

## Trend Analysis of the Sex Ratio at Birth in the United States

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### Abstract

**Objectives**—This report presents total sex ratios at birth from 1940 to 2002, for race starting in 1970, for Hispanic origin groups starting in 1989, for live birth order starting in 1943, and for age of mother for the full time period.

**Methods**—Descriptive tabulations of sex ratios using the birth data set are presented and interpreted. Joinpoint regression analysis is used to detect changes in the sex ratio over time.

**Results**—The United States sex ratio at birth had three significant transitions from 1940 to 2002 (1942, 1959, and 1971). White women were the only race group to have any significant changes in the sex ratio between 1970 and 2002 (1972, 1976, and 1988). Between 1940

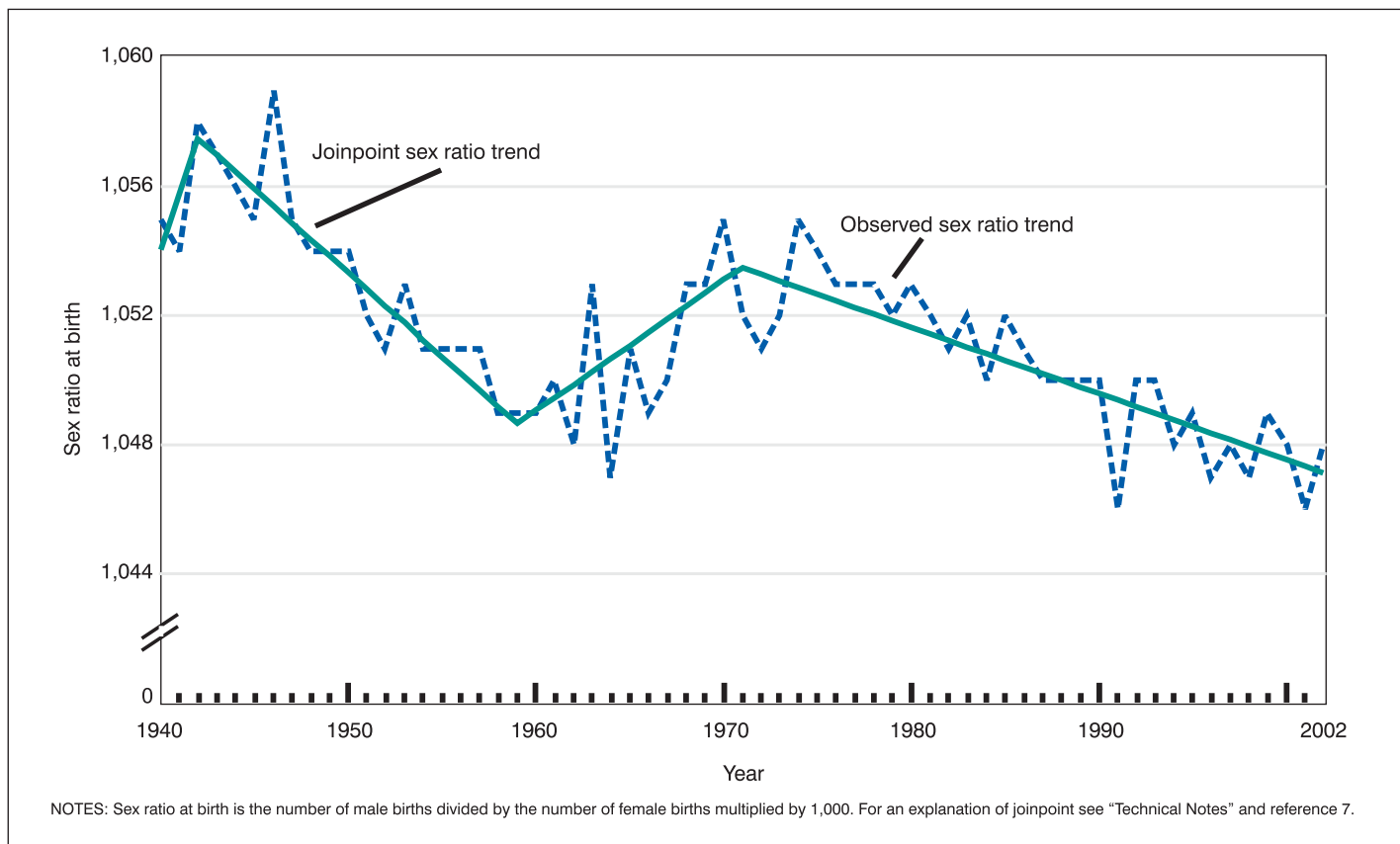


Figure 1. Sex ratio at birth and joinpoint segments, 1940–2002

and 2002 significant transitions in sex ratios occurred to women aged 20–24 (1942, 1966, 1974, and 1987); 25–29 (1961 and 1968); 35–39 (1965 and 1976); and 40–44 years (1967).

**Keywords:** sex ratio • births

## Introduction

The sex ratio at birth is an important demographic indicator that was initially studied in the late 17th century (1,2). The sex composition of a population is determined, in part, by the number of male births relative to the number of female births. The sex ratio at birth also affects critical demographic measures. For example, the “doubling-time” of a population (the number of years required for the population to double its size given a rate of population growth) rises as the ratio of males to females at birth increases (3,4). Moreover, data about the sex ratio at birth is necessary to understanding trends in infant morbidity, such as low birthweight and mortality, since male infants are more susceptible to illness and have higher infant mortality rates, including rates of Sudden Infant Death syndrome, than females (5–7). The ratio of males to females at birth has been used to assess the impact of environmental factors on the endocrine system and reproductive health of humans (8–14). In addition, the President’s Council on Bioethics has discussed “sex control” and used sex ratio data of the United States to assist with their understanding of this apparent practice (15,16). And finally, there is the question asked of all new parents, “Is it a girl or is it a boy?”

This report presents the sex ratio at birth for the United States for the past 60 years, a substantial expansion of previously published time trends (17,18). These data provide important information on the overall trends in the sex ratio at birth and a variety of characteristics including age of mother, birth order, and race and Hispanic origin of mother. The purpose of this report is twofold: to provide baseline data on the sex ratio at birth, which are necessary for understanding changes in the health and population composition of this country, and to provide an overall indication of the trends in the sex ratio at birth.

Data shown in this report are based on birth certificates registered in all States and the District of Columbia (tables 1–5, and figures 1–7). Race and Hispanic origin are reported independently on the birth certificate. Data for American Indian and specified Asian or Pacific Islander (API) births are not shown separately by Hispanic origin because the vast majority of these populations are non-Hispanic.

The objectives of this report are to present sex ratios at birth for the United States from 1940 to 2002 and to analyze the trend. Trends for selected populations defined by age of mother from 1940, live birth order starting in 1943, race of mother starting in 1970, and Hispanic origin of mother starting in 1989 are also provided. Joinpoint regression analysis is used to detect significant changes in the trends.

### Trends in the sex ratio since 1940

The sex ratio of the United States generally declined between 1942 and 1959, increased between 1959 and 1971, and declined from 1971 to 2002 (tables 1, 5, and figure 1) (see section on “Trend Analysis”). The highest sex ratio occurred in 1946 (1,059 male births per 1,000 female births) and the lowest in 1991 and 2001 (1,046). The annual number of male births that exceeded the number of

female births during this time period ranged from 62,969 in 1940 to 105,244 in 1963. The total number of “excess” males born in the United States since 1940 is 5,776,130 (the annual mean is 91,685). The number in 2002, 94,232, is slightly higher than the mean and of course the “excess” number of males is not only dependent on the sex ratio but also the total number of births each year.

### Age of mother

The trends and total sex ratio by age of mother for the years 1940 to 2002 are shown in table 2. For all years combined, the two oldest age groups, 40–44 years and 45 years and over, have the lowest total sex ratios, 1,038 and 1,039, respectively. A reduced sex ratio at birth has been linked to older age at childbearing (19–21).

Mothers under age 15 years and 45 years and over are the only age groups to have had sex ratios less than 1,000 (more female live births than male) and greater than 1,100 in some years (figure 2). The youngest and oldest mothers have the lowest numbers of births and a large annual variation (that is, range) in sex ratio is expected (22,23).

### Ratios by live-birth order

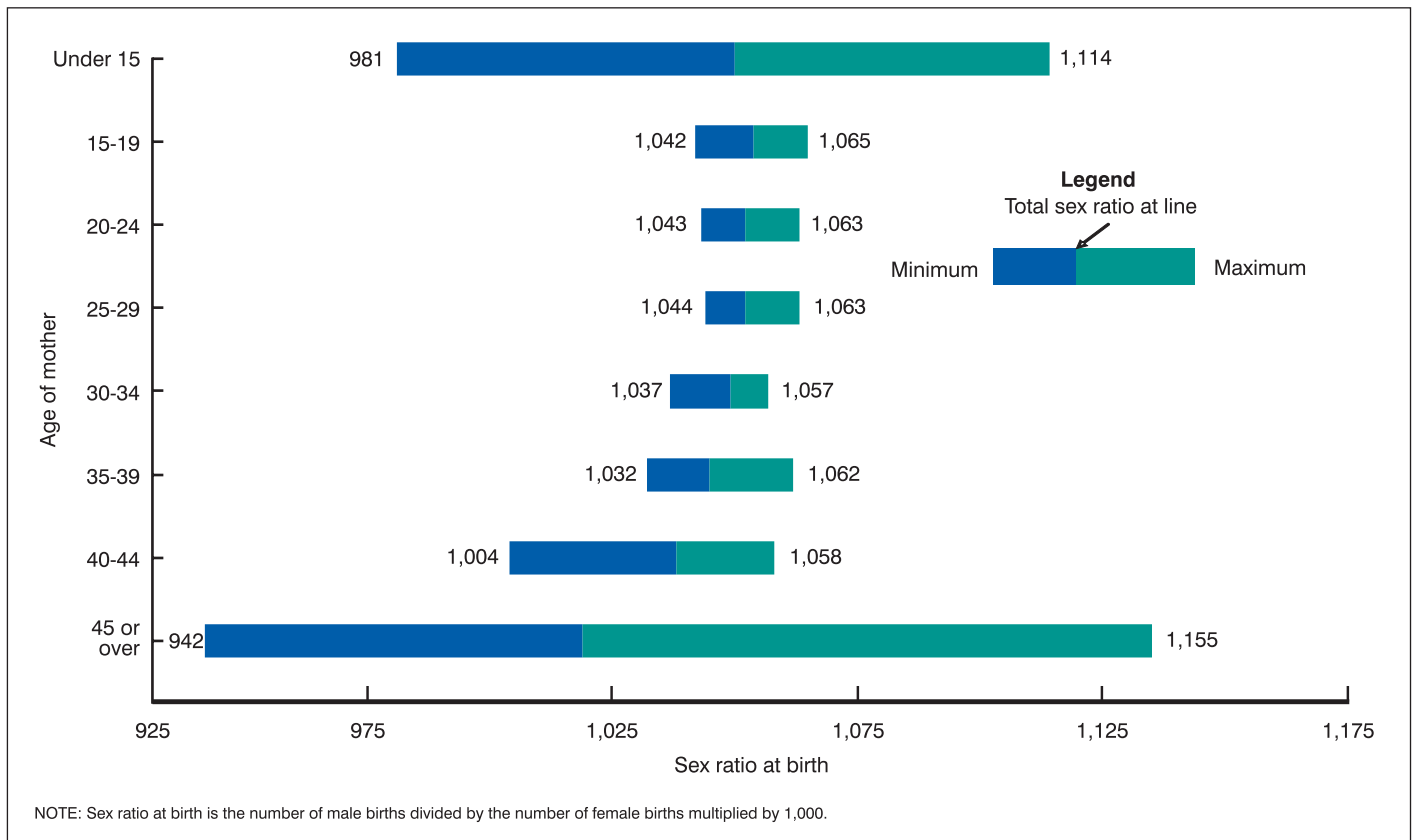
Table 3 shows trends and total sex ratio by live-birth order for the years 1943 to 2002. Seventh and eighth and higher order births have the lowest total sex ratio for all years combined (both 1,031). Research has found that the sex ratio decreases with birth order (19–21,24). The decline in sex ratio for higher birth orders is consistent with a reduced sex ratio for older women. The sex ratio for seventh-order births is the only birth order with a ratio for a single year below 1,000 (figure 3). The number of seventh-order births is the smallest of all live-birth orders observed here and thus the year-to-year variation in the sex ratio is expected to be larger (23).

