

Article

Changes in Multiple Birth Rates and Parental Demographic Factors in South Korea During the Last Four Decades: 1981–2019

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Abstract

Over the previous decades, twinning rates worldwide have increased remarkably. This study aimed to describe changes in multiple birth rates and related demographic characteristics, such as maternal age and the level of education of parents in South Korea from 1981 to 2019. This study analyzed birth data obtained from the Korean Statistical Information Service. From 1981 to 2019, the total twinning rate increased from 5 to 22.5 pairs per 1000 births. This rapid increase was due to an increase in dizygotic twin births, which mainly occurred in mothers aged between 30 and 39 years. The average maternal age of multiples increased from 26.06 years in 1981 to 33.98 years in 2019, suggesting that a delay in childbearing contributed to the increase in the twinning rate. The percentage of mothers of multiples who completed a college or higher degree (CHD) increased by 1000% from 1981 to 2019, indicating that a sharp increase in the level of education of females in part explains the delay in childbearing. The percentages of individuals who completed a CHD were higher among parents of multiples than among those of singletons in recent years when public funding arrangements for fertility treatments were available. This result suggested that completion of higher education may be associated with increased use of assisted reproductive technology (ART) independent of the financial status of couples. Taken together, the analysis suggested that increased maternal age, ART and the increased number of females who completed CHD may be responsible for the remarkable increase in the rates of multiple births in South Korea in the last four decades.

Keywords: Twinning rate; twin; multiple; parental education; maternal age; assisted reproductive technology

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Twins are powerful and flexible tools to enhance understanding of the biological substrate of complex human diseases and behaviors (Hur et al., 2019; Hur & Craig, 2013). It has been shown that more than 1.5 million twins and their families have participated in various scientific studies worldwide (Hur & Craig 2013). However, multiple births are an area of public health concern because multiple pregnancies are associated with high risks of prenatal and perinatal complications. Furthermore, multiples have higher infant mortality and morbidity rates compared with those of singletons (Ko et al., 2018; Monden & Smits, 2017).

It is well known that although monozygotic (MZ) twin birth rates are relatively constant, naturally conceived dizygotic (DZ) twin birth rates vary across human populations (Bulmer, 1970). Traditionally, DZ twin birth rates were low in East Asia and Latin America, high in Africa, and at intermediate level in Europe and North America (Bulmer, 1970). However, since the 1980s, DZ twin birth rates have increased in many Asian countries, and in Europe, North America and Oceania as a consequence of the widespread use of assisted reproductive technology (ART) and delayed childbearing (Monden et al., 2021). In South Korea, the number of multiple births increased dramatically, whereas

the total number of singleton births decreased by 66% over the past four decades (Korean Statistical Information Service [KOSIS], 2019). Along with these trends, several changes in socio-demographic factors occurred in South Korea. Such changes include the increased use of ART, the implementation of the government's financial aid for ART for subfertile and infertile couples, a sharp increase in years of education especially among females, and delayed marriage and childbearing. For example, in 2019, the average ages at first marriage were 30.59 and 33.37 years for females and males, respectively. However, the corresponding ages for 1981 were 23.00 and 26.40 years for females and males, respectively (KOSIS, 2019). The number of graduates of a college or higher education continued to be higher for males than for females in the past decades. However, this trend was reversed in recent years, indicating that more women are pursuing higher education than men in South Korea. In vitro fertilization (IVF) was introduced in South Korea in 1984; and government financial assistance programs for subfertile and infertile couples for lower income couples were implemented for the first time in 2006. Although the subsidy was given only to lower income couples at the start, it was extended to middle-income couples later. From 2018 onward, infertility treatments were covered by national health insurance so all subfertile and infertile couples in South Korea can gain the benefit. However, additional public funds for fertility treatments are given to lower income couples to overcome the continuously declining fertility rates in South Korea.

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This study aimed to describe the changes in multiple birth rates from 1981 to 2019 in South Korea and to examine parallel changes in demographic characteristics, such as maternal age and educational attainment of parents of multiples and singletons.

