85 to 100 years and over. Therefore, net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates could not be computed for those years. The Internet release of this report will be updated to include the rates for those years when the life tables become available.

Between the 1990 and 2000 data years, U.S. life table methodology was revised (10,17). Prior to the final data reported for 1997, life tables were abridged and constructed by reference to a standard table. In addition, the age range for the earlier life tables was limited to 5-year age groups ending with the group 85 years and over. Beginning with the 1997 data year, the revised life table methodology was used to construct complete life tables by single year of age that extend to age 100 years, using methodology similar to that used to construct the

decennial life tables. The advantages of the new over the previous methodology include its comparability with decennial life table methodology, greater accuracy, and greater age detail.

Due to a change in the age detail of the populations received from the U.S. Census Bureau, the life tables for 2000 and 2001 were constructed using a slightly modified version of the revised life table methodology. Populations for 2000 and 2001 were provided by single year of age to age 84 years, followed by the age group, 85 years and over. As a result, it was necessary to estimate the probability of dying for each year of age from age 85 to 100 years and over. The procedures for estimating the probability of dying by single year of age for ages 85 to 100 years and over are described in detail elsewhere (10,17).

In addition, the life table data used to compute the net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates for 2000 and 2001 in this report are based on abridged life tables, derived from the complete life tables, summarized in 5-year age groups extending to 100 years of age and over (9,10). This was done to maintain, as much as possible, consistency in the computation of the rates over time. As mentioned above, the rates for 1990 and earlier years also used abridged life tables. The effect of these changes on the comparability of rates over time is believed to be negligible.

Net reproduction rates, intrinsic rates of natural increase, intrinsic birth rates, and intrinsic death rates for American Indian, API, and Hispanic origin subgroups cannot be computed because the necessary life tables are not available (9,10,17). The life tables for these groups will not be produced with the revised life tables.

Computation of reproduction rates

The *total fertility rate* (TFR) is defined as the sum of the age-specific birth rates of women in their childbearing years (11). It is expressed as:

$$TFR = 5 \cdot \sum_{i=10-14}^{45-49} R_i = 5 \cdot \sum_{i=10-14}^{45-49} \frac{B_i}{P_i} \cdot 1,000$$

Where

- R_i = age-specific birth rate of women aged 10–49 years by 5-year age group (per 1,000)
- B_i = number of births to women aged 10–49 years by 5-year age group
- P_i = population of women aged 10–49 years by 5-year age group

In computing the total fertility rate the age-specific birth rates by 5-year age groups of women (10–49 years) are summed and multiplied by 5.

The *gross reproduction rate* (GRR) is defined as the sum of the age-specific birth rates of female infants per 1,000 women in their childbearing years (11). Adapting the TFR formula, the GRR is expressed as:

$$GRR = \frac{B^F}{B^T} \cdot TFR = \frac{B^F}{B^T} \cdot 5 \cdot \sum_{i=10-14}^{45-49} R_i = \frac{B^F}{B^T} \cdot 5 \cdot \sum_{i=10-14}^{45-49} \frac{B_i}{P_i} \cdot 1,000$$

Where

- B^F = female births
- B^T = total births

- R_i = age-specific birth rate of women aged 10–49 years by 5-year age group (per 1,000)
- B_i = number of births to women aged 10–49 years by 5-year age group
- P_i = population of women aged 10–49 years by 5-year age group

In computing the gross reproduction rate the age-specific birth rates by 5-year age groups of women are summed, multiplied by 5, and the product (i.e., the total fertility rate) multiplied by the proportion of births that are female.

