

Secular Trends in Sex Ratio at Birth by Birth Order in South Korea, 1981–2017

Daroh Lim¹, Sang Hwa Park², Inmyung Song¹

¹Professor, Department of Health Administration, College of Nursing and Health, Kongju National University, Gongju; ²Senior Researcher, Institute of Reproductive Medicine and Population, Medical Research Center, Seoul National University, Seoul, Korea

Objectives: This study analyzed secular trends in sex ratio at birth in Korea by birth order using birth records from Statistics Korea between 1981 and 2017. **Methods:** A total of 21,685,402 birth records were used and the sex ratio was measured as the number of males per 100 females. Sex order was categorized into the first, second, and third and higher. Births of unclassified sex order ($n=47,445$) were excluded from the analysis. We conducted logistic regression analyses to test if there are significant changes in sex ratio at birth for all other periods, using the period 1981-1984 as the reference group, and to test if there are significant changes for the higher order births, using the first order births as the reference group. Odds ratio and 95% confidence interval were calculated for each period. **Results:** Since having peaked at 116.5 in 1990, the ratio for total births gradually declined to reach the lowest point of 105.0 in 2016. The sex ratio increased with rising birth order. A baby born for the second and the third and higher birth order was 1.07 (95% confidence interval, 95% CI: 1.06-1.08) and 1.86 (95% CI: 1.85-1.88), respectively, times more likely to be male than a first-born baby for period 1990-1994. **Conclusions:** Having peaked at 209.7 in 1993, the sex ratio for the third and higher order births reverted to the naturally occurring level of 105.5 in 2015. Despite the return, the abnormally high sex ratio for the third and higher order births persisted until the early 2010s.

Key words: Sex ratio, Son preference, Birth order, Korea

INTRODUCTION

The sex ratio at birth is nearly constant if not artificially manipulated by using sex-selective abortion [1]. The sex ratios at birth in the United States have been stable from 104.6 to 105.9 males (per 100 females) between 1940 and 2002 [2]. However, East Asian countries that shared a traditional culture of son preference reported unnaturally high sex ratios at birth [3]. In China, Taiwan, South Korea, India, and Viet Nam, the sex ratios at birth were 108 or more males (per 100 females) at some point by the early 2000s; this imbalance was attributed to son preference and sex selection [4]. The distortion in the natural sex ratio can have undesirable social consequences, such as a disequilibrium in the marriage market [5,6]. This can further have a negative impact on the psychological well-being of never-married men, such as increased depression, aggression,

and suicidal thoughts [7].

The practice of sex selection appeared to increase for higher order births in countries with strong son preference, such as China and Korea, as evidenced by correspondingly rising sex ratios at birth [5]. The sex ratio at birth in Korea increased from 108.9, 117.5, 195.9, to 234.4 for the first, second, third, and fourth order births, respectively, in 1990 [8]. The same association between sex ratio and birth order was not observed in other regions. For example, the neonatal sex ratio was not associated with birth order in Denmark and Israel [1,2] and decreased with rising birth order in the United States [9].

Yoo et al. [10] reported a decline in son preference in Korea. Therefore, it is worth reexamining if the sex ratio at birth by birth order has also changed in Korea in recent years. This study aims to analyze secular trends in sex ratios at birth by birth order based on the latest birth re-

Corresponding author: Inmyung Song

56 Gongjudaehak-ro, Gongju 32588, Korea
Tel: +82-41-850-0324, Email: inmyungs@gmail.com

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cords from 1981 to 2017 in Korea in order to inform population policy.