Materials and Methods

Information on the plurality of births (i.e., singleton, twin, triplet and other higher-order births), maternal age at birth of multiples and singletons, and educational attainment of parents of multiples and singletons from 1981 to 2019 were selected from the natality file at the KOSIS for data analysis. For data from 1981 to 1999, although the plurality of birth was indicated for each child, twins were not paired in the natality file. Thus, for this period, twins were counted individually instead of pairwise, and the total twin birth rate was calculated as the number of twin individuals per 1000 births. However, the natality file provided data for the number of same- and opposite-sex twin pairs born in each year from 2000 to 2019. Therefore, MZ and DZ twin birth rates were estimated separately using Weinberg’s differential rule (WDR) for the period. As WDR assumes equal birth rates for same- and opposite-sex DZ pairs, the proportion of MZ pairs can be calculated by the difference between the proportions of same- and opposite-sex twin pairs.

Results

Changes in Twin Birth Rates: 1981–2019

Figure 1 shows the twin birth rates by maternal age and the total twin birth rate from 1981 to 2019. Notably, it only includes twins, and excludes triplets and other higher-order births. The figure illustrates that the total twin birth rate remained nearly constant between 1981 and 1991, at approximately 10 twin individuals (i.e., five pairs per 1000 births). This number may reflect the natural twin birth rates in the South Korean population because ART was not common in South Korea during this period. From 1992 onward, however, the total twin birth rate continued to increase and reached about 45 twin individuals in 2019, that is, about 22.5 pairs per 1000 births. The total twin birth rate increased by more than fourfold in the last four decades. Moreover, the figure demonstrates that twin birth rates among mothers between 30 and 39 years of age increased in parallel with the total twin birth rate, whereas twin birth rates among mothers of other age groups either decreased or remained constant. This finding suggested that the increase in the total twin birth rate over the past decades mainly occurred among mothers aged between 30 and 39 years. The monotonic decrease in twin birth rates among women aged less than 25 years may be attributable to delayed marriage and the spread of pharmaceutical contraception in South Korea in recent years, which has reduced the frequency of unplanned pregnancies.

Twin Birth Rates by Zygosity: 2000–2019

Figure 2 shows the MZ and DZ twin birth rates per 1000 births for 2000–2019. The rate of MZ twin births during these years was constant at approximately four pairs per 1000. However, the rate of DZ twin births was approximately five pairs per 1000 in 2000 and increased rapidly to about 18 pairs per 1000 in 2019. Notably, there was a small upswing in 2007, which may be due to the introduction of the government subsidy for ART in 2006. Overall, the trend of DZ twin birth rates paralleled that of the total twin birth rate in Figure 1, indicating that the increase in total twin

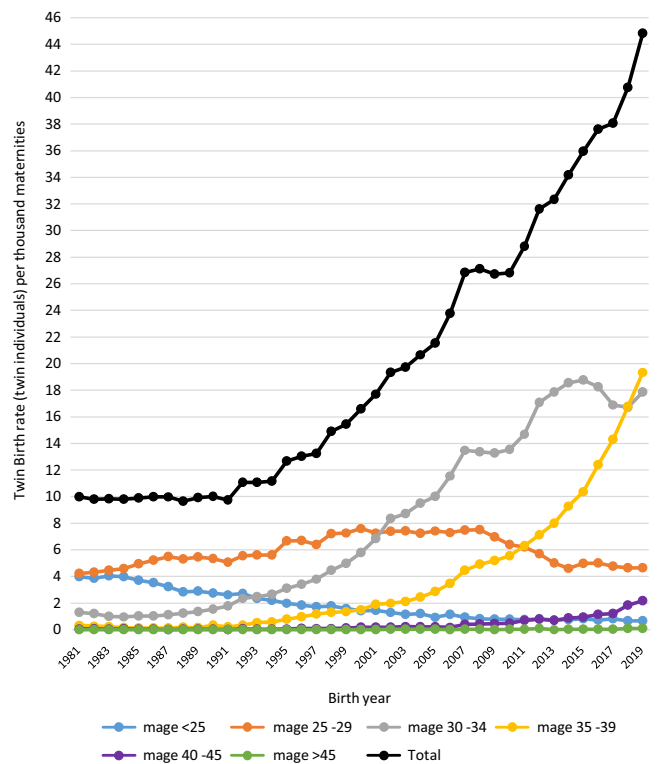


Fig. 1. Twin birth rates by maternal age in South Korea from 1981 to 2019. Twin birth rate was calculated as the number of twin individuals per thousand maternities. Note: Mage, maternal age.