### Sex ratio by race and Hispanic origin of mother

Trends in sex ratios are shown by race and ethnicity from 1970 to 2002 in table 4. Puerto Rican, Cuban, Central and South American, and Mexican ratios are presented from 1980 to 2002 and those for non-Hispanic whites and non-Hispanic blacks are from 1989 to 2002. The range and total ratio for all years in the sex ratio at birth for each of these populations are shown in figure 4. Filipino mothers had the highest sex ratio in any single year (1,128 in 1974) and Japanese mothers had the lowest (985 in 1972). The highest total sex ratio for all years combined was for Chinese (1,074) and Filipino mothers (1,072). The lowest sex ratio for all years combined were observed for black (1,030) and American Indian mothers (1,031).

### Trend analysis

The U.S. sex ratio at birth has varied between 1,046 to 1,059 for over 60 years. There have been considerable swings in the trend within this range. In the past 60 years the sex ratio has risen and fallen repeatedly (figure 1), such that short-term comparisons provide little useful information about long-term trends and changes in the sex ratio. In order to detect these changes (both number and timing) as well as the trends, the sex ratio at birth was analyzed by joinpoint analysis (JPA) software (25). The results are described in this section of the report.



**Figure 2. Minimum, maximum, and total sex ratio reported by age of mother for 1940 to 2002**

The segmented regression lines in figures 1, 5, 6, and 7 (with detailed data in table 5) indicate where statistically significant changes occur in the long-term trend of the sex ratio. Each line segment was estimated using JPA. JPA provides a useful means for monitoring long-term changes or trends in data.

Developed by the National Cancer Institute, the JPA software takes trend data and fits the smallest number of change-points supported by the data, that is, where significant shifts of the annual percent change (APC) are observed (25,26). These are called “joinpoints.” Each joinpoint denotes a statistically significant change in the trend. Other applications of JPA analyses include cancer trends and more recently patterns in the alcohol consumption of youth (26–30).

The joinpoint regression program begins with a minimum number of joinpoints, that is, 0 (which is a straight line with constant change over time) and a maximum number of joinpoints, that is, 4, the maximum number allowed by the program. Thus the range of possible outcomes is 0 to 4 joinpoints. For a more detailed explanation of JPA see “Technical Notes.”

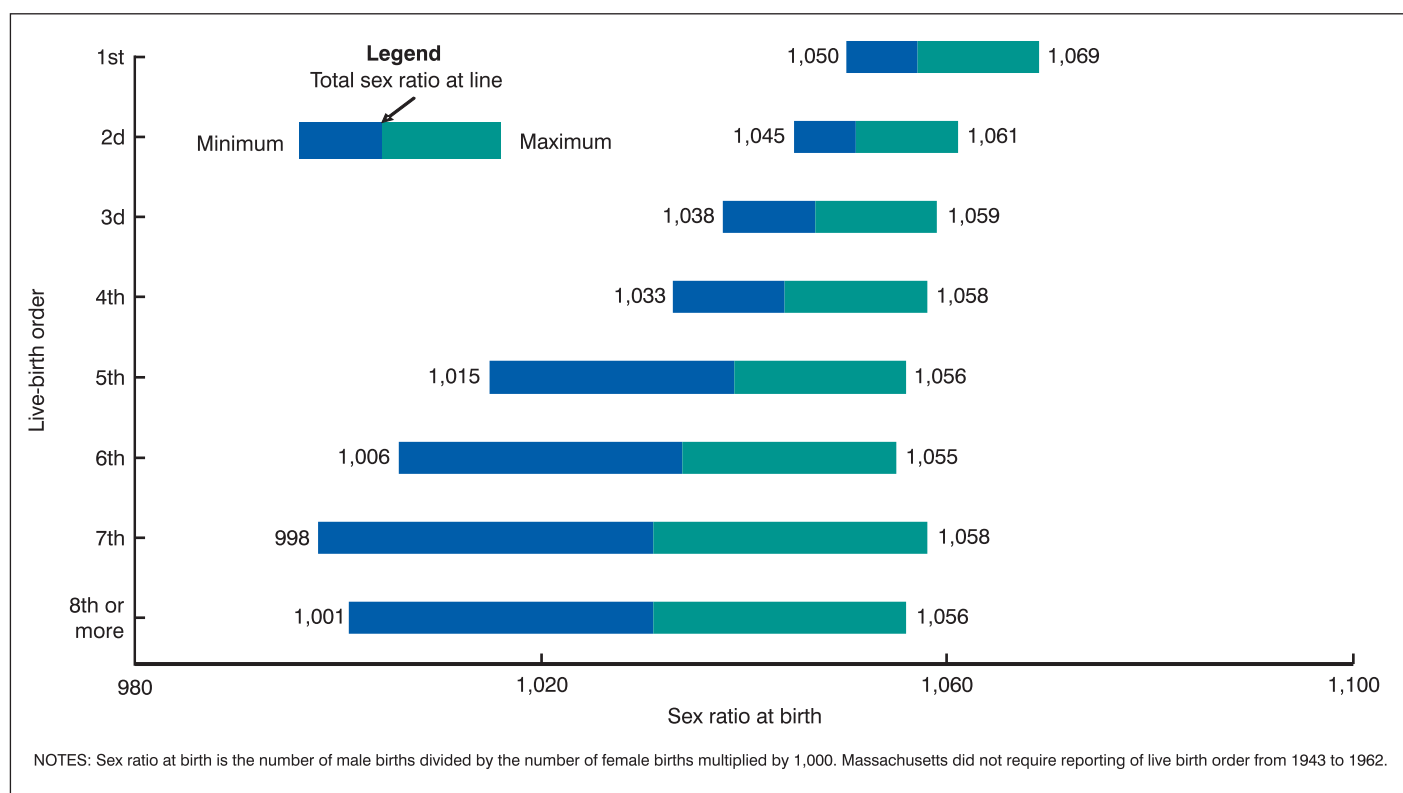
For these analyses a maximum of four joinpoints and five line segments were allowed for each long-term trend. In addition, each segment had to contain at least two observed data points (years), and no segment could begin or end closer than two data points from the beginning or end of the data series. The regression line segments between the joinpoints, are on a logarithmic scale so that the APC in the ratio over time for each segment, the slope of the line, can be interpreted (table 5). Joinpoints and the APC are estimated based on the sex ratio and the variance of the sex ratio. For the formula for the variance of the ratio, see “Technical Notes.” Adapted from the methodology of the National Cancer Institute (31), a trend in this report

was characterized as “stable,” if the APC was not statically significant, “rising slightly” or “falling slightly” if the APC was statically significant with a value from 0.005 to 0.015, and “rising” or “falling” if the APC was statically significant and more than 0.015. For example, a significant APC of 0.008 would signify a “slightly rising” trend in the sex ratio (table 5). Although APCs can be very small (for example, 0.008) they often cover numerous years and thus have a cumulative impact on the observed change over time.

From 1940 to 2002, the trend of the sex ratio at birth was marked by three significant shifts (table 5 and figure 1). The first joinpoint occurred in 1942. Beginning in 1942, the trend fell by  $-0.049$  percent per year for nearly two decades. The second joinpoint occurred in 1959 and the third in 1971. In the period between these last two shifts, the trend in the sex ratio at birth rose by  $0.039$  percent per year. After the third shift (1971), the sex ratio at birth again fell as it did during most of the 1940s and 1950s, but not by as much per year ( $-0.020$  percent). Possible explanations for these trends are discussed in “Factors affecting the sex ratio at birth.”

These same shifts were not generally observed in the sex ratios for all groups defined by age of mother or live-birth order (live-birth order data begins with 1943). The trend for mothers age 15–19 years fell slightly throughout the entire period of 1940 to 2002, whereas the trends for mothers age 10–14, 30–34, and 45 years and over were stable (table 5).

The sex ratio for women age 20–24, 25–29, and 35–39 years however, did display significant shifts in the 1960s and 1970s (see figure 5). Women in their twenties represent the prime childbearing ages, trends in the sex ratio for births to these women largely reflect the overall trend illustrated in figure 1. For women age 20–24 years,



**Figure 3. Minimum, maximum, and total sex ratio reported by live-birth order for 1943 to 2002**

there were significant joinpoints in 1942, 1966, 1974, and 1987, with significant declining APCs from 1942 to 1966 (−0.028 percent), from 1974 to 1987 (−0.042 percent), and from 1987 to 2002 (−0.025). The APCs of the remaining segments are not significant. The trend for women age 25–29 years was marked by two joinpoints in 1961 and 1968 whereas the trend for women age 35–39 years was also marked by two joinpoints but in 1965 and 1976. In both cases, the sex ratio first fell (−0.060 and −0.055 percent, respectively), then was stable for 25–29 year-olds but rose 0.124 percent for 35–39 year-olds, and then fell again for both groups (−0.021 and −0.029 percent). The sex ratio at birth for mothers age 40–44 years also displayed significant change, but only at one joinpoint, in 1967, when the trend shifted from falling to rising (from −0.077 to 0.058 percent).

The trends for first- through fourth-order births as well as sixth-order births significantly declined through the entire period (from 1943 to 2002) with only first- and sixth-order births falling more than slightly (more than 0.015 percent) (table 5). A single shift was seen in the sex ratio for the seventh order in 1951, the only trend by birth order to have a joinpoint (figure 6). The trend fell from 1943 to 1951 (−0.340 percent) and then rose from 1951 to 2002 (0.035 percent). The trends for fifth and eighth and higher-order births were stable.

The sex ratio at birth by race and Hispanic origin of mother for two of the largest groups (white and Mexican) did mirror the overall downward trend in the sex ratio observed for the last 30 years. (Observable trends for some race and Hispanic-origin groups begin later than 1970 due to reporting changes, see “Technical Notes.”) For white mothers there are significant joinpoints in 1972, 1976, and 1988 (figure 7). The trend for Mexican mothers fell from 1980 to 2002. The trends for black and Chinese mothers rose (slightly for black mothers) from 1970 to 2002. Finally, the trends for American Indian and Alaskan

Native, Japanese, Hawaiian, Filipino, Puerto Rican, Cuban, Central and South American, non-Hispanic white, and non-Hispanic black mothers were stable.

In interpreting the results, the limitations of JPA must be considered. For groups with a small number of births (for example, American Indian and Alaskan Native), JPA often shows fewer significant changes in trends than for groups based on a larger number of births (for example, white) (27). In addition, the comparison of joinpoints and APCs among different groups is further complicated by the different periods of coverage (for example, white 1970–2002 and Mexican 1980–2002) (see tables 4 and 5).