METHODS

We extracted birth records from Statistics Korea [11]. Using a total of 21,685,402 births from 1981 to 2017, we calculated and plotted the sex ratio at birth [(number of males/number of females) × 100] by year and birth order. Birth orders were classified into three groups: 1st, 2nd, and

3rd and higher birth order. A total of 47,446 births for which birth order was unidentified were excluded from this analysis. To further analyze secular trends in sex ratio at birth by year and birth order, birth data were grouped into a period of 3 to 5 years: 1981-1984, 1985-1989, 1990-1995 ... 2010-2014, and 2015-2017. Consistent grouping of 5 years, which was initially intended, could not be achieved due to limited data availability at the time of this study, so that 3 and 4 years were included in the first and last time periods, respectively. Using the period 1981-1984 as the reference group, we conducted a logistic regression analysis to test if there were significant changes in sex ratio at birth for all other periods. For each period, a logistic regression analysis was performed to test if there was a significant change in sex ratio at birth for higher order births by using the first order births as the reference group. Odds ratios (OR) and 95% confidence interval (CI) were calculated. SPSS Statistics version 23 (IBM Co., Armonk, NY, USA) was used to perform all statistical analyses.

RESULTS

The sex ratio at birth was 109.4 for total births (n=21,685,402) between 1981 and 2017 (Table 1). The sex ratio at birth peaked at 116.5 in 1990 and gradually declined to the lowest point of 105.0 in 2016. A baby born in 1990-1994 was 1.07 times (95% CI: 1.06-1.07) more likely to be male than a baby born in 1981-1984 (Table 2). The odds ratio for a baby born to be male has declined since the mid-2000s and reached 0.98 (95% CI: 0.98-0.99) in 2010-2014.

The average sex ratio at birth was highest for the third and higher order births (132.0), followed by the second order births (108.8) (Table 3). The sex ratio at birth increased with birth order. The sex ratio at birth

Table 1. Sex ratio at birth by year in Korea, 1981–2017

| Year | Sex ratio at birth | Number of births |
|-------|--------------------|------------------|
| 1981 | 107.1 | 867,409 |
| 1982 | 106.8 | 848,312 |
| 1983 | 107.3 | 769,155 |
| 1984 | 108.3 | 674,793 |
| 1985 | 109.4 | 655,489 |
| 1986 | 111.7 | 636,019 |
| 1987 | 108.8 | 623,831 |
| 1988 | 113.2 | 633,092 |
| 1989 | 111.8 | 639,431 |
| 1990 | 116.5 | 649,738 |
| 1991 | 112.4 | 709,275 |
| 1992 | 113.6 | 730,678 |
| 1993 | 115.3 | 715,826 |
| 1994 | 115.2 | 721,185 |
| 1995 | 113.2 | 715,020 |
| 1996 | 111.5 | 691,226 |
| 1997 | 108.2 | 675,394 |
| 1998 | 110.1 | 641,594 |
| 1999 | 109.5 | 620,668 |
| 2000 | 110.1 | 640,089 |
| 2001 | 109.0 | 559,934 |
| 2002 | 109.9 | 496,911 |
| 2003 | 108.6 | 495,036 |
| 2004 | 108.2 | 476,958 |
| 2005 | 107.8 | 438,707 |
| 2006 | 107.6 | 451,759 |
| 2007 | 106.2 | 496,822 |
| 2008 | 106.4 | 465,892 |
| 2009 | 106.4 | 444,849 |
| 2010 | 106.9 | 470,171 |
| 2011 | 105.7 | 471,265 |
| 2012 | 105.7 | 484,550 |
| 2013 | 105.3 | 436,455 |
| 2014 | 105.3 | 435,435 |
| 2015 | 105.3 | 438,420 |
| 2016 | 105.0 | 406,423 |
| 2017 | 106.3 | 357,771 |
| Total | 109.4 | 21,685,402 |

Sex ratio at birth = (number of males/number of females) × 100.

Table 2. Logistic regression of sex ratios at birth in Korea, 1981-2017

| Year | Number of births | Sex ratio | Odds ratio (95% CI) |
|-----------|------------------|-----------|---------------------|
| 1981-1984 | 3,159,669 | 107.3 | 1.00 |
| 1985-1989 | 3,187,862 | 111.0 | 1.03 (1.03-1.04)** |
| 1990-1994 | 3,526,702 | 114.5 | 1.07 (1.06-1.07)** |
| 1995-1999 | 3,343,902 | 110.5 | 1.03 (1.03-1.03)** |
| 2000-2004 | 2,668,928 | 109.2 | 1.02 (1.01-1.02)** |
| 2005-2009 | 2,298,029 | 106.8 | 0.99 (0.99-1.00)** |
| 2010-2014 | 2,297,876 | 105.8 | 0.98 (0.98-0.99)** |
| 2015-2017 | 1,202,434 | 105.5 | 0.98 (0.98-0.99)** |

CI, confidence interval.

