

Sex Ratio at Birth(SRB) Transition and the Diffusion Story: Evidence from South Korea

Background & Objective:

In recent decades, South Korea is the only country to show a unique Sex Ratio at Birth (SRB) transition. After drastic ups and downs, the transition epidemic appears to be over. Sex selective abortion was widely thought to be the main contributor to this trend. Despite the enormous focus given to Korea's uniquely fluctuating SRB statistics, and in particular the factors that caused the decrease in the SRB figures, little is known about the socioeconomic factors behind the trend. By employing the diffusion theory with regards to the spread of medical technology and the increase of SRB, this study aims to examine the trends in the proportion of male births (out of the total of annual live births) from 1981 to 2005 in Korea, when social and geographical variations are taken into account.

Methods:

The data was taken from "Vital Statistics Birth" for the period from 1981 to 2005. We computed the annual male proportion of live births according to mother's education (college+, less than high school), mother's occupation (non-manual, manual, housewife/others) and residential patterns (urban – Seoul and city- vs. rural). To compare the time series trends in SRB by subgroups, three year moving average was computed. Logistic regression analysis was employed to estimate the odds ratios of male birth according to social and spatial groups for equidistant three time periods, where the changes were observed (1981-1984 for the rising, 1991-1994, for the peak and 2001-2004 for the falling of the SRB).

Result:

For Seoul dwellers and people with higher social position, the higher male proportion was more prominent until the early 1980's. However, from the late 1980's onwards, a higher male proportion in the less educated, manual job, and country living mothers was observed. The socioeconomic and geographical gap in male proportion was most notable in the early 1990s when the SRB in the country was at its peak. From the late 1990's onwards, however, the gap has since narrowed. The disparity in SRB was still significantly observed in early 2000 by mother's education (OR 1.016, 95% CI 1.010-1.022), by mother's occupation (OR 1.019, 95% CI 1.002-1.037, and by district level (OR 1.033, 95% CI 1.022-1.044).

Conclusion:

This unique South Korean phenomenon of a social and geographical reversal pattern in SRB supports the diffusion theory of populations adopting medical technology for sex selective abortion. The study can therefore conclusively surmise that the results shown in Korea can serve as a model to predict the future trends in countries exhibiting an imbalance in SRB such as China, India, and Vietnam.

Introduction

In recent decades, South Korea (hereafter Korea) is alone in the fact that it is the only country to successfully bring its skewed sex ratio at birth (SRB) back to normal range after experiencing a steep rise in SRB. Sex selective abortion was widely thought to be the main contributor to this trend. With a spread of prenatal sex determination technology since the mid 1980s, the SRB in Korea started to increase, were at its peak in 1990 as of SRB 116, and continued to be high until the early-1990s. After leveling off in mid-1990s, SRB started to slowly decline. The very recent SRB trend (106 as of 2012) suggests that the transition epidemic is over in Korea (Guilmoto, 2009). Since the turn of the century, we can rather observe that child sex preference shifted to daughter in Korean society (Chun & Das Gupta, 2009), with the weakening son preference.

Despite the enormous focus given to Korea's uniquely fluctuating SRB statistics, and in particular the factors that caused the decrease in the SRB figures, little is known about the socioeconomic factors behind the trend. Some recent studies showed the positive relationship with socioeconomic status and SRB in China and India (Guilmoto, 2008; 2009), namely urban dwellers, better educated or the better-off. A recent Korean study (Chun et al., 2009) showed a reversal pattern in associations between parental socioeconomic status (education and occupational class) and SRB; a positive trend for the first stage, but a negative trend for the later stage of SRB transition. We hereby aim to build on the evidence that geographical differentials to medical technology also could have affected the imbalanced SRB trend, which is described as "spatial or horizontal diffusion".