### Sex ratio at birth for selected countries

According to the latest available data for selected countries, the sex ratio at birth varies from 1,040 male births for every 1,000 female births for Belgium to 1,092 for Singapore (table A). These values do not represent the full range of the sex ratio at birth for all countries. Ratios as low as 863 male births for every 1,000 female births (Cayman Islands in 1994) and as high as 1,117 (Macao in 2000) have been reported (32,33). Nevertheless, the sex ratio at birth for most countries is between 1,050 and 1,060. The U.S. sex ratios at birth from 1940–2002 were mostly within this range of variability.

### Factors affecting the sex ratio at birth

The chance that a birth will be male is generally considered random with the chance being slightly better than even (51.2 percent based on a sex ratio at birth of 1,050) that the child will be male.

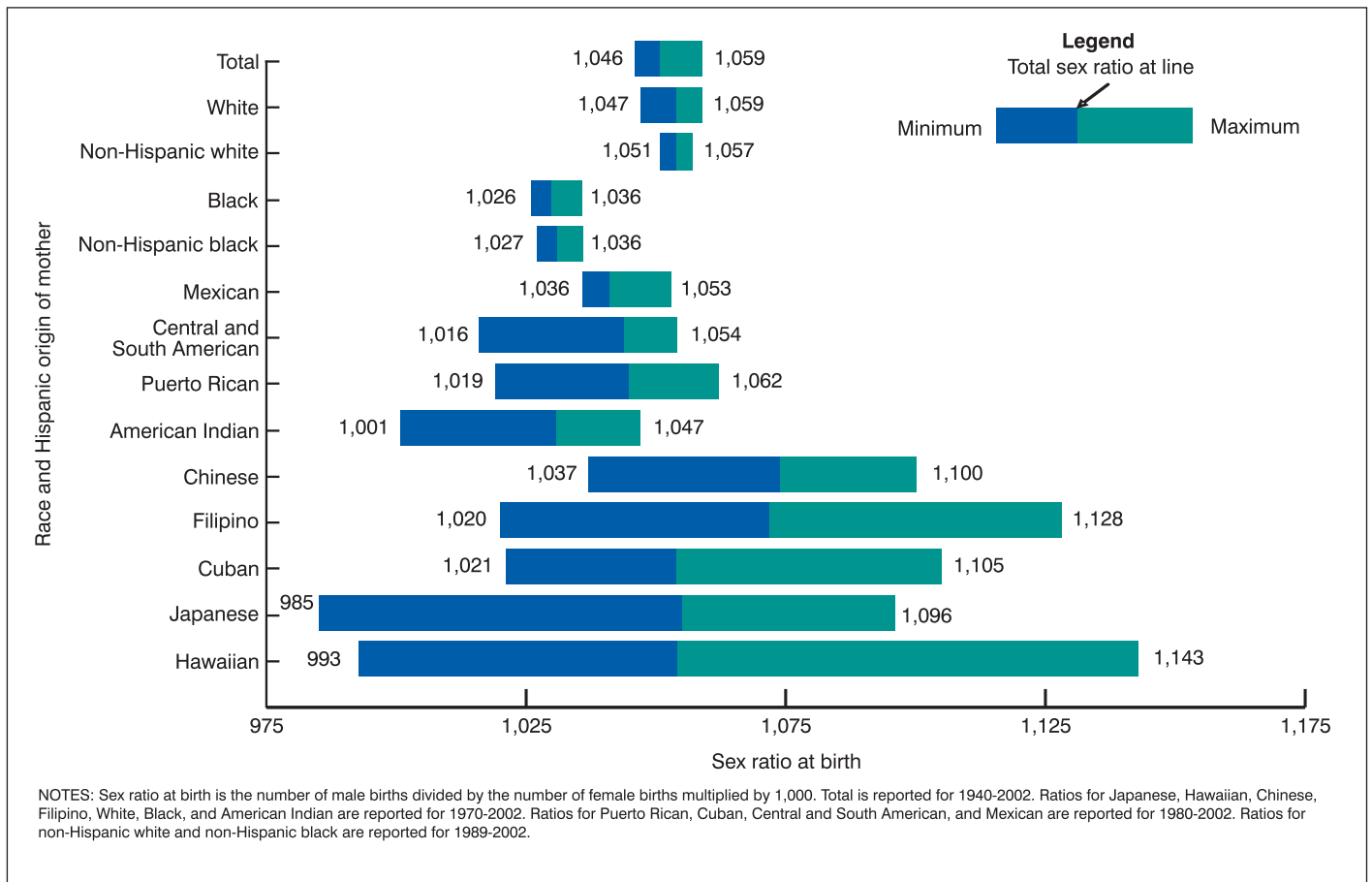


Figure 4. Minimum, maximum, and total sex ratio reported by race and Hispanic origin of mother

Table A. Sex ratio at birth for selected countries

Country	Year	Sex ratio at birth
Belgium	2001	1,040
Netherlands	2001	1,045
Morocco	1999	1,047
Chile	1999	1,048
United States	2002	1,048
United Kingdom	2001	1,050
Germany	2001	1,051
Croatia	2001	1,052
Australia	2000	1,056
Canada	2000	1,056
Spain	2001	1,057
Colombia	2000	1,058
Egypt	1999	1,058
Japan	2000	1,058
Thailand	2000	1,059
Italy	2001	1,061
New Zealand	2000	1,062
El Salvador	2000	1,063
Russian Federation	2001	1,063
Portugal	2001	1,073
Pakistan	1997	1,077
Cuba	2000	1,083
Singapore	2000	1,092

SOURCE: Council of Europe. Recent Demographic Development in Europe 2002. Strasbourg: Council of Europe Publishing, 2002. United Nations. Demographic yearbook/Annuaire demographique 2001. New York: United Nations, 2002.

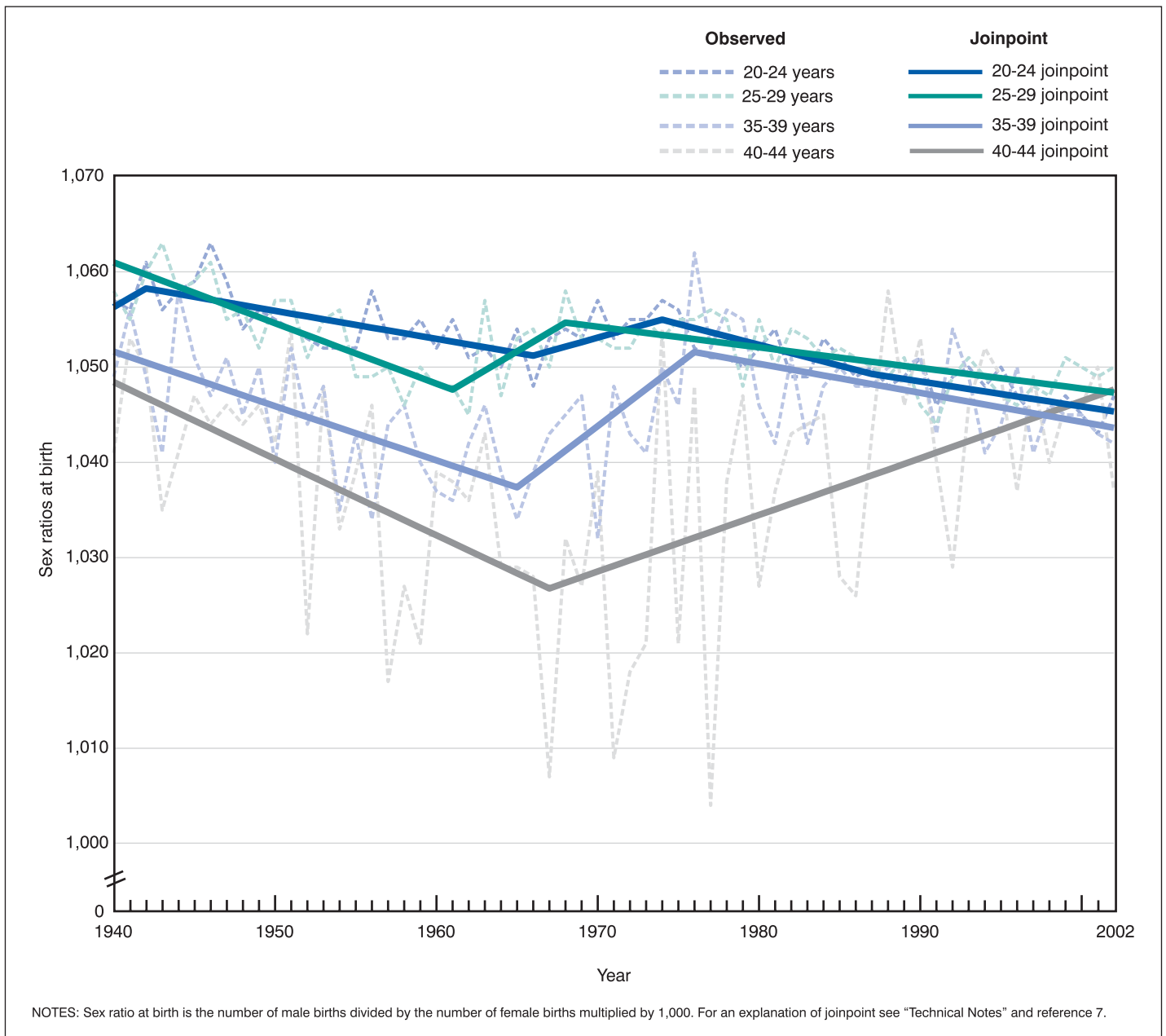
Indeed, the sex ratio at birth is generally viewed as remarkably stable. This was noted as early as 1662 by John Graunt, and statistically examined in 1710 by John Arbuthnot (1,2).

Nevertheless, the sex ratio is associated in a limited way with age, race and Hispanic origin of mother, and birth order of the child (19–21) (see previous sections on these topics). Rather than invariant, the sex ratio at birth is affected by factors from conception to birth including fetal loss (34–36). In 2002 the sex ratio reported for fetal loss was higher than for live births (1,128 compared with 1,048) (37). In addition to those factors previously mentioned, a lower occurrence of male births relative to female births has been associated with increased age of father, lower maternal weight, stress (for example, earthquakes and economic distress), and environmental toxins (for example, pesticides and cigarette smoking) (19–21,24,38–44). The effect of these and other factors should be considered in understanding the annual variation and overall decline in the sex ratio at birth for the United States.

In addition to these biological and environmental factors, a higher than normal sex ratio has also been noted for some countries in terms of a strong male sex preference and sex selection (45).

## Conclusion

This report presented the sex ratio at birth for the United States for the past 60 years. The data presented provide important information on the overall trends in sex ratio at birth and some selected characteristics including age of mother, birth order, and race and Hispanic origin of mother.