**p < 0.01.

Table 3. Sex ratio at birth by birth order in Korea, 1981-2017

| Year | Sex ratio by birth order | | | Year | Sex ratio by birth order | | |
|------|--------------------------|-------|-------|-------------------|--------------------------|-----------|-----------|
| | 1st | 2nd | ≥3rd | | 1st | 2nd | ≥3rd |
| 1981 | 106.3 | 106.7 | 109.1 | 2001 | 105.4 | 106.4 | 141.1 |
| 1982 | 105.4 | 106.1 | 110.6 | 2002 | 106.5 | 107.2 | 140.6 |
| 1983 | 105.8 | 106.1 | 114.5 | 2003 | 104.8 | 107.0 | 136.2 |
| 1984 | 106.1 | 107.2 | 120.5 | 2004 | 105.1 | 106.2 | 132.4 |
| 1985 | 106.0 | 107.9 | 134.4 | 2005 | 104.8 | 106.6 | 128.3 |
| 1986 | 107.3 | 111.2 | 141.7 | 2006 | 105.8 | 106.1 | 121.9 |
| 1987 | 104.7 | 109.1 | 138.1 | 2007 | 104.5 | 106.0 | 115.7 |
| 1988 | 107.2 | 113.2 | 168.9 | 2008 | 104.9 | 105.6 | 116.6 |
| 1989 | 104.1 | 112.4 | 185.9 | 2009 | 105.1 | 105.8 | 114.3 |
| 1990 | 108.5 | 117.1 | 193.7 | 2010 | 106.4 | 105.8 | 110.9 |
| 1991 | 105.7 | 112.5 | 183.4 | 2011 | 105.0 | 105.3 | 109.5 |
| 1992 | 106.3 | 112.4 | 196.4 | 2012 | 105.3 | 104.9 | 109.2 |
| 1993 | 106.4 | 114.8 | 209.7 | 2013 | 105.4 | 104.5 | 108.0 |
| 1994 | 105.9 | 114.2 | 206.9 | 2014 | 105.6 | 104.6 | 106.7 |
| 1995 | 105.7 | 111.7 | 180.3 | 2015 | 106.0 | 104.5 | 105.5 |
| 1996 | 105.2 | 109.8 | 166.1 | 2016 | 104.4 | 105.2 | 107.4 |
| 1997 | 105.0 | 106.3 | 135.5 | 2017 | 106.5 | 106.1 | 106.4 |
| 1998 | 106.2 | 107.7 | 145.0 | | | | |
| 1999 | 105.5 | 107.5 | 142.5 | Total | 105.7 | 108.8 | 132.0 |
| 2000 | 106.2 | 107.4 | 143.6 | (n [†]) | 10,863,909 | 8,446,458 | 2,327,589 |

[†]Excluded birth cases of unclassified birth order.