By employing the diffusion theory with regards to the spread of medical technology and the increase of SRB, this current study aims to examine the trends in the proportion of male births (out of the total of annual live births) from 1981 to 2005 in Korea, when social and geographical variations are taken into account. We base our study on the following hypotheses; 1) the imbalance SRB could not have been possible without social intervention in Korea. 2) Sex selective abortion needs the supporting technology such as ultrasound and amniocentesis. 3) Similar to fertility decline (in regards of awareness on and the use of contraceptive), a SRB would have started among "pioneer" groups.

Investigating the socioeconomic differentials and the unique SRB trends by using vital statistics data in Korea would provide historical evidence for the diffusion of innovations in SRB literature.

Specifically, our research sets out to answer the following questions: Can we see the socioeconomic differentials in male births and how are the trends in Korea? Were there social and geographical differentials in the early rise SRB period in 1980s? Who were the forerunner groups? How have social patterns changed in the process of SRB transition: during the SRB rise in early 1980s, during the SRB peak in early 1990s, and during the SRB decrease in early 2000s?

Methods

The study is based on annual birth registration raw data from 1981 through to 2005. We calculated the male proportion of the total births, where SRB 105 is comparable to male proportion 0.512. Vital statistics of South Korea (Births and Death) started to be officially enumerated from 1970 merging family register and vital statistics data. In Korea, the registration of every birth or death is mandatory. The data quality, however, has been evaluated as accurate since the 1980s, when Korean National Statistical Office started the publication of the "Annual Reports on Vital Statistics in Korea" (Choi 1991; Kim 1997).

To illustrate SRB trends in social and spatial diffusion over the last two decades, we considered maternal socioeconomic position and residence: mother's education (college+, less than high school), mother's occupation (non-manual, manual, housewife/others) and residential patterns (urban – Seoul and other cities- vs. rural area). Occupational class was divided into non-manual (legislators, senior officers and managers, professionals, technicians and associate professionals, office workers); manual (service and sales workers, skilled agricultural/ fishery workers, craft and related trades workers, plant/machine operators/assemblers, and unskilled labor); housewife and economically inactive others (students, unemployed and non-employed). Korean vital statistics data does not provide diverse socioeconomic variables other than maternal and paternal education and occupation. Yet, the births data can be reliable in that all the new born babies are registered by law to show the national trends of SRB in Korea. From 16,753,769 births registered in 1981-2005, (a total of 15,912,371) were finally analyzed for this study, with the inclusion criteria that if mother's age is 20-49, and if there is not missing in maternal education, occupation, or birth place variables. In total, the missing variable cases were minimal (0.09%).

To compare the times series trends in male proportions of births by subgroups, three year moving average was computed, for example, the mean of 1981, 1982, 1983 year calculated for 1982 one. Moving average method is widely used to do modeling for linear trends, and is a good

way to capture the general trend by smoothing the fluctuation of data. To adjust for the changes in mother's age structure for the past two decades, we calculated the direct standardized male proportions for trends comparison, with a reference to the women's age structure population from the census of year 2000.

Logistic regression analysis was employed to estimate the odds ratios(and 95%) of male births according to social and spatial groups for equidistant three time periods, where the changes were observed: 1) Phase I. The SRB rising period, 1981-1984; 2) Phase II. The SRB peak period, 1991-1994; and 3) Phase III. The SRB decreasing period, 2001-2004. We merged four year data by each decade, demonstrating the male proportion(SRB) ups and downs in South Korea.

Result

Table 1 shows the study population of numbers of births mother's aged 20-49. The size of births was reduced dramatically by almost 52%, from 833,329 in 1981 to 433,891 in 2005 along with the falling Total Fertility Rate (TFR 2.57 in 1981 to TFR 1.08 in 2005). SRB started to rise in the early 1980s, reaching at its peak in early 1990s, and decreasing in late 1990s.

Figure 1 shows trends in SRB 1981-2005 with three year moving average according to mother's education, mother's occupation, and district level. For Seoul dwellers and people with a higher social position, the SRB was more prominent until the early 1980's. However, from the late 1980's onwards, a higher SRB in the less educated, manual job, and country living mothers was observed. The socioeconomic and geographical gap in SRB was most notable in the early 1990s when the SRB in the country was at its peak. From the late 1990's onwards, however, the gap has since narrowed.