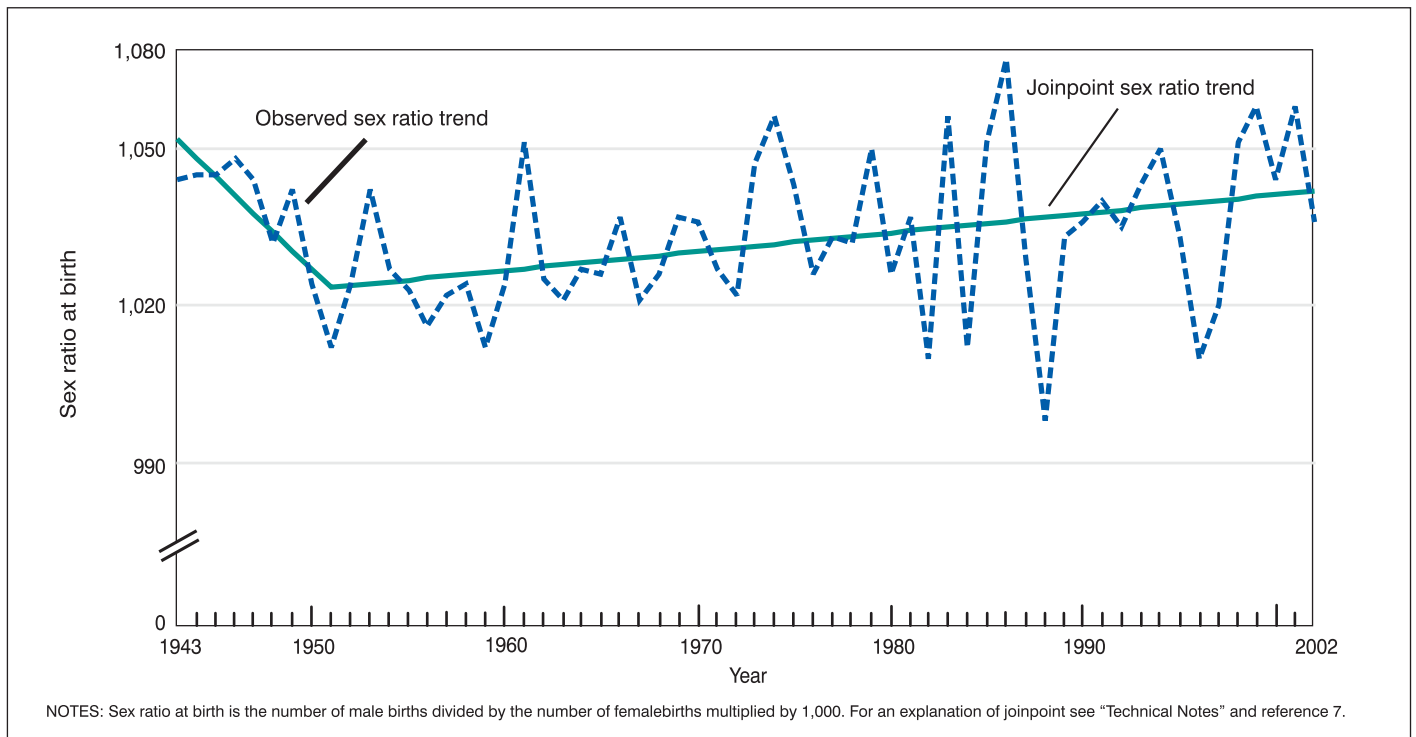


**Figure 5. Sex ratio at birth and joinpoint segments by selected age of mother for 1940–2002**

Changes in the sex ratio at birth in the United States have been attributed to many different factors. The factors examined in this report include age of mother, birth order, and race and Hispanic origin of mother. Other factors not examined here but cited by others in determining the sex of a child and, thus, the sex ratio at birth are weight of mother, stress, age of father, family size, geographic and climatic conditions, environmental toxins, and a preference for male offspring. As such, the effect of these factors should be considered in understanding the annual variation and overall decline in the sex ratio at birth.

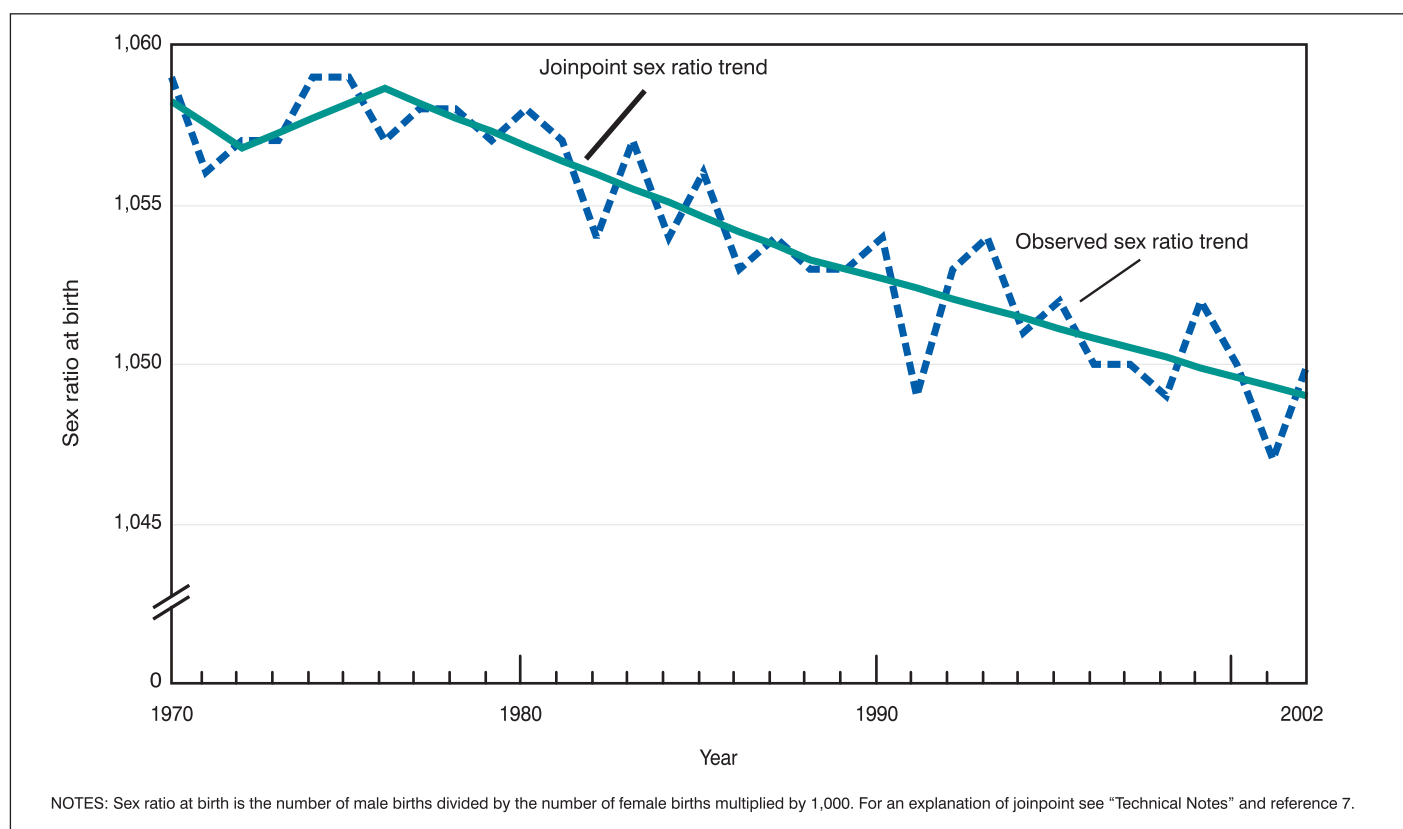
## References

1. Graunt J. Natural and political observations on the bills of mortality. London. 1662.
2. Arbuthnot J. An argument for divine providence taken from the constant regularity observed in the births of both sexes. *Philosophical Transactions of the Royal Society of London* 27:186–90. London. 1710.
3. Markle GE. Sex ratio at birth: values, variance, and some determinants. *Demography* 11:131–42. 1974.
4. Petersen W, Petersen R. *Dictionary of demography: terms, concepts, and institutions*. New York: Greenwood Press, Inc. 1986.
5. Stevenson DK, Verter J, Fanaroff AA, et al. Sex differences in outcomes of very low birthweight infants: the newborn male disadvantage. *Arch Dis Child Fetal Neonatal Ed* 83:182–5. 2000.
6. Mathews TJ, Menacker F, MacDorman MF. Infant mortality statistics from the 2002 period linked birth/infant death data set. *National vital statistics reports; vol 53 no 10*. Hyattsville, Maryland: National Center for Health Statistics. 2004.
7. Getahun D, Amre D, Rhoads GG, Demissie K. Maternal and obstetric risk factors for sudden infant death syndrome in the United States. *Obstet Gynecol* 103(4):646–52. 2004.



**Figure 6. Sex ratio at birth and joinpoint segments for seventh-order live births for 1943–2002**

8. Harrison PT, Holmes P, Humfrey CD. Reproductive health in humans and wildlife: are adverse trends associated with environmental chemical exposure? *Sci Total Environ* 205:97–106. 1997.
9. Yoshimura T, Kaneko S, Hayabuchi H. Sex ratio in offspring of those affected by dioxin and dioxin-like compounds: the Yusho, Seveso, and Yucheng incidents. *Occup Environ Med* 58:540–1. 2001.
10. Toppari J, Skakkebaek NE. Sexual differentiation and environmental endocrine disrupters. *Baillieres Clin Endocrinol Metab* 12:143–56. 1998.
11. Martuzzi M, Di Tanno ND, Bertollini R. Declining trends of male proportion at birth in Europe. *Arch Environ Health* 56:358–64. 2001.
12. Moller H. Change in male:female ratio among newborn infants in Denmark. *Lancet* 348:828–9. 1996.
13. Davis DL, Gottlieb MB, Stampnitzky JR. Reduced ratio of male to female births in several industrial countries: a sentinel health indicator? *JAMA* 279:1018–23. 1998.
14. Mizuno R. The male/female ratio of fetal deaths and births in Japan. *Lancet* 356:738–9. 2000.
15. President's Council on Bioethics. Beyond therapy: Controlling the sex of children. Available at: <http://bioethicsprint.bioethics.gov/transcripts/jan03/session4.html>.
16. President's Council on Bioethics. Ethical aspects of sex control. Available at: [http://bioethicsprint.bioethics.gov/background/sex\\_control.html](http://bioethicsprint.bioethics.gov/background/sex_control.html).
17. Marcus M, Kiely J, Xu F, et al. Changing sex ratio in the United States, 1969–1995. *Fertil Steril* 70:270–3. 1998.
18. Nicolich MJ, Huebner WW, Schnatter AR. Influence of parental and biological factors on the male birth fraction in the United States: an analysis of birth certificate data from 1964 through 1988. *Fertil Steril* 73:487–92. 2000.
19. Teitelbaum M. Factors associated with the sex ratio in human populations. In: Harrison GA and Boyce AJ, eds. *The structure of human populations*. Oxford, England: Clarendon Press. 1972.
20. Jacobsen R, Moller H, Mouritsen A. Natural variation in the human sex ratio. *Hum. Reprod* 14(12):3120–5. 1999.
21. James WH. The Human Sex Ratio. Part 1: A Review of the literature. *Social Biology* 59(5):721–52. 1987.
22. Martin JA, Hamilton BE, Sutton PD, et al. Births: Final data for 2002. National vital statistics reports; vol 52 no 10. Hyattsville, Maryland: National Center for Health Statistics. 2003.
23. James WH. The variation of the probability of a son within and across couples. *Hum Reprod* 15(5):1184–8. 2000.
24. Biggar RJ, Wohlfahrt J, Westergaard T, Melbye M. Sex ratios, family size, and birth order. *American J Epidemiology* 150(9):957–62. 1999.
25. National Cancer Institute. Joinpoint Regression Program, Version 2.7. Released on September 2003. Available at: <http://srab.cancer.gov/joinpoint/>.
26. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Statist Med* 19(3):335–51. 2000.
27. Edwards BK, Howe HL, Ries LA, et al. Annual report to the nation on the status of cancer, 1973–1999, featuring implications of age and aging on the U.S. cancer burden. *Cancer* 94(10):2766–92. 2002.
28. Weir HK, Thun MJ, Hankey BF, et al. Annual report to the nation on the status of cancer, 1975–2000, featuring the uses of surveillance data for cancer prevention and control. *J Natl Cancer Inst* 95(17):1276–99. 2003.
29. Fernandez E, Gonzalez JR, Borrás JM, et al. Recent decline in cancer mortality in Catalonia (Spain): A joinpoint regression analysis. *Eur J Cancer* 37(17):2222–8. 2001.
30. Faden VB, Fay MP. Trends in drinking among Americans age 18 and younger: 1975–2002. *Alcoholism: Clinical & Experimental Research*. 28(9):1388–95. 2004.
31. National Cancer Institute. Cancer Progress Report—2003 Update (Appendices—Methodology for Characterizing Trends). Bethesda: National Institute of Health. 2004. Available at: <http://progressreport.cancer.gov/doc.asp?pid=1&did=21&chid=15&coid=41&mid=vpco>.
32. United Nations. Demographic yearbook/Annuaire démographique 2000. New York: United Nations. 2002.