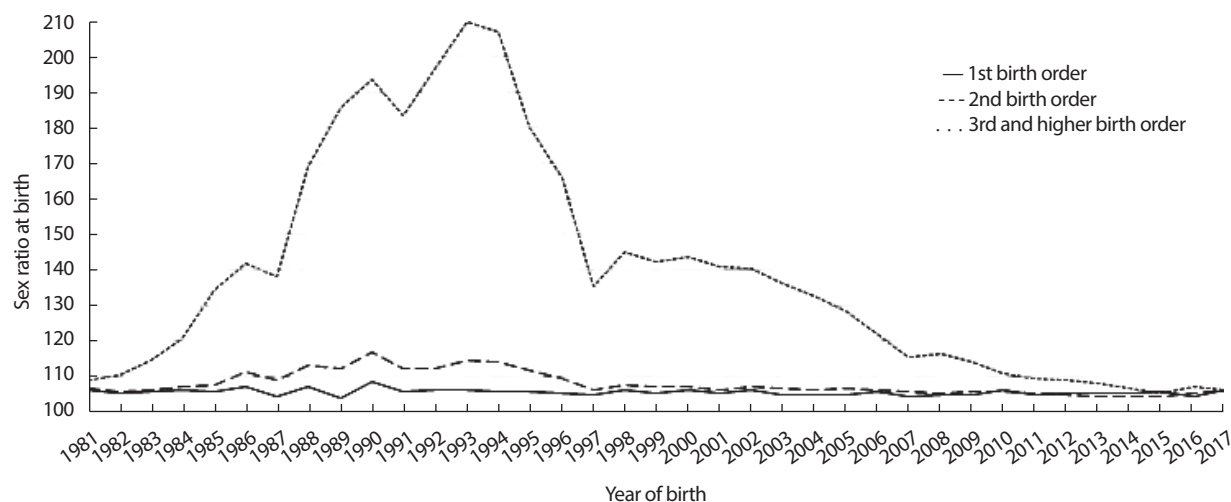


Figure 1. Secular trend of sex ratios at birth by birth order in Korea, 1981-2017.

ranged from 104.1 in 1989 to 108.5 in 1990 for first-born children, from 104.5 in 2013 to 117.1 in 1990 for second-born children, and from 106.4 in 2017 to 209.7 in 1993 for third and higher order births. The difference in sex ratio at birth between first and third and higher order births was greatest in 1993 (Figure 1). Since then, the difference has gradually decreased over time and nearly disappeared by the mid-2010s. In 2015, the

sex ratio at birth was lower for the second (104.5) and the third and higher order births (105.5) than for the first order births (106.0) (Table 3).

A baby born for the second and the third and higher birth order was 1.07 (95% CI: 1.06-1.08) and 1.86 (95% CI: 1.85-1.88), respectively, times more likely to be male than a first-born baby in 1990-1994. Since then, the odds ratio decreased and reached 0.99 (95% CI: 0.99-1.00) for the

Table 4. Logistic regression of sex ratios at birth by birth order in Korea, 1981-2017

| Year | Number of births [†] | Sex ratio by birth order | | | Odds ratio (95% CI) | | |
|-----------|-------------------------------|--------------------------|-------|-------|---------------------|--------------------|--------------------|
| | | 1st | 2nd | ≥ 3rd | 1st | 2nd | ≥ 3rd |
| 1981-1984 | 3,159,645 | 105.9 | 106.5 | 112.2 | 1.00 | 1.01 (1.00-1.01)* | 1.12 (1.11-1.13)** |
| 1985-1989 | 3,187,805 | 105.8 | 110.8 | 149.9 | 1.00 | 1.05 (1.04-1.05)** | 1.42 (1.40-1.43)** |
| 1990-1994 | 3,526,536 | 106.5 | 114.1 | 198.4 | 1.00 | 1.07 (1.06-1.08)** | 1.86 (1.85-1.88)** |
| 1995-1999 | 3,341,532 | 105.5 | 108.7 | 152.6 | 1.00 | 1.03 (1.02-1.03)** | 1.45 (1.44-1.46)** |
| 2000-2004 | 2,651,370 | 105.6 | 106.8 | 139.2 | 1.00 | 1.01 (1.00-1.02)** | 1.32 (1.31-1.33)** |
| 2005-2009 | 2,280,921 | 105.0 | 106.0 | 119.2 | 1.00 | 1.01 (1.00-1.02)** | 1.14 (1.13-1.15)** |
| 2010-2014 | 2,290,980 | 105.5 | 105.0 | 108.9 | 1.00 | 0.99 (0.99-1.00) | 1.03 (1.02-1.04)** |
| 2015-2017 | 1,199,167 | 105.6 | 105.2 | 106.4 | 1.00 | 0.99 (0.99-1.00) | 1.00 (0.99-1.02) |

CI, confidence interval.

[†]Excluded birth cases of unclassified birth order.

* $p < 0.05$, ** $p < 0.01$.

second order births and 1.00 (95% CI: 0.99-1.02) for the third and higher order births in 2015-2017 (Table 4). The numbers of births in Table 3 and Table 4 excluded births of unclassified birth order.