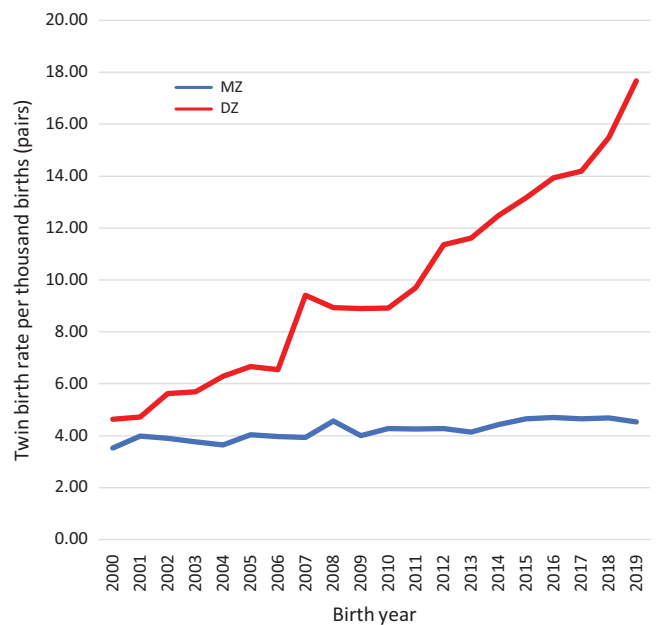


Fig. 2. Monozygotic (MZ) and dizygotic (DZ) twin birth rates in South Korea from 2000 to 2019. Twin birth rate was calculated as the number of twin pairs per thousand maternities.

births in past decades was due to an increase in DZ instead of MZ twins. These increasing numbers of DZ twins are likely due to the consequences of the use of ART and delayed childbearing, given that the rate of the spontaneous DZ twin births in the South Korean population is extremely low.

Trend of Triplet and Other Higher-Order Multiple Births: 1981–2019

Figure 3 depicts the rate of triplet and other higher-order births from 1981 to 2019. As information that differentiates triplets and other higher-order multiple births is unavailable in the natality file, the number of higher-order multiple births per 1000 per year was divided by 3 to calculate the rate, assuming that the number of other higher-order births, such as quadruplets, is negligible. Overall, the rate of higher-order multiple births fluctuated more than that of the DZ twin births shown in Figure 2, perhaps because of the small number of incidence of higher-order multiple births per year. However, despite the rapid upswings in 1995 and 1996, the rate was relatively stable (0.04–0.07 set per 1000 births) until 2006. From 2007 onward, the rate continued to rise until 2019. The upturn in 2007 is likely the result of the public funding arrangement for ART in 2006. The total number of triplets and higher-order births born between 1981 and 2019 was 6844 individuals.

Comparison of Mean Maternal Ages of Multiples and Singletons: 1981–2019

Figure 4 depicts the mean ages of mothers of singletons and multiples (twins and all other higher-order multiple births) from 1981 to 2019. The mean age increased from 25.69 to 32.51 years in 1981 and 2019, respectively, for singletons, whereas the corresponding ages for multiples increased from 26.06 to 33.98 years in 1981 and 2019, respectively. These results suggest that delayed childbearing substantially contributed to the increase in the total twin birth rate over the past decades. Notably, mothers of multiples were older than those of singletons across 1981–2019. The age differences were relatively small in the 1980s and early 1990s when ART was not prevalent in South Korea. From 1992 onward, however, the age gaps continued to increase to 1.47 years in 2019 because the ages of mothers of multiples increased more rapidly than those of singletons in the past decades. If delayed childbearing alone is responsible for the increase in the twinning rate, then the age gap between mothers of multiples and singletons should be comparable before and after the era of ART. However, the age gap became larger with increasing years after the introduction of ART, which suggests that in addition to delayed childbearing, ART played a significant role in the increase of twinning rates.

