Assessing the Quality of U.S. Vital Statistics at the County Level Using the Sex Ratio at Birth

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Introduction

Using the sex ratio at birth, this paper assesses the quality of vital statistics at the county level in the United States. The work presented here is an integration of previous research on the fluctuation in the sex ratio at birth for the total population at the county level in the United States (Steinmetz et al., 2013) and an evaluation of the sex ratio at birth by characteristics of mother in selected countries at the national level (Steinmetz et al., 2014). As shown in the literature and in previous research efforts, the sex ratio at birth varies within a narrow range. However, this expected range is affected by both the demographic characteristics of mother and the noise introduced by examining a small number of births. Problems with data quality can also increase the random component in the sex ratio at birth and can contribute to a high proportion of sex ratios at birth that fall outside of the expected range. We propose a method to evaluate birth data quality at the county level by controlling for the differences in the sex ratio at birth by race and Hispanic origin of mother and live birth order and accounting for the effect of examining a small number of births. A Bayesian approach to the same end will also be explored.

Background

The sex ratio at birth is an important analytical measure across several disciplines such as biology, genetics, sociology and demography. In this work, we define the sex ratio as the number of male live births per 100 female live births. As a demographic measure, it can provide valuable information regarding other demographic trends. For example, as the sex ratio in an area increases over time, it can lead to a marriage squeeze and slow the overall natural increase in a population (Mathews and Hamilton, 2005).

Data on the sex ratio at birth have also been used to understand trends in low birth weight and infant mortality since male babies have higher infant mortality rates than females (Mathews and Hamilton, 2005). The sex ratio at birth can also be indicative of other societal trends. An extremely imbalanced sex ratio at birth has been associated with a son preference in some Asian countries (Anderson and Silver, 1995; Belanger et al., 2003; Goodkind, 2004). In Nordic countries, there is some evidence of a relationship between birth order and gender preference (Andersson et al., 2006).

Tables 1 and 2 and Figures 1 and 2 show the sex ratio at birth for the United States according to various characteristics. It has often been noted that African-background populations have a lower sex ratio at birth, and there is some evidence that Asian populations have a higher sex ratio at birth than other populations (Garenne, 2002; Smith and Behren, 2005). Differences in the sex ratio at birth by race have

also been observed in the United States (Table 1 and Figure 1). In addition, births to younger mothers (Table 1) and births with lower live birth order (Table 2) tend to have a higher sex ratio. Figure 2 shows the tendency of births of lower birth order to exhibit a higher sex ratio among white mothers in the United States from 1990 to 2011.

Data and Methods

When vital statistics data are of low quality, this will increase the random component in the sex ratio at birth. Thus, the lower the quality of vital statistics data, the more likely the sex ratio at birth will be outside of the expected range. Calculating the proportion of years in which the sex ratio at birth is outside the expected range yields an indicator of the quality of county level vital statistics. After accounting for varying characteristics of mother and the noise introduced from examining a small number of births, we evaluate the quality of birth data at the county level by determining if the proportion of sex ratios at birth out of the expected range is significantly higher than would be expected.

Time series data on total number of births and births by sex, live birth order, and race and Hispanic origin of mother by county for the United States are examined. To evaluate the level of agreement between the time series of the observed sex ratios at birth and expected sex ratios at birth for each county, we assume that the number of male births for each year follows a binomial distribution. That is, each birth is independent of one another and the probability of a male birth is the same for each birth. We use the expected sex ratio at birth for each group in a county by taking into account live birth order and race and Hispanic origin of mother. For each race and Hispanic origin of mother and live birth order group in every county, the expected sex ratio at birth is set to the historical sex ratio in the corresponding group for the total population in the United States.

We investigate use of the sex ratio at birth to assess which counties have vital statistics data that might be of low quality. To do this, we account for the effects of race and Hispanic origin of mother and live birth order on the observed sex ratio. This analysis can reveal how useful sex ratio at birth could be as a data quality assessment tool and the extent to which the characteristics of births influence the results of that assessment. We also explore a Bayesian method alternative. In a Bayesian framework, we use the historical sex ratio at birth of the total population to inform a prior distribution and the distribution of county births by race and Hispanic origin of mother and live birth order group to update this baseline expected sex ratio in the likelihood distribution.

Table 1. United States Sex Ratio at Birth by Characteristics of Mother

Race and Hispanic Origin of Mother	Sex Ratio (1970-2002)
White	105.4
Black	103.0
Asian/Pacific Islander	106.4[*]
Hispanic	104.6[**]
Age of Mother	Sex Ratio (1940-2002)
Under 15 years	105.0
15-19 years	105.4
20-24 years	105.2
25-29 years	105.2
30-34 years	104.9
35-39 years	104.5
40-44 years	103.8
45 years and over	103.9

*Source: Mathews, T.J. and Brady E. Hamilton. 2005. "Trend Analysis of the Sex Ratio at Birth in
          the United States." National Vital Statistics Reports Volume 53, Number 20.*

[*] The sex ratio of births to Japanese, Hawaiian, Chinese, and Filipino mothers in the United States from 1970
 to 2002 were averaged to create an estimate of the expected sex ratio among Asian/Pacific Islander births.

[**] The sex ratio of births to Puerto Rican, Cuban, Central American, and Mexican mothers in the United
States from 1989 to 2002 (and from some years prior to 1989 when available) were averaged to create an
estimate of the expected sex ratio among Hispanic births.