The *net reproduction rate* (NRR) represents the average number of daughters who would be born to 1,000 women, if throughout their lifetime, from birth to completion of their childbearing, they conformed to the age-specific birth and mortality rates for a given year (11).

$$NRR = \frac{B^F}{B^T} \cdot \sum_{i=10-14}^{45-49} R_i \cdot \frac{{}_5L_i^F}{I_0^F} = \frac{B^F}{B^T} \cdot \sum_{i=10-14}^{45-49} \frac{B_i}{P_i} \cdot \frac{{}_5L_i^F}{I_0^F} \cdot 1,000$$

Where

- B^F = female births
- B^T = total births
- R_i = age-specific birth rate of women aged 10–49 years by 5-year age group (per 1,000)
- ${}_5L_i^F$ = the number of life table person-years lived by females for each 5-year age group
- I_0^F = number of females in the life table “cohort” living at the beginning of the 0–4 years age group, equal to 100,000
- B_i = number of births to women aged 10–49 years by 5-year age group
- P_i = population of women aged 10–49 years by 5-year age group

The NRR is derived by multiplying the age-specific birth rates by 5-year age groups of women by the probability of women surviving to that age group (${}_5L_i^F / I_0^F$), as determined from the life table for that year. The sum of these products is then multiplied by the proportion of all births that are female.

For the reproduction rates, the 5-year age groups of women used were 10–14 years to 45–49 years; births to women aged 50 years and over were attributed to women aged 45–49 years.

Computation of intrinsic rates

The mathematical derivation of the intrinsic rates and techniques of calculation are based on the discussion of Dublin and Lotka (11,20,21).

The intrinsic rates are calculated based on a stable population. A stable population is a hypothetical population that would eventually result from the continuance of the age-specific fertility and mortality rates of a given year over a long period of time, assuming no migration.

The intrinsic rate of natural increase, the rate of growth of a stable population, can be expressed as

$$r = \frac{\frac{R_1}{R_0} - \sqrt{\left(\frac{R_1}{R_0}\right)^2 - 2\left[\frac{R_2}{R_0} - \left(\frac{R_1}{R_0}\right)^2\right] \log_e R_0}}{\frac{R_2}{R_0} - \left(\frac{R_1}{R_0}\right)^2}$$

Where

R_0 = zero moment or net reproduction rate per woman
 R_1 = first moment

$$R_1 = \frac{B^F}{B^T} \cdot \sum_{i=10-14}^{45-49} \frac{B_i}{P_i} \cdot \frac{{}_5L_i^F}{I_0^F} \cdot (i + 2.5)$$

R_2 = second moment

$$R_2 = \frac{B^F}{B^T} \cdot \sum_{i=10-14}^{45-49} \frac{B_i}{P_i} \cdot \frac{{}_5L_i^F}{I_0^F} \cdot (i + 2.5)^2$$

$i + 2.5$ = midpoint (central age) of the 5-year age intervals, that is, 12.5, 17.5, 22.5, 27.5, 32.5, 37.5, 42.5, and 47.5

The values for R_0 , R_1 , and R_2 are computed as follows. R_0 is the net reproductive rate (NRR) per woman. R_1 is derived by multiplying the products of the age-specific birth rates per woman and the probability of a woman surviving to an age group, computed for the net reproductive rate, by the midpoint (central age) of the 5-year age group, summing the products for the range of ages (10–49 years) and multiplying by the proportion of female births. R_2 is derived by multiplying the product of the age-specific birth rates per woman, probability of a woman surviving to the specific age group, and midpoint (central age) of the age-specific group, computed for R_1 , by the midpoint of the specific age group again, summing the products for the range of ages (10–49 years), and multiplying by the proportion of female births.