DISCUSSION

Using birth records from 1981 to 2017, we analyzed secular trends in sex ratio at birth in Korea by birth order. The sex ratio at birth in Korea peaked at 116.5 in 1990 and remained at unnaturally high levels until the 2000s. While son preference was an underlying factor to the high sex ratios at birth, the imbalance was likely to be caused by the use of selective abortion based on prenatal sex determination. When the fertility rates were high, families may have achieved their desired sex composition through the random biological process. However, merely the presence of the families who keep bearing children until they give birth to a son did not affect the sex ratio at birth [12]. Instead, the introduction of ultrasound technology in the early 1980s coincided with the increasing sex ratios at birth in Korea [13]. Strong son preference, enabled by the widespread practice of sex selective abortion, may have led to the high sex ratios at birth in Korea in the 1990s when the socially desired family size became smaller [6,14].

While the sex ratios at birth were still increasing in other Asian countries, South Korea was recognized as the first Asian country to reverse the trend of rising sex ratios at birth [15]. In India, the sex ratio at birth was 1.060 in the 1950s, 1.070 in the 1960s, and sharply increased to 1.133 in 2001-2006 [16]. The 2000 census in China showed that there were 120 boys per 100 girls [13]. On the contrary, the sex ratio at birth in Korea, as shown in our data, has gradually declined since the mid-1990s before

reaching the natural levels of 105-106 in the early 2010s.

The decrease in the sex ratio at birth in Korea might have been attributable to a decline in son preference. Women's odds of stating that they must have a son has declined significantly in Korea from 1991 to 2003 [17]. The proportion of married Korean women reporting that it is either necessary or better to have a son has also declined from 69.2% in 1991 to 40.5% in 2012 [10]. den Boer et al. [15] attributed the decline in son preference in Korea to a number of factors: an effective legal attack on patri-lineality, the decline in the importance of agricultural land as a principal asset which tended to be inherited to sons, the increased provision of social insurance for old age, state advocacy for gender equality, and legal sanctions against physicians practicing fetal sex identification [15]. In fact, the percent of parents stating reliance on sons for old age support has declined for all educational levels from the late 1990s to 2006 in Korea [13]. The Medical Law revised in 1987 included a clause of prohibiting fetal sex identification by medical practitioners, although the provision was ruled unconstitutional in 2008 [18].

In addition to a decline in son preference, a number of other factors such as declining family size, increasing maternal age, and increased number of infants per plural birth might have contributed to the decline in the sex ratio at birth in Korea. These factors were reported to be associated with a decrease in the sex ratio at birth in other countries [19,20]. For example, A smaller average family size, as reflected in the declining average birth order, was associated with a decrease in the sex ratio at birth in European countries including Denmark [19]. The sex ratio at birth has declined with advancing maternal age up to 27 years in Latin American countries [20]. The sex ratio at birth decreased with increased number of infants per plural birth in Denmark (1980-1993) and in Swe-

den (1869-2004) [1,21]. The multiple birth rate, measured as the number of multiple births per 1,000 live births, has increased from 10.0 in 1991 to 27.5 in 2008 in Korea [22]. We can also speculate that the declining fertility rates in Korea might have contributed to the decrease in the sex ratio at birth but a future study is needed to examine the relationship.

A study based on all birth records from 1972 to 1990 in Korea showed that the sex ratio at birth did not vary much by birth order (1st to 6th) until 1980; it is only after 1980 that the sex ratio at birth increased with rising birth order [8]. Our data showed that there remained a serious imbalance in the sex ratio at birth by birth order in the 1990s. While the sex ratio for children of the third and higher birth order peaked at 209.7 in 1993, the imbalance in the sex rate at birth for them has persisted until the early 2010s, as shown by the results of our logistic regression analysis. The positive relationship between sex ratio at birth and birth order was also observed in other East Asian countries such as China and Taiwan but not in Western countries [1,3].