Comparison of Educational Attainment Between Parents of Multiples and Singletons: 1981–2019

Figures 5(a) and (b), respectively, depict the proportions of mothers and fathers of singletons and multiples who completed college or higher degree (CHD) in each year between 1981 and 2019. Consistent with prior studies (Chambers et al., 2013; Deng et al., 2019), the proportions were slightly higher for parents of multiples than for those of singletons. These results suggested that the utilization of ART became more common among parents of higher than lower education, which reflected the greater ability of the parents with higher education to pay for fertility treatments. Interestingly, despite that public funding arrangements for fertility treatments have been available for lower income couples since 2006, the differences in proportions who completed CHD between parents of multiples and singletons were more pronounced in the recent 10 years. These results suggested that completion of CHD is associated with the increase in twinning rates independent of the financial status of couples.

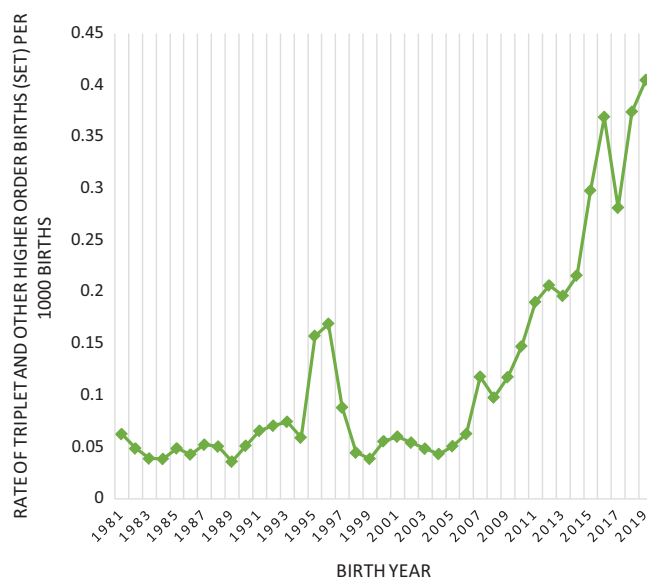


Fig. 3. Rate of triplet and other higher-order multiple births per 1000 births from 1981 to 2019. The rate was calculated by the total number of higher-order multiple births per year divided by three per thousand births, assuming that the number of multiples higher than triplet is negligible.

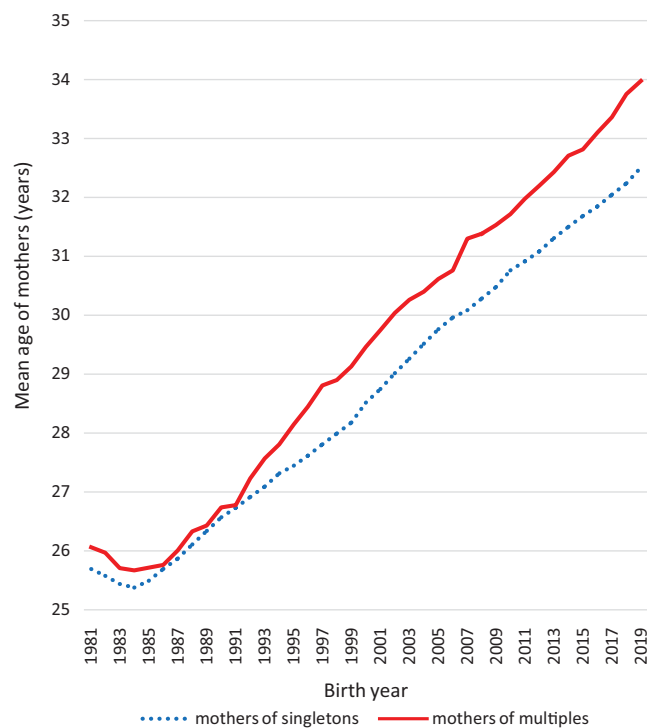


Fig. 4. Mean ages of mothers of singletons and multiples (years): 1981–2019.