**Figure 7. Sex ratio at birth and joinpoint segments for births to white mothers for 1970–2002**

33. Council of Europe. Recent Demographic Development in Europe 2002. Strasbourg: Council of Europe Publishing. 2002.
34. James WH, Walters DE. Analysing data on the sex ratio of human births by cycle day of conception. *Hum Reprod* 15:1206–8. 2000.
35. Martin JF. Length of the follicular phase, time of insemination, coital rate and the sex of offspring. *Hum Reprod* 12:611–6. 1997.
36. Lazarus J. Human sex ratios: adaptations and mechanisms, problems and prospects. In: Hardy ICW, ed. *Sex ratios: concepts and research methods*. Cambridge, England: Cambridge University Press. 2002.
37. National Center for Health Statistics. 2002 Perinatal mortality data file. Fetal death documentation table 3. CD-ROM Series 20 No 23. Hyattsville, Maryland: National Center for Health Statistics. 2005.
38. Jacobsen R. Parental ages and the secondary sex ratio. *Hum Reprod* 16(10):2244–4. 2001.
39. Jacobsen R, Moller H, Engholm G. Fertility rates in relation to sexes of preceding children in the family. *Hum Reprod* 14(4): 1127–30. 1999.
40. Cagnacci A, Renzi A, Arangino S, et al. Influences of maternal weight on the secondary sex ratio of human offspring. *Hum Reprod* 19(2): 442–4. 2004.
41. Fukuda M, Fukuda K, Shimizu T, Moller H. Decline in sex ratio at birth after Kobe earthquake. *Hum Reprod* 13(8):2321–2. 1998.
42. Catalano RA. Sex ratios in the two Germanies: a test of the economic stress hypothesis. *Hum Reprod* 18(9):1972–5. 2003.
43. Ryan JJ, Amirova Z, Carrier G. Sex ratios of children of Russian pesticide producers exposed to dioxin. *Environ Health Perspect* 110(11):A699–701. 2002.
44. Fukuda M, Fukuda K, Shimizu T, et al. Parental periconceptional smoking and male: female ratio of newborn infants. *Lancet* 359: 1407–8. 2002.
45. Gu B, Roy K. Sex ratio at birth in China, with reference to other areas in East Asia: What we know. *Asia-Pacific Population Journal* 10(3):17–42. 1995. Available at: <http://www.unescap.org/esid/psis/population/journal/1995/v10n3a2.htm>.
46. National Center for Health Statistics. Vital statistics of the United States, 1967, volume I, natality. Washington: U.S. Department of Health and Human Services. 1969. Available at: [http://www.cdc.gov/nchs/data/vsus/nat67\\_1.pdf](http://www.cdc.gov/nchs/data/vsus/nat67_1.pdf).
47. National Center for Health Statistics. Technical appendix. Vital statistics of the United States, 2002, vol I natality. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Hyattsville, MD: National Center for Health Statistics. Available at: <http://www.cdc.gov/nchs/data/techap02.pdf>.
48. National Center for Health Statistics. Technical appendix. Vital statistics of the United States, 1999, vol I natality. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Hyattsville, MD: National Center for Health Statistics. Available at: <http://www.cdc.gov/nchs/data/techap99.pdf>.
49. Ventura SJ, Martin JA, Taffel SM, et al. Advance report of final natality statistics, 1992. Monthly vital statistics report; vol 43 no 5 supp. Hyattsville, Maryland: National Center for Health Statistics. 1994. Available at: [http://www.cdc.gov/nchs/data/mvsr/supp/mv43\\_05s.pdf](http://www.cdc.gov/nchs/data/mvsr/supp/mv43_05s.pdf).
50. Mathews TJ, Ventura SJ, Curtin SC, Martin JA. Births of Hispanic origin, 1989–95. Monthly vital statistics report; vol 46 no 6 supp. Hyattsville, Maryland: National Center for Health Statistics. 1998. Available at: [http://www.cdc.gov/nchs/data/mvsr/supp/mv46\\_06s.pdf](http://www.cdc.gov/nchs/data/mvsr/supp/mv46_06s.pdf).
51. National Center for Health Statistics. Vital Statistics of the United States, 1943, part II, natality and mortality data for the United States tabulated by place of residence. Washington, DC. 1945. Available at: [http://www.cdc.gov/nchs/data/vsus/VSUS\\_1943\\_2.pdf](http://www.cdc.gov/nchs/data/vsus/VSUS_1943_2.pdf).



52. Gart JJ, Zweifel JR. On the bias of various estimators of the logit and its variance with applications to quantal bioassay. *Biometrika* 54(1):181–7. 1967.

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**Table 1. Number of male and female births, sex ratio at birth, and number of excess males: United States, 1940–2002**

[Sex ratio at birth is the number of male births divided by the number of female births multiplied by 1,000. Based on registered births for all years]

Year	Live births		Sex ratio	Excess males
	Male	Female		
2002	2,057,979	1,963,747	1,048	94,232
2001	2,057,922	1,968,011	1,046	89,911
2000	2,076,969	1,981,845	1,048	95,124
1999	2,026,854	1,932,563	1,049	94,291
1998	2,016,205	1,925,348	1,047	90,857
1997	1,985,596	1,895,298	1,048	90,298
1996	1,990,480	1,901,014	1,047	89,466
1995	1,996,355	1,903,234	1,049	93,121
1994	2,022,589	1,930,178	1,048	92,411
1993	2,048,861	1,951,379	1,050	97,482
1992	2,082,097	1,982,917	1,050	99,180
1991	2,101,518	2,009,389	1,046	92,129
1990	2,129,495	2,028,717	1,050	100,778
1989	2,069,490	1,971,468	1,050	98,022
1988	2,002,424	1,907,086	1,050	95,338
1987	1,951,153	1,858,241	1,050	92,912
1986	1,924,868	1,831,679	1,051	93,189
1985	1,927,983	1,832,578	1,052	95,405
1984 <sup>1</sup>	1,879,490	1,789,651	1,050	89,839
1983 <sup>1</sup>	1,865,553	1,773,380	1,052	92,173
1982 <sup>1</sup>	1,885,676	1,794,861	1,051	90,815
1981 <sup>1</sup>	1,860,272	1,768,966	1,052	91,306
1980 <sup>1</sup>	1,852,616	1,759,642	1,053	92,974
1979 <sup>1</sup>	1,791,267	1,703,131	1,052	88,136
1978 <sup>1</sup>	1,709,394	1,623,885	1,053	85,509
1977 <sup>1</sup>	1,705,916	1,620,716	1,053	85,200
1976 <sup>1</sup>	1,624,436	1,543,352	1,053	81,084
1975 <sup>1</sup>	1,613,135	1,531,063	1,054	82,072
1974 <sup>1</sup>	1,622,114	1,537,844	1,055	84,270
1973 <sup>1</sup>	1,608,326	1,528,639	1,052	79,687
1972 <sup>1</sup>	1,669,927	1,588,484	1,051	81,443
1971 <sup>2</sup>	1,822,910	1,733,060	1,052	89,850
1970 <sup>2</sup>	1,915,378	1,816,008	1,055	99,370
1969 <sup>2</sup>	1,846,572	1,753,634	1,053	92,938
1968 <sup>2</sup>	1,796,326	1,705,238	1,053	91,088
1967 <sup>3</sup>	1,803,388	1,717,571	1,050	85,817
1966 <sup>2</sup>	1,845,862	1,760,412	1,049	85,450
1965 <sup>2</sup>	1,927,054	1,833,304	1,051	93,750
1964 <sup>2</sup>	2,060,162	1,967,328	1,047	92,834
1963 <sup>2</sup>	2,101,632	1,996,388	1,053	105,244
1962 <sup>2</sup>	2,132,466	2,034,896	1,048	97,570
1961 <sup>2</sup>	2,186,274	2,082,052	1,050	104,222
1960 <sup>2</sup>	2,179,708	2,078,142	1,049	101,566
1959 <sup>2</sup>	2,173,638	2,071,158	1,049	102,480
1958 <sup>2</sup>	2,152,546	2,051,266	1,049	101,280
1957 <sup>2</sup>	2,179,960	2,074,824	1,051	105,136
1956 <sup>2</sup>	2,133,588	2,029,502	1,051	104,086
1955	2,073,719	1,973,576	1,051	100,143
1954 <sup>2</sup>	2,059,068	1,958,294	1,051	100,774
1953 <sup>2</sup>	2,001,798	1,900,322	1,053	101,476
1952 <sup>2</sup>	1,971,262	1,875,724	1,051	95,538
1951 <sup>2</sup>	1,923,020	1,827,830	1,052	95,190
1950	1,823,555	1,730,594	1,054	92,961
1949	1,826,352	1,733,177	1,054	93,175
1948	1,813,852	1,721,216	1,054	92,636
1947	1,899,876	1,800,064	1,055	99,812
1946	1,691,220	1,597,452	1,059	93,768
1945	1,404,587	1,330,869	1,055	73,718
1944	1,435,301	1,359,499	1,056	75,802
1943	1,508,959	1,427,901	1,057	81,058
1942	1,444,365	1,364,631	1,058	79,734
1941	1,289,734	1,223,693	1,054	66,041
1940	1,211,684	1,148,715	1,055	62,969
1940 to 2002 <sup>4</sup>	118,792,776	113,016,646	1,051	5,776,130

<sup>1</sup> Based on a 100-percent sample in selected States and on a 50-percent sample in all other States.<sup>2</sup> Based on a 50-percent sample of births.<sup>3</sup> Based on a 20- to 50-percent sample of births.<sup>4</sup> Numbers and ratios based on all years.