Our data indicated that the long-held positive relationship between sex ratio at birth and birth order in Korea has disappeared in recent years. Although the sex ratio for all births has remained high at 132.0 for the entire study period (1981-2017), the annual sex ratio for the third and higher birth orders has become comparable to that for the first and second birth orders by the mid-2010s. As a result, the huge differences in sex ratio at birth between the first- and the third and higher birth orders observed for period 1989-1994 have gradually declined until they disappeared in 2015. Our findings suggest that sex-selective abortion was practiced more often for the fetuses of third or higher birth orders in the past but that the disproportional use of the practice by birth order has decreased as son preference declined.

Our analysis of latest birth records showed that although the sex ratio at birth in Korea returned to the natural levels in the late-2000s, the abnormally high sex ratio for the third and higher birth order persisted until the early 2010s. Consequently, the once considerable variation in the sex ratio at birth by birth order has disappeared only in the mid-2010s. Our findings suggest that son preference, while on the decline in the past several decades, still remained a force that influenced the sex ratio at birth in Korea until the mid-2010s. This study was intended to describe trends in the sex ratio at birth based on latest birth records in Korea but not to explain the reasons for changes in the sex ratio, in large part due to the limitation of the data source used in this study. Future research should use other data sources to investigate what has led to the

drastic changes in the sex ratio at birth, especially for the third and higher order births, in Korea.

CONCLUSION

In conclusion, the sex ratio at birth in Korea has peaked at 116.5 males per 100 females in 1990 and thereafter has gradually declined to the natural levels of 105-106 males per 100 females in the 2010s. For all births between 1981 and 2017, the sex ratio at birth increased with rising birth order. Despite the decrease in the overall sex ratio at birth in Korea, the abnormally high sex ratio for the third and higher birth order disappeared only in the mid-2010s. Although the decline in the overall sex ratio at birth might have been attributable to a decline in son preference, the age-old attitude of parents might have contributed to the persistently high sex ratio at birth especially for the third and higher birth order until the early 2010s.

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국문초록

우리나라 인구의 출생순위에 따른 출생성비의 장기적 동향, 1981-2017

임달오¹·박상화²·송인명¹

¹공주대학교 간호보건대학 보건행정학과 교수, ²서울대학교 의학연구원 인구의학연구소 선임연구원

목적: 본 연구는 1981년부터 2017년까지 출생신고에 의해 집계되는 우리나라의 출생성비 관련 자료를 통계청 국가통계포털에서 이용하여 출생순위에 따른 출생성비의 연도별 추이를 분석하였다.

방법: 성별, 출생 순위별 출생아 21,685,402건을 이용하였으며, 출생성비는 남아수/여아수×100로 산출하였다. 출생순위는 1아, 2아, 3아 이상으로 구분하였고, 출생순위 미상(47,446건)은 본 분석에서 제외하였다. 1981-1984년 출생성비를 기준으로 하여, 다른 기간 동안에 출생성비에 유의한 변화가 있었는지 시험하기 위해서 로지스틱 회귀분석을 실시하였다. 각 연도 구간별로 출생순위 1아의 출생성비를 기준으로 하여 출생순위 2아, 3아 이상의 출생성비의 연도별 증감 폭을 비교 분석하였다. 각각의 기간에 대한 출생성비 교차비(odds ratio) 및 95% 신뢰구간을 분석하였다.

결과: 출생성비는 1990년에 최고점(116.5)을 찍은 후 점차 감소하여 2016년에 최저점(105.0)을 기록하였다. 출생순위가 증가함에 따라 출생성비도 같이 증가하였다. 1990-1994년 동안 출생순위 1군을 기준으로 하여 출생순위 2아, 3아 이상이 남아일 교차비가 각각 1.07 (95% 신뢰구간: 1.06-1.08)과 1.86 (95% 신뢰구간: 1.85-1.88)이었다.

결론: 3아 이상에 대한 출생성비는 1993년 209.7로 최고점을 도달한 후 2015년 105.5로 자연적으로 발생 가능한 수준으로 감소하였다. 그럼에도 불구하고 3아 이상에 대한 비정상적으로 높은 출생성비는 2010년대 초반까지 지속되었다.

주제어: 출생성비, 남아선호, 출생순위