Figure 5(a) shows that percentages of CHD increased remarkably in females during the past four decades: They rose by 1200% (6.10% in 1981 to 79.80% in 2019) among mothers of singletons and by 1000% (7.40% in 1981 to 81.40% in 2019) among mothers of multiples. Much smaller increases in educational attainment occurred in fathers (Figure 5(b)) as follows: 462% (13.80% in 1981 to 77.60% in 2019) in fathers of singletons and 411% (15.70% in 1981 to 80.30% in 2019) in fathers of multiples. These results suggest that increased years of education in females

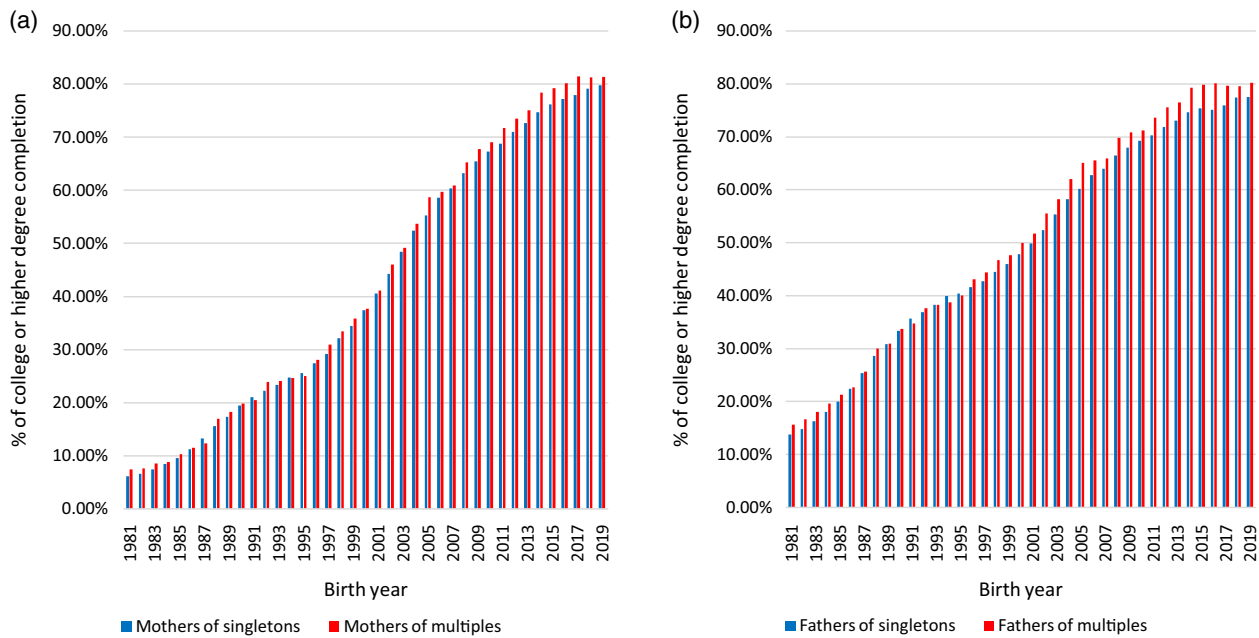


Fig. 5. (a) Proportions of mothers of singletons and multiples with a college or higher degree. (b) Proportions of fathers of singletons and multiples with a college or higher degree.

in the past decades likely caused delayed marriage and child bearing, resulting in the increased use of ART.

Discussion

From 1981 to 2019, the total twinning rate increased sharply from 5 to 22.5 pairs per 1000 births in South Korea. A rate of 22.5 pairs per 1000 means that 1 out of 22 newborn children in South Korea is a twin, which is much higher than the average of 18.8 twin individuals (about 9.4 pairs) per 1,000 in China during 2007–2014 (Deng et al., 2019). In addition, the rate is nearly twice the global twin birth rate of 12.0 pairs reported recently (Monden et al., 2021). The present analysis reveals that this rapid increase was due to an increase in DZ twin births, which mainly occurred among mothers aged between 30 and 39 years. Assuming that the rate of MZ twin births is about 4 pairs per 1,000 across 1981–2019, the rate of DZ twin birth increased from approximately 1–2 pairs in 1981 to about 18 pairs per 1000 in 2019 in South Korea. The rate of triplet and other higher-order multiple births has also increased since 2007. This increasing trend contrasted with that of the USA, where the triplet and other higher-order births peaked in 1998 and declined thereafter (Martin et al., 2016). The decline in the USA was associated with changes in ART practices, such as reducing the number of embryos transferred to the uterus (Hazekamp et al., 2000). In South Korea, the government guidelines for the number of embryos transferred were introduced for the first time in 2008 and were strengthened in 2015.