The intrinsic birth rate is obtained as follows:

$$b = \frac{1 + \frac{B^M}{B^F}}{\left(\sum_{i=0-4}^{100+} e^{-r(i+2.5)} \cdot \frac{{}_5L_i^F}{I_0^F} \right) + \left(\sum_{i=0-4}^{100+} e^{-r(i+2.5)} \cdot \frac{{}_5L_i^M}{I_0^M} \cdot \frac{B^M}{B^F} \right)}$$

Where

B^M = male births
 B^F = female births
 e = base of the natural logarithm (2.718281828459045)
 r = intrinsic rate of natural increase per person
 $i + 2.5$ = midpoint (central age) of the 5-year age intervals, that is, 2.5, 7.5, 12.5, 17.5, 22.5, 27.5, 32.5, 37.5, and so on
 ${}_5L_i^F$ = the number of life table person-years lived by females for each 5-year age group
 ${}_5L_i^M$ = the number of life table person-years lived by males for each 5-year age group
 I_0^F = number of females in the life table “cohort” living at the beginning of the 0–4 years age group, equal to 100,000
 I_0^M = number of males in the life table “cohort” living at the beginning of the 0–4 years age group, equal to 100,000

The intrinsic birth rate, the birth rate of a stable population, is calculated by raising e , the base of the natural log, to the negative exponent (or, power) of the intrinsic rate of natural increase multiplied

by the midpoint of the age interval. The value $e^{-r(i+2.5)}$ is then multiplied by the probability of a woman surviving to that age interval (${}_5L_i^F/I_0^F$), as determined from the life table for the year, and summed for all of the age intervals. The reciprocal of the sum, female births per person, is the intrinsic birth rate for women. In order to compute the intrinsic birth rate for men and women, male births per person must be computed also. The value $e^{-r(i+2.5)}$ is multiplied by the product of the probability of a man surviving to the age interval (${}_5L_i^M/I_0^M$), as determined from the life table for the year, and the sex ratio at birth, and summed for all of the age intervals. With this last step, the product of 1 plus the sex ratio is divided by the product of female births per head plus male births per head.

Finally, the intrinsic death rate, the death rate of a stable population, is derived by subtracting the intrinsic birth rate from intrinsic rate of natural increase, or

$$d = r - b$$

Where

d = intrinsic death rate
 r = intrinsic rate of natural increase
 b = intrinsic birth rate

Significance testing

Data presented in this report are not subject to sampling error. However, data, even based on complete counts, may be affected by random variation. That is, the number of events that *actually* occurred may be considered one outcome in a large series of possible results that *could have* occurred under the same circumstances. When the number of births is used for analytic purposes and considered in this way, the comparison of rates over time or between groups can be tested, according to certain statistical assumptions.

Random variability in the denominators of the rates (the population estimates) is not considered in the calculation of standard errors because its contribution to the overall variability of the rates is negligible compared with the variability in the numerators.

The difference between the two rates, irrespective of sign (+/-), is considered statistically significant if it exceeds the statistic in the formula below. This statistic equals 1.96 times the standard error for difference between two rates.

$$1.96 \cdot \sqrt{\frac{R_1^2}{N_1} + \frac{R_2^2}{N_2}}$$

Where:

R_1 = first rate
 R_2 = second rate
 N_1 = first number of births
 N_2 = second number of births

If the difference is **greater** than this statistic, then the difference would occur by chance less than 5 times out of 100. If the difference is **less than or equal** to this statistic, the difference might occur by chance more than 5 times out of 100. We say that the difference is not statistically significant at the 95-percent confidence level.

Example

Is the total fertility rate for Hispanic women in 2002 (2,718.0 per 1,000) significantly lower than the rate in 2000 (2,730.0)? The

difference between the rates is $2,718.0 - 2,730.0 = (-)12.0$. The statistic is then calculated as follows:

$$1.96 \cdot \sqrt{\frac{2,718.0^2}{876,642} + \frac{2,730.0^2}{815,868}}$$
$$1.96 \cdot \sqrt{(7,387,524 / 876,642) + (7,452,900 / 815,686)}$$
$$1.96 \cdot \sqrt{8.43 + 9.13}$$
$$1.96 \cdot \sqrt{17.56}$$
$$1.96 \cdot 4.19$$
$$8.21$$

The difference between the rates (12.0) is greater than this statistic (8.21). Therefore, the difference is statistically significant at the 95-percent confidence level.

Information on testing differences between rates for Hispanic subgroups is presented elsewhere (3).

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