**Table 2. Sex ratio at birth by age of mother: United States, 1940–2002**

[Sex ratio at birth is the number of male births divided by the number of female births multiplied by 1,000. Based on registered births for all years]

Year	Age of Mother							
	Under age 15 years	15–19	20–24	25–29	30–34	35–39	40–44	45 years or over
2002	1,051	1,052	1,047	1,050	1,049	1,042	1,037	1,097
2001	1,063	1,047	1,043	1,049	1,045	1,043	1,050	1,032
2000	1,089	1,051	1,045	1,050	1,048	1,045	1,046	1,073
1999	1,078	1,052	1,047	1,051	1,048	1,045	1,046	1,067
1998	1,079	1,049	1,045	1,047	1,049	1,046	1,040	1,073
1997	1,044	1,051	1,045	1,048	1,051	1,041	1,049	1,039
1996	1,045	1,050	1,047	1,046	1,047	1,050	1,037	1,037
1995	1,063	1,053	1,050	1,047	1,050	1,044	1,049	1,010
1994	1,050	1,047	1,048	1,049	1,049	1,041	1,052	1,004
1993	1,038	1,050	1,050	1,051	1,049	1,049	1,046	1,047
1992	1,035	1,051	1,049	1,049	1,051	1,054	1,029	1,074
1991	1,066	1,046	1,046	1,044	1,050	1,043	1,040	1,062
1990	1,085	1,052	1,051	1,046	1,052	1,051	1,053	1,030
1989	1,039	1,052	1,049	1,051	1,049	1,050	1,046	977
1988	1,033	1,052	1,048	1,049	1,053	1,050	1,058	1,099
1987	1,053	1,053	1,050	1,050	1,049	1,048	1,043	1,086
1986	1,048	1,056	1,049	1,051	1,053	1,048	1,026	970
1985	1,075	1,052	1,051	1,052	1,055	1,050	1,028	1,042
1984 <sup>1</sup>	1,030	1,048	1,053	1,051	1,046	1,048	1,045	1,067
1983 <sup>1</sup>	1,063	1,055	1,049	1,053	1,057	1,042	1,044	1,028
1982 <sup>1</sup>	1,051	1,048	1,049	1,054	1,050	1,051	1,043	1,016
1981 <sup>1</sup>	1,064	1,057	1,054	1,050	1,047	1,042	1,037	1,024
1980 <sup>1</sup>	1,075	1,053	1,052	1,055	1,052	1,046	1,027	1,158
1979 <sup>1</sup>	1,081	1,058	1,050	1,048	1,055	1,055	1,047	1,046
1978 <sup>1</sup>	1,053	1,054	1,051	1,055	1,049	1,056	1,038	1,016
1977 <sup>1</sup>	1,098	1,055	1,051	1,056	1,047	1,052	1,004	964
1976 <sup>1</sup>	1,045	1,053	1,052	1,055	1,044	1,062	1,048	1,088
1975 <sup>1</sup>	1,042	1,057	1,056	1,055	1,045	1,046	1,021	1,045
1974 <sup>1</sup>	1,021	1,056	1,057	1,053	1,054	1,050	1,054	942
1973 <sup>1</sup>	994	1,052	1,055	1,055	1,046	1,041	1,021	1,155
1972 <sup>1</sup>	1,034	1,049	1,055	1,052	1,047	1,043	1,018	1,032
1971 <sup>2</sup>	1,056	1,052	1,053	1,052	1,054	1,048	1,009	984
1970 <sup>2</sup>	1,114	1,057	1,057	1,053	1,057	1,032	1,039	976
1969 <sup>2</sup>	1,037	1,059	1,053	1,053	1,051	1,047	1,027	1,027
1968 <sup>2</sup>	994	1,052	1,054	1,058	1,051	1,045	1,032	1,069
1967 <sup>3</sup>	1,072	1,053	1,053	1,050	1,048	1,043	1,007	991
1966 <sup>2</sup>	986	1,048	1,048	1,054	1,050	1,039	1,028	993
1965 <sup>2</sup>	1,032	1,060	1,054	1,053	1,044	1,034	1,029	1,069
1964 <sup>2</sup>	1,027	1,056	1,050	1,047	1,039	1,039	1,029	1,057
1963 <sup>2</sup>	1,070	1,064	1,052	1,057	1,042	1,046	1,043	1,011
1962 <sup>2</sup>	999	1,053	1,051	1,045	1,047	1,042	1,036	1,037
1961 <sup>2</sup>	1,081	1,060	1,055	1,048	1,044	1,036	1,038	1,047
1960 <sup>2</sup>	1,035	1,056	1,052	1,048	1,047	1,037	1,039	1,023
1959 <sup>2</sup>	1,095	1,053	1,055	1,050	1,043	1,040	1,021	1,044
1958 <sup>2</sup>	1,034	1,052	1,053	1,046	1,050	1,046	1,027	1,114
1957 <sup>2</sup>	1,042	1,053	1,053	1,050	1,054	1,044	1,017	1,094
1956 <sup>2</sup>	1,073	1,050	1,058	1,049	1,054	1,034	1,046	1,009
1955	1,077	1,056	1,052	1,049	1,053	1,043	1,039	1,019
1954 <sup>2</sup>	1,047	1,060	1,052	1,056	1,037	1,035	1,033	1,020
1953 <sup>2</sup>	1,096	1,060	1,052	1,055	1,051	1,048	1,048	1,014
1952 <sup>2</sup>	1,056	1,054	1,053	1,051	1,051	1,044	1,022	1,063
1951 <sup>2</sup>	1,007	1,042	1,054	1,057	1,049	1,052	1,054	1,031
1950	1,039	1,057	1,055	1,057	1,052	1,040	1,042	1,014
1949	1,016	1,056	1,056	1,052	1,055	1,050	1,046	1,027
1948	1,042	1,061	1,054	1,056	1,050	1,045	1,044	1,024
1947	1,059	1,052	1,059	1,055	1,054	1,051	1,046	1,070
1946	1,040	1,058	1,063	1,061	1,055	1,047	1,044	1,040
1945	1,026	1,053	1,059	1,059	1,050	1,051	1,047	1,003
1944	1,045	1,053	1,058	1,058	1,052	1,058	1,041	1,022
1943	981	1,058	1,056	1,063	1,051	1,041	1,035	1,028
1942	1,054	1,065	1,061	1,060	1,052	1,049	1,050	1,048
1941	1,066	1,052	1,056	1,055	1,049	1,056	1,053	1,041
1940	1,025	1,057	1,057	1,058	1,050	1,049	1,041	1,054
1940 to 2002 <sup>4</sup>	1,050	1,054	1,052	1,052	1,049	1,045	1,038	1,039

<sup>1</sup>Based on a 100-percent sample in selected States and on a 50-percent sample in all other States.<sup>2</sup>Based on a 50-percent sample of births.<sup>3</sup>Based on a 20- to 50-percent sample of births.<sup>4</sup>Ratio based on all years.

**Table 3. Sex ratio at birth by live-birth order: United States, 1943–2002**

[Sex ratio at birth is the number of male births divided by the number of female births multiplied by 1,000. Based on registered births for all years]

Year	Live-birth order							
	1st	2nd	3rd	4th	5th	6th	7th	8th or more
2002	1,055	1,048	1,040	1,040	1,031	1,028	1,036	1,030
2001	1,051	1,045	1,038	1,040	1,044	1,015	1,058	1,040
2000	1,054	1,047	1,045	1,038	1,030	1,006	1,044	1,029
1999	1,053	1,049	1,043	1,041	1,035	1,028	1,058	1,023
1998	1,050	1,048	1,044	1,037	1,041	1,031	1,051	1,045
1997	1,052	1,049	1,041	1,038	1,040	1,030	1,020	1,046
1996	1,050	1,047	1,043	1,042	1,036	1,055	1,010	1,053
1995	1,056	1,047	1,044	1,040	1,035	1,024	1,033	1,010
1994	1,052	1,047	1,045	1,039	1,039	1,036	1,050	1,021
1993	1,054	1,049	1,048	1,037	1,034	1,054	1,043	1,030
1992	1,054	1,051	1,047	1,040	1,040	1,026	1,035	1,024
1991	1,053	1,043	1,041	1,033	1,035	1,019	1,040	1,056
1990	1,056	1,049	1,043	1,041	1,031	1,034	1,036	1,028
1989	1,054	1,050	1,046	1,035	1,045	1,037	1,033	1,044
1988	1,055	1,051	1,043	1,040	1,029	1,050	998	1,055
1987	1,054	1,051	1,042	1,045	1,040	1,038	1,029	1,043
1986	1,054	1,051	1,045	1,043	1,050	1,037	1,067	1,037
1985	1,057	1,050	1,050	1,043	1,035	1,032	1,051	1,031
1984 <sup>1</sup>	1,054	1,050	1,048	1,046	1,038	1,006	1,012	1,009
1983 <sup>1</sup>	1,056	1,051	1,047	1,055	1,040	1,016	1,056	1,003
1982 <sup>1</sup>	1,056	1,049	1,047	1,044	1,042	1,039	1,010	1,041
1981 <sup>1</sup>	1,057	1,049	1,047	1,052	1,035	1,036	1,037	1,043
1980 <sup>1</sup>	1,058	1,055	1,046	1,038	1,040	1,025	1,026	1,045
1979 <sup>1</sup>	1,056	1,047	1,053	1,049	1,044	1,037	1,050	1,020
1978 <sup>1</sup>	1,058	1,052	1,046	1,036	1,055	1,043	1,032	1,018
1977 <sup>1</sup>	1,058	1,053	1,043	1,052	1,040	1,020	1,033	1,036
1976 <sup>1</sup>	1,058	1,054	1,042	1,049	1,041	1,028	1,026	1,033
1975 <sup>1</sup>	1,059	1,055	1,051	1,048	1,015	1,028	1,043	1,001
1974 <sup>1</sup>	1,060	1,054	1,048	1,045	1,048	1,030	1,056	1,033
1973 <sup>1</sup>	1,055	1,059	1,049	1,036	1,026	1,032	1,047	1,017
1972 <sup>1</sup>	1,055	1,053	1,049	1,045	1,047	1,022	1,022	1,038
1971 <sup>2</sup>	1,060	1,050	1,048	1,042	1,049	1,025	1,027	1,044
1970 <sup>2</sup>	1,061	1,056	1,059	1,038	1,035	1,026	1,036	1,030
1969 <sup>2</sup>	1,058	1,053	1,050	1,049	1,048	1,037	1,037	1,032
1968 <sup>2</sup>	1,061	1,051	1,054	1,058	1,035	1,041	1,026	1,029
1967 <sup>3</sup>	1,060	1,049	1,048	1,047	1,036	1,025	1,021	1,031
1966 <sup>2</sup>	1,054	1,048	1,048	1,049	1,049	1,026	1,037	1,027
1965 <sup>2</sup>	1,060	1,058	1,047	1,050	1,035	1,033	1,026	1,019
1964 <sup>2</sup>	1,058	1,048	1,050	1,042	1,037	1,033	1,027	1,017
1963 <sup>2</sup>	1,064	1,052	1,058	1,048	1,034	1,035	1,021	1,041
1962 <sup>2,4</sup>	1,054	1,052	1,049	1,044	1,036	1,040	1,025	1,020
1961 <sup>2,4</sup>	1,066	1,054	1,044	1,036	1,037	1,036	1,051	1,029
1960 <sup>2,4</sup>	1,058	1,049	1,048	1,047	1,039	1,040	1,024	1,030
1959 <sup>2,4</sup>	1,064	1,051	1,048	1,042	1,040	1,040	1,012	1,030
1958 <sup>2,4</sup>	1,058	1,048	1,048	1,056	1,033	1,035	1,024	1,041
1957 <sup>2,4</sup>	1,058	1,054	1,053	1,040	1,046	1,027	1,022	1,042
1956 <sup>2,4</sup>	1,063	1,055	1,044	1,047	1,045	1,036	1,016	1,031
1955 <sup>4</sup>	1,061	1,049	1,052	1,050	1,040	1,029	1,023	1,024
1954 <sup>2,4</sup>	1,059	1,059	1,048	1,039	1,037	1,034	1,027	1,032
1953 <sup>2,4</sup>	1,066	1,051	1,051	1,041	1,041	1,038	1,042	1,043
1952 <sup>2,4</sup>	1,056	1,056	1,049	1,048	1,033	1,030	1,024	1,025
1951 <sup>2,4</sup>	1,059	1,053	1,052	1,040	1,052	1,040	1,012	1,041
1950 <sup>4</sup>	1,063	1,057	1,048	1,039	1,044	1,032	1,024	1,037
1949 <sup>4</sup>	1,060	1,056	1,049	1,050	1,043	1,039	1,042	1,030
1948 <sup>4</sup>	1,061	1,058	1,044	1,051	1,037	1,049	1,032	1,028
1947 <sup>4</sup>	1,062	1,054	1,050	1,047	1,052	1,044	1,044	1,031
1946 <sup>4</sup>	1,069	1,060	1,052	1,052	1,035	1,045	1,048	1,035
1945 <sup>4</sup>	1,061	1,061	1,049	1,052	1,056	1,021	1,045	1,030
1944 <sup>4</sup>	1,063	1,056	1,058	1,048	1,035	1,044	1,045	1,041
1943 <sup>4</sup>	1,063	1,059	1,051	1,052	1,032	1,044	1,044	1,027
1943 to 2002 <sup>5</sup>	1,057	1,051	1,047	1,044	1,039	1,034	1,031	1,031

<sup>1</sup>Based on a 100-percent sample in selected States and on a 50-percent sample in all other States.<sup>2</sup>Based on a 50-percent sample of births.<sup>3</sup>Based on a 20- to 50-percent sample of births.<sup>4</sup>Excludes Massachusetts, which did not require reporting of live birth order.<sup>5</sup>Ratio based on all years.