Many twin researchers to date have suggested that advanced maternal age and the expansion of ART are major factors that influenced the recent sharp increases in twinning rates in developed countries (Monden et al., 2021). The present study suggests that increased years of education in females may be another factor that contributes to the recent increases in twin births. As the natal file in South Korea does not include information on the mode of conception for multiples, determining the rate of multiple births from the use of ART is difficult. However, the rates of multiple births by ART have been reported to be 30% in the USA in

2009 and 20% in Europe in 2010 (Kupka et al. 2014). Among couples who received the subsidy for fertility treatments from the government, the rates of multiple births were estimated to be between 30% and 40% in South Korea (Hwang et al., 2019). Recently, Pison et al. (2016) suggested that, on average, the effect of various fertility treatments was about three times greater than the effect of delayed childbearing on the increases in twin births in developed countries. Especially in Japan, the effect was more than 10 times greater than that of delayed childbearing. However, the effects of advanced maternal age and the use of ART are unlikely independent of each other. In South Korea, the proportions of females who completed CHD increased substantially (over 1000%) from 1981 to 2019. These increases in educational attainment along with increases in labor force participation among females likely contributed to delayed marriage and childbearing. As infertility increases with women's aging (Balasch, 2010), older women who delayed childbearing tend to seek ART more frequently than do younger women, indicating that the use of ART is mainly a consequence of delayed childbearing. In support of this argument, Hwang et al. (2019) reported that among women who received the government subsidy for fertility treatments, the rate of women aged less than 30 years was only 5% in South Korea in 2016.

Notably, the gap in educational attainment between parents of multiples and singletons in South Korea were greater 'after' compared with 'before' the initiation of the policy to provide financial aid for ART. These results suggested that the increase in the completion of CHD in recent decades independently influenced the increase in twin birth rates above and beyond the effect of income levels of couples. Arguably, however, fertility treatments remained expensive for couples with lower socioeconomic status because public funding did not fully cover the cost of treatments in South Korea (Shin et al., 2020). In line with the present investigation, however, Smith et al. (2011) reported that a college degree was associated with a higher probability of achieving pregnancy aided by fertility treatments after adjusting for income of couples and other demographic variables. Previous studies showed that college-educated individuals displayed better overall

health status independent of age (e.g., Braveman et al., 2010). Thus, better health among college-educated than noncollege-educated women may have partly contributed to the increase in the twinning rate. In addition, college-educated couples may have better knowledge and more information on the utilization and outcomes of fertility treatments compared with noncollege-educated couples, which may have influenced the increase in the twin birth rate.

The finding of high levels of educational attainment among parents of multiples than those of singletons has implications in twin studies because the results of twin studies may not be generalized to the population in general when the variables under study are significant correlates of parental socioeconomic status (SES).

Although WDR is widely used to estimate MZ and DZ twin birth rates in the population, controversy exists regarding its validity (Fellman & Eriksson, 2006; James, 1992). However, previous studies showed that WDR is a generally robust and reliable indicator of MZ and DZ twin birth rates, especially in the analysis of large birth registry data (Fellman & Eriksson, 2006). Furthermore, other studies verified the robustness of WDR through comparisons between Weinberg's estimates and the known zygosity of observed data (Vlietinck et al., 1988), and more recently, through comparisons of estimates derived using the maximum likelihood function (Fellman & Eriksson, 2006).

In conclusion, this study indicates that the twin birth rate in South Korea increased more than fourfold during the last four decades. The rate of triplet and higher-order multiple births is also on the increase. Such increases are mainly attributable to the increased use of ART, maternal age and the increased number of women who completed CHD. The rise of multiples in the South Korean population suggests that new policies are required to enhance prenatal and postnatal care for multiples and mothers of multiples given the high risk of adverse health outcomes associated with multiples and multiple pregnancies.

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