Table 2. United States Sex Ratio at Birth by Live Birth Order

| Live Birth Order	Sex Ratio (1943-2002)
1	105.7
2	105.1
3	104.7
4	104.4
5	103.9
6	103.4
7	103.1
8+	103.1

*Source: Mathews, T.J. and Brady E. Hamilton. 2005. "Trend Analysis of the Sex Ratio at Birth in the United
States." National Vital Statistics Reports Volume 53, Number 20.*

Figure 1. United States Sex Ratio at Birth by Race of Mother: 1970 to 2002
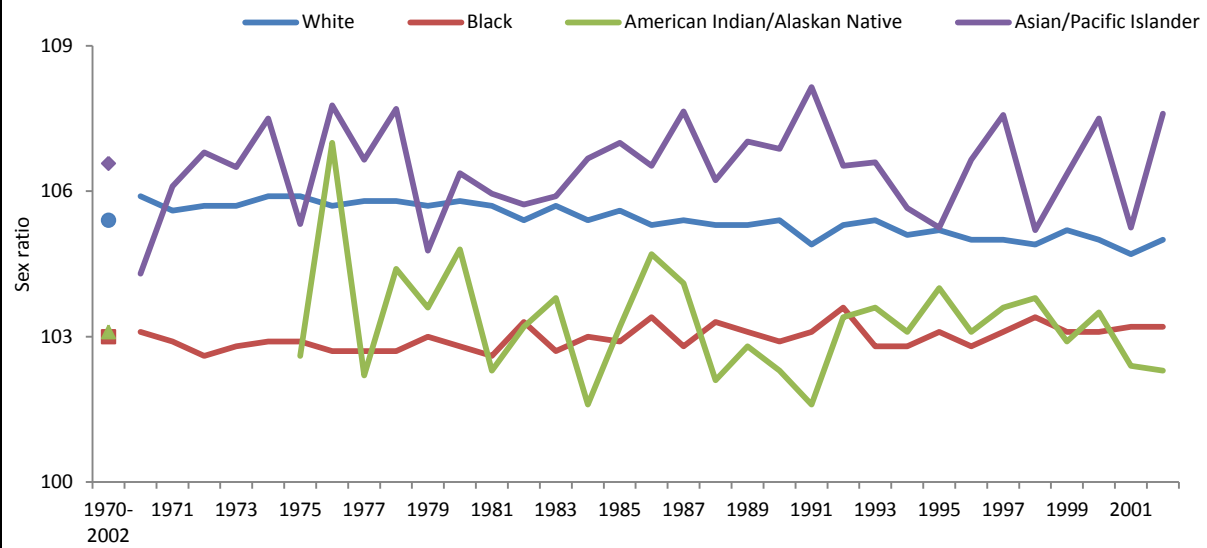
Legend: White, Black, American Indian/Alaskan Native, Asian/Pacific Islander

Source: Mathews, T.J. and Brady E. Hamilton. 2005. "Trend Analysis of the Sex Ratio at Birth in the United States."
National Vital Statistics Reports. Volume 53, Number 20.

Figure 2. United States Sex Ratio at Birth by Live Birth Order among White Mothers: 1990 to 2011

Legend: 1, 2, 3, 4, 5
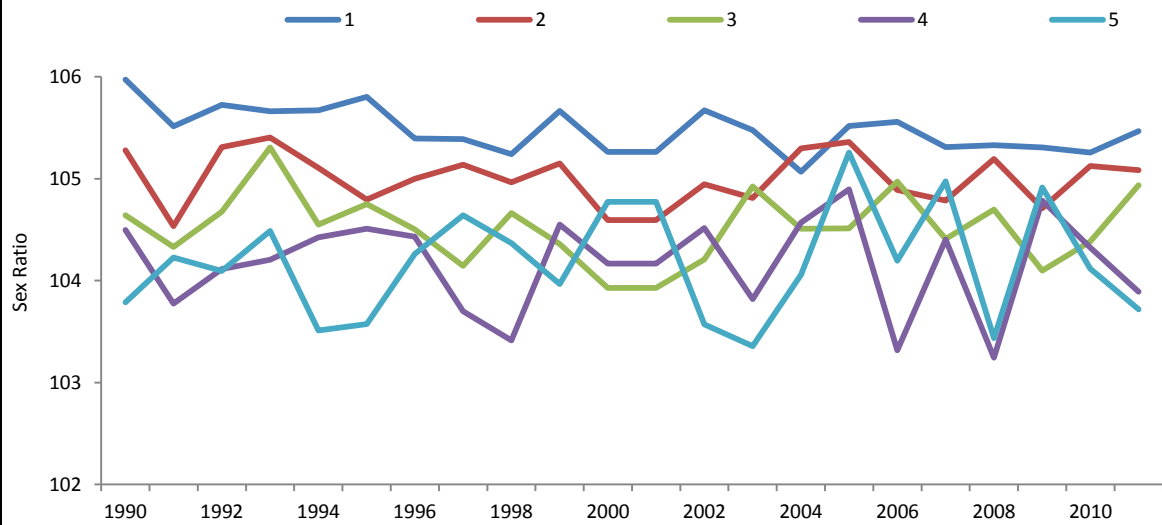
Source: National Vital Statistics System, National Center for Health Statistics (NCHS), Centers for Disease Control.
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