**Table 4. Sex ratio at birth by race and Hispanic origin of mother: United States, 1970–2002**

[Sex ratio at birth is the number of male births divided by the number of female births multiplied by 1,000]

Race and Hispanic origin of Mother	Year								
	2002	2001	2000	1999	1998	1997	1996	1995	1994
Total . . . . .	1,048	1,046	1,048	1,049	1,047	1,048	1,047	1,049	1,048
White . . . . .	1,050	1,047	1,050	1,052	1,049	1,050	1,050	1,052	1,051
Black . . . . .	1,032	1,032	1,031	1,031	1,034	1,031	1,028	1,031	1,028
American Indian . . . . .	1,023	1,024	1,035	1,029	1,038	1,036	1,031	1,040	1,031
Japanese . . . . .	1,089	1,041	1,084	1,063	1,030	1,068	1,053	1,054	1,048
Hawaiian . . . . .	1,075	1,000	1,059	1,047	1,044	1,066	1,062	1,009	1,034
Chinese . . . . .	1,070	1,092	1,077	1,075	1,067	1,100	1,090	1,068	1,093
Filipino . . . . .	1,070	1,077	1,080	1,069	1,067	1,069	1,061	1,079	1,051
Puerto Rican <sup>1</sup> . . . . .	1,061	1,052	1,051	1,031	1,044	1,049	1,037	1,056	1,042
Cuban <sup>1</sup> . . . . .	1,056	1,032	1,050	1,038	1,105	1,043	1,044	1,051	1,021
Central & South American <sup>1</sup> . . . . .	1,046	1,037	1,046	1,054	1,042	1,042	1,046	1,043	1,045
Mexican <sup>1</sup> . . . . .	1,038	1,037	1,042	1,040	1,037	1,038	1,039	1,040	1,040
Non-Hispanic white . . . . .	1,054	1,051	1,053	1,055	1,052	1,052	1,053	1,054	1,054
Non-Hispanic black . . . . .	1,032	1,032	1,031	1,032	1,034	1,031	1,027	1,031	1,029
	1993	1992 <sup>2</sup>	1991 <sup>2</sup>	1990 <sup>2</sup>	1989 <sup>2</sup>	1988 <sup>2</sup>	1987 <sup>2</sup>	1986 <sup>2</sup>	1985 <sup>2</sup>
Total . . . . .	1,050	1,050	1,046	1,050	1,050	1,050	1,050	1,051	1,052
White . . . . .	1,054	1,053	1,049	1,054	1,053	1,053	1,054	1,053	1,056
Black . . . . .	1,028	1,036	1,031	1,029	1,031	1,033	1,028	1,034	1,029
American Indian . . . . .	1,036	1,034	1,016	1,023	1,028	1,021	1,041	1,047	1,032
Japanese . . . . .	1,063	1,049	1,042	1,063	1,061	1,048	1,096	1,066	1,062
Hawaiian . . . . .	1,060	1,064	1,143	1,043	1,073	1,051	1,062	1,074	1,051
Chinese . . . . .	1,080	1,065	1,080	1,077	1,074	1,073	1,064	1,055	1,102
Filipino . . . . .	1,061	1,083	1,061	1,092	1,073	1,077	1,084	1,066	1,065
Puerto Rican <sup>1</sup> . . . . .	1,055	1,057	1,019	1,044	1,050	1,052	1,037	1,046	1,046
Cuban <sup>1</sup> . . . . .	1,063	1,079	1,073	1,077	1,030	1,049	1,085	1,023	1,071
Central & South American <sup>1</sup> . . . . .	1,046	1,040	1,043	1,049	1,044	1,047	1,052	1,028	1,041
Mexican <sup>1</sup> . . . . .	1,042	1,040	1,040	1,041	1,040	1,042	1,050	1,040	1,044
Non-Hispanic white . . . . .	1,057	1,056	1,051	1,056	1,056	---	---	---	---
Non-Hispanic black . . . . .	1,028	1,036	1,030	1,029	1,030	---	---	---	---
	1984 <sup>2,3</sup>	1983 <sup>2,3</sup>	1982 <sup>2,3</sup>	1981 <sup>2,3</sup>	1980 <sup>2,3</sup>	1979 <sup>3</sup>	1978 <sup>3</sup>	1977 <sup>3,4</sup>	1976 <sup>3,4</sup>
Total . . . . .	1,050	1,052	1,051	1,052	1,053	1,052	1,053	1,053	1,053
White . . . . .	1,054	1,057	1,054	1,057	1,058	1,057	1,058	1,058	1,057
Black . . . . .	1,030	1,027	1,033	1,026	1,028	1,030	1,027	1,027	1,027
American Indian . . . . .	1,016	1,038	1,032	1,023	1,048	1,036	1,044	1,022	1,070
Japanese . . . . .	1,038	1,037	1,031	1,014	1,072	1,071	1,073	1,077	1,081
Hawaiian . . . . .	1,090	1,050	1,023	1,073	1,020	1,009	1,098	1,111	1,097
Chinese . . . . .	1,050	1,042	1,087	1,080	1,093	1,057	1,060	1,058	1,069
Filipino . . . . .	1,089	1,107	1,088	1,071	1,070	1,054	1,077	1,020	1,064
Puerto Rican <sup>1</sup> . . . . .	1,036	1,045	1,062	1,034	1,035	---	---	---	---
Cuban <sup>1</sup> . . . . .	1,045	1,053	1,086	1,024	1,053	---	---	---	---
Central & South American <sup>1</sup> . . . . .	1,047	1,046	1,034	1,031	1,016	---	---	---	---
Mexican <sup>1</sup> . . . . .	1,036	1,048	1,038	1,050	1,053	---	---	---	---
Non-Hispanic white . . . . .	---	---	---	---	---	---	---	---	---
Non-Hispanic black . . . . .	---	---	---	---	---	---	---	---	---

See footnotes at end of table.

**Table 4. Sex ratio at birth by race and Hispanic origin of mother: United States, 1970–2002—Con.**

[Sex ratio at birth is the number of male births divided by the number of female births multiplied by 1,000]

Race and Hispanic origin of Mother	Year						All years <sup>6</sup>
	1975 <sup>3,4</sup>	1974 <sup>3,4</sup>	1973 <sup>3,4</sup>	1972 <sup>3,4</sup>	1971 <sup>3,5</sup>	1970 <sup>3,5</sup>	
Total . . . . .	1,054	1,055	1,052	1,051	1,052	1,055	
White . . . . .	1,059	1,059	1,057	1,057	1,056	1,059	1,054
Black . . . . .	1,029	1,029	1,028	1,026	1,029	1,031	1,030
American Indian . . . . .	1,026	1,055	1,001	1,025	1,016	1,019	1,031
Japanese . . . . .	1,023	1,009	1,077	985	1,076	1,064	1,055
Hawaiian . . . . .	1,090	1,095	1,093	1,073	1,116	993	1,054
Chinese . . . . .	1,037	1,075	1,065	1,068	1,061	1,043	1,074
Filipino . . . . .	1,063	1,128	1,068	1,073	1,092	1,083	1,072
Puerto Rican <sup>1</sup> . . . . .	---	---	---	---	---	---	1,045
Cuban <sup>1</sup> . . . . .	---	---	---	---	---	---	1,054
Central & South American <sup>1</sup> . . . . .	---	---	---	---	---	---	1,044
Mexican <sup>1</sup> . . . . .	---	---	---	---	---	---	1,041
Non-Hispanic white . . . . .	---	---	---	---	---	---	1,054
Non-Hispanic black . . . . .	---	---	---	---	---	---	1,031

--- Data not available for 1970 to 1977, reporting of Hispanic origin is underreported for 1978 and 1979, and for non-Hispanic origin is underreported for 1978 to 1988.

<sup>1</sup>Persons of Hispanic origin may be of any race.<sup>2</sup>Specified Hispanic origin was reported in 22 States in 1980 to 1982, 23 States and the District of Columbia (DC) from 1983 to 1987, 30 States and DC in 1988, 47 States and DC in 1989, 48 States and DC in 1990, and 49 States and DC in 1991 and 1992. It is estimated that at least 90 percent all the Hispanic population resided in these reporting areas for all of these time periods.<sup>3</sup>Based on a 100-percent sample in selected States and on a 50-percent sample in all other States.<sup>4</sup>Hispanic origin was not reported before 1978.<sup>5</sup>Based on a 50-percent sample of births.<sup>6</sup>Ratio based on available years.

**Table 5. Annual percent change and significance of trends from joinpoint analysis of sex ratio at birth by race and Hispanic origin, age of mother, and live-birth order: United States**

[Years covered varies, see column for first year covered]

Characteristics	First year covered	Joinpoint analyses														
		Segment 1			Segment 2			Segment 3			Segment 4			Segment 5		
		Years	APC <sup>1</sup>	P <sup>2</sup>	Years	APC <sup>1</sup>	P <sup>2</sup>	Years	APC <sup>1</sup>	P <sup>2</sup>	Years	APC <sup>1</sup>	P <sup>2</sup>	Years	APC <sup>1</sup>	P <sup>2</sup>
Total	1940	1940–1942	0.163	NS	1942–1959	-0.049	††	1959–1971	0.039	††	1971–2002	-0.020	††	...	...	...
<b>Race and ethnicity</b>																
White	1970	1970–1972	-0.070	NS	1972–1976	0.043	NS	1976–1988	-0.042	††	1988–2002	-0.029	††	...	...	...
Black	1970	1970–2002	0.012	††	...	...	...	...	...	...	...	...	...	...	...	...
American Indian	1970	1970–2002	0.000	NS	...	...	...	...	...	...	...	...	...	...	...	...
Japanese	1970	1970–2002	0.042	NS	...	...	...	...	...	...	...	...	...	...	...	...
Hawaiian	1970	1970–2002	-0.079	NS	...	...	...	...	...	...	...	...	...	...	...	...
Chinese	1970	1970–2002	0.070	†	...	...	...	...	...	...	...	...	...	...	...	...
Filipino	1970	1970–2002	-0.017	NS	...	...	...	...	...	...	...	...	...	...	...	...
Puerto Rican	1980	1980–2002	0.035	NS	...	...	...	...	...	...	...	...	...	...	...	...
Cuban	1980	1980–2002	-0.020	NS	...	...	...	...	...	...	...	...	...	...	...	...
Central and South American	1980	1980–2002	0.029	NS	...	...	...	...	...	...	...	...	...	...	...	...
Mexican	1980	1980–2002	-0.034	††	...	...	...	...	...	...	...	...	...	...	...	...
Non-Hispanic white	1989	1989–2002	-0.021	NS	...	...	...	...	...	...	...	...	...	...	...	...
Non-Hispanic black	1989	1989–2002	0.015	NS	...	...	...	...	...	...	...	...	...	...	...	...
<b>Age of mother</b>																
Under age 15 years	1940	1940–2002	0.035	NS	...	...	...	...	...	...	...	...	...	...	...	...
15–19 years	1940	1940–2002	-0.010	††	...	...	...	...	...	...	...	...	...	...	...	...
20–24 years	1940	1940–1942	0.093	NS	1942–1966	-0.028	††	1966–1974	0.045	NS	1974–1987	-0.042	†	1987–2002	-0.025	†
25–29 years	1940	1940–1961	-0.060	††	1961–1968	0.096	NS	1968–2002	-0.021	††	...	...	...	...	...	...
30–34 years	1940	1940–2002	-0.001	NS	...	...	...	...	...	...	...	...	...	...	...	...
35–39 years	1940	1940–1965	-0.055	††	1965–1976	0.124	†	1976–2002	-0.029	†	...	...	...	...	...	...
40–44 years	1940	1940–1967	-0.077	††	1967–2002	0.058	††	...	...	...	...	...	...	...	...	...
45 years and over	1940	1940–2002	0.028	NS	...	...	...	...	...	...	...	...	...	...	...	...
<b>Live-birth order</b>																
First	1943	1943–2002	-0.018	††	...	...	...	...	...	...	...	...	...	...	...	...
Second	1943	1943–2002	-0.015	††	...	...	...	...	...	...	...	...	...	...	...	...
Third	1943	1943–2002	-0.014	††	...	...	...	...	...	...	...	...	...	...	...	...
Fourth	1943	1943–2002	-0.014	††	...	...	...	...	...	...	...	...	...	...	...	...
Fifth	1943	1943–2002	-0.007	NS	...	...	...	...	...	...	...	...	...	...	...	...
Sixth	1943	1943–2002	-0.018	††	...	...	...	...	...	...	...	...	...	...	...	...
Seventh	1943	1943–1951	-0.340	†	1951–2002	0.035	††	...	...	...	...	...	...	...	...	...
Eighth or more	1943	1943–2002	-0.004	NS	...	...	...	...	...	...	...	...	...	...	...	...

... Category not applicable.

<sup>1</sup>APC is the annual percent change of the sex ratio at birth.

<sup>2</sup>P is the probability (two sided) that the slope is statistically significant from zero: † is  $P < 0.05$ ; †† is  $P < 0.01$ ; NS is not significant.

NOTE: Joinpoints, annual percent change (APC), and significance of APC are estimated using joinpoint analysis (JPA). The maximum of four joinpoints and five line segments was allowed for each long-term trend. In addition, segments had to contain at least two observed data points, and no segment could begin or end closer than two data points from the beginning or end of the data series.

## 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). Data prior to 1951, for 1955, and since 1985 are based on 100 percent of the total number of births. From 1951 to 1954, 1956 to 1966, and 1968 to 1971, data are based on a 50-percent sample of birth certificates. During the processing of the 1967 data, the sampling rate was reduced from 50 percent to 20 percent (46).

Between 1972 and 1984, 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 during that time were based on a 50-percent sample of birth certificates filed in those States. Detailed information on data collected from the birth certificate file is presented in the natality "Technical Appendix" (47,48).

### Age of mother

Age of mother is computed in most cases from the mother's and infant's dates of birth as reported on the birth certificate. From 1964 to 1996, mother's age was edited for ages 10–49 years. Births reported to occur to mothers younger than age 10 or older than age 49 years had age imputed according to the age of mother from the previous record with the same race and total birth order (total of live births and fetal deaths). Starting in 1997, age of mother was imputed for ages 9 years or under and 55 years and over.

### 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 statistically 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 (49). 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 percent in 1980 to 5.4 percent 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 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.

Data for Hispanic subgroups are shown in most cases for five groups: Mexican, Puerto Rican, Cuban, Central and South American, and 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 mothers are reported as white. In this report, data for non-Hispanic persons are classified according to the race of the mother, specifically non-Hispanic white and non-Hispanic black mothers. If Hispanic origin is not stated, it is not imputed.

Hispanic origin was first reported on the birth certificates of 17 States in 1978. By 1980, 22 States representing an estimated 90 percent of all births of Hispanic origin in the United States reported Hispanic identity. By 1989 all but three States reported Hispanic origin (Louisiana, New Hampshire, and Oklahoma). In 1990 neither New Hampshire nor Oklahoma collected information on Hispanic origin, while in 1991 and 1992 New Hampshire was the only State that did not ask for information on Hispanic origin. There has been full reporting of Hispanic origin from all States and the District of Columbia since 1993 (50).

Sex ratios for Japanese, Hawaiian, Chinese, Filipino, white, black, and American Indian are reported here for 1970 to 2002. Sex ratios for Puerto Rican, Cuban, Central and South American, and Mexican are reported for 1980 to 2002. Sex ratios for non-Hispanic white and non-Hispanic black are reported for 1989 to 2002.

### Live-birth order

Live-birth order indicates what number the present birth represents; for example, a child born to a mother who has had two previous live births (even if one or both are not now living) has a live-birth order of three.

U.S. data for sex ratio by live-birth order were first published and are shown here starting with 1943 (51). The sex ratio at birth by live-birth order for the United States from 1943 to 1962 excludes data for Massachusetts, which did not report live-birth order in those years. The effect of excluding Massachusetts is believed to be negligible on the U.S. sex ratio by live-birth order.

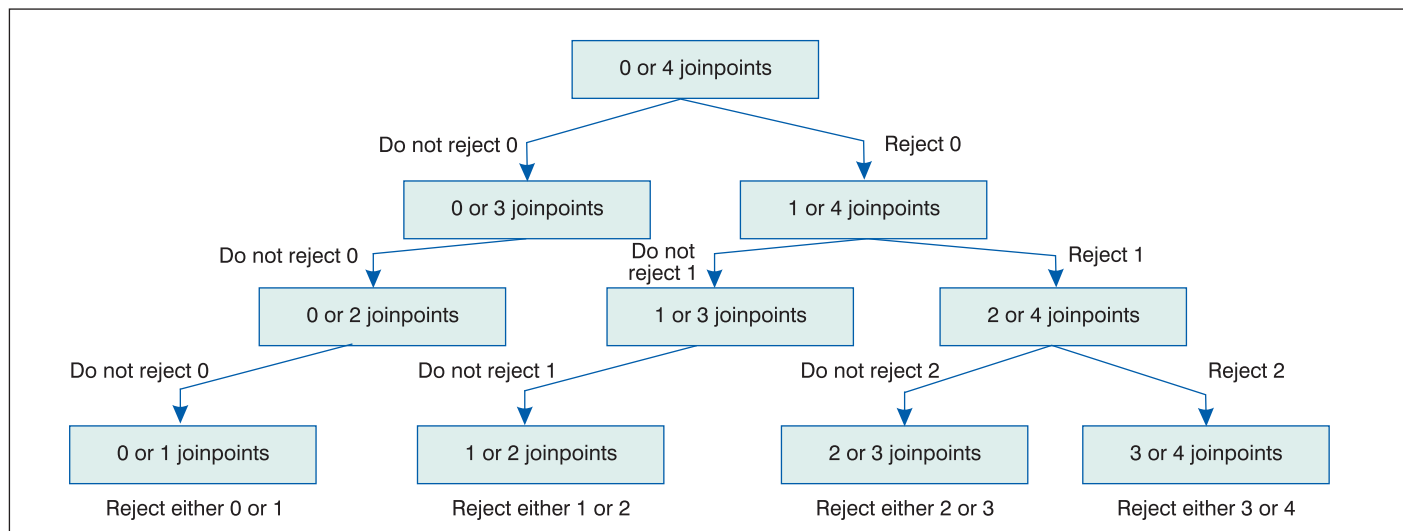
### Joinpoint analysis

Joinpoint analysis (JPA) software, developed by the National Cancer Institute, provides a method for analyzing trend data (25). The JPA program analyzes trend data and fits the smallest number of joinpoints. It increases the number of joinpoints under the null hypothesis by one if the null is rejected or decreases the number of joinpoints under the alternative by one otherwise, until it tests the null or  $k$  joinpoints against the alternative of  $k + 1$  joinpoints. The number of joinpoints is selected as  $k + 1$  if the final null is rejected, and  $k$  otherwise. In the case of these analyses, the program tests 0



joinpoints against 4 joinpoints. If 0 joinpoints is rejected then the program tests 1 joinpoint against 4 joinpoints. If 1 joinpoint is rejected then 2 is tested against 4 joinpoints. If 2 joinpoints is rejected then 3 is tested against 4 joinpoints. If the program fails to reject, for example, 2 joinpoints, then 2 is tested against 3 joinpoints. This example is shown in the following diagram:

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



**Decision tree diagram for 0 to 4 joinpoints**

**Significance testing**

The number of male and female births, while essentially a complete count and not subject to sampling error may be affected by nonsampling errors in the registration process. When the number of births is used for analytic purposes (such as, the comparison of sex ratios at birth over time or between different groups), 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 considered in this way, the number of births is subject to random variation and the difference between the ratios can be tested, according to certain statistical assumptions.

The difference between two ratios, 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 the difference between two ratios.

$$1.96 \cdot \sqrt{SR_1^2 \cdot \left(\frac{1}{F_1} + \frac{1}{M_1}\right) + SR_2^2 \cdot \left(\frac{1}{F_2} + \frac{1}{M_2}\right)}$$

where:

- SR<sub>1</sub> = first sex ratio at birth
- SR<sub>2</sub> = second sex ratio at birth
- M<sub>1</sub> = first number of male births
- M<sub>2</sub> = second number of male births
- F<sub>1</sub> = first number of female births
- F<sub>2</sub> = second number of female births.

Note that the term  $SR^2 \cdot (1 / F + 1 / M)$  in the formula above is the variance of the ratio, used in the joinpoint regression analysis (52).

If the difference is **less than or equal** to this statistic, the difference might occur by chance more than 5 times out of 100. In this

**Example**

Is the sex ratio at birth for Hispanic women in 2002 (1,041 per 1,000 female births) significantly higher than the rate in 2001 (1,038)? The difference between the ratios is 1,041 – 1,038 = 3. The statistic is then calculated as follows:

$$1.96 \cdot \sqrt{1,041^2 \cdot \left(\frac{1}{429,611} + \frac{1}{447,031}\right) + 1,038^2 \cdot \left(\frac{1}{417,985} + \frac{1}{433,866}\right)}$$

$$1.96 \cdot \sqrt{1,083,681 \cdot \left(\frac{1}{429,611} + \frac{1}{447,031}\right) + 1,077,444 \cdot \left(\frac{1}{417,985} + \frac{1}{433,866}\right)}$$

$$1.96 \cdot \sqrt{1,083,681 \cdot (0.000004565) + 1,077,444 \cdot (0.000004697)}$$

$$1.96 \cdot \sqrt{4.95 + 5.06}$$

6.20

The difference between the rates, 3, is less than this statistic (6.20). Therefore, the difference is not statistically significant at the 95-percent confidence level.

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