Table 2 shows total numbers of births and the changes in male proportion by three phases in South Korea according to mother's education, mother's occupation, and district level. Mother's education increased dramatically during the study period: the proportion of 'college graduate+' mothers increased from 7.6% in early 1980s to 46.6% in early 2000s. Further analysis(not seen in the table) showed that the proportion of 'less than primary school' mothers decreased from 26.2% to less than 1.0% during the same period. More than 80% of mothers were in the "housewives and others" group (87.3%, 88.6%, 82.8% respectively in three phases), implying the hardship of

work-family balance in Korea. While manual workers decreased from 10.6% to 3.3%, non-manual workers increased from 2.1% to 13.8% during the three phases. During the rising SRB Phase I, there were higher male proportions among mothers with higher education (0.522 vs. 0.517), non-manual group (0.520 vs. 0.515 of manual mothers), and Seoul dwellers (0.519 vs. 0.617 in other city and 0.518 in country). Turning to the SRB peak in the 1990s, the male proportion reversed to be higher in low educated mothers (0.535 vs. 0.528), manual working mothers (0.541 vs. 0.524 of manual workers), and country dwellers (0.537 vs. 0.528 in Seoul and 0.533 in other cities). This higher male proportion among lower socioeconomically positioned mothers and country dwellers appeared to show in the decreasing SRB Phase III, although the differences narrowed.

Table 3 shows the relative inequality by social and spatial diffusion trends. The significantly higher SRB was led by higher education mothers, non-manual mothers, and Seoul dwellers in early 1980s when the sex detecting technology was introduced. But turning to the early 1990s when ultrasound was easily accessible, the relative disparity in male proportions reversed to be favorable to low educated, manual working, and country living mothers. This relative gap was still significantly observed in early 2000 by mother's low education (OR 1.016, 95% CI 1.010-1.022), by manual workers (OR 1.019, 95% CI 1.002-1.037), and by country dwellers (OR 1.033, 95% CI 1.022-1.044).

Discussion and concluding remark

Using the national data of vital statistics and births 1981-2005, this study showed the socioeconomic and geographical differentials and the reversal pattern in male proportions in births, supporting the diffusion innovation theory of SRB transition in Korea. There were positive associations between mothers with higher education, non-manual jobs, and Seoul dwellers and higher male proportions in early 1980s when the national SRB was on the rise. A reverse in patterns was detected in the associations between lower education, manual working mothers, and country dwellers in early 1990s when the SRB rise was at its peak. The reversed association remains apparent up until the early 2000s when the SRB was on the decline.

The reasons behind the rise and fall in SRB transition in Korea have been explored in large body of studies (Chun and Das Gupta, 2009; Chung and Das Gupta, 2007; Guilamoto 2009). The results indicated that the availability of sex selective abortion technology in society based on strong son

preference and patriarchal culture aggravated the skewed SRB in low fertility. The decline has slowly continued since the late 1990s, supported by social and governmental efforts against gender discrimination, such as campaigns, law, and policy. Urbanization and modernization could also have affected changes in the family structure and the value of a son. A study (Chung and Das Gupta, 2007) argued that government policy was not that effective in regards to the decreased pace of the Korean SRB.

Our result of socioeconomic differentials in the SRB and the reversal pattern could be likened to that of fertility decline. In the same process, more educated women and city dwellers could readily adopt contraceptive methods with better information and accessibility than that of their lower-educated, rural dwelling counterparts. Alternatively, more educated women could have higher autonomy when choosing to give birth. A Korean study (Kim et al., 2006) on fertility differentials showed the strong effect of women's education on the decline of fertility level. The study showed the inverse relationship between mother's education and numbers of children; five children of primary school mothers, four of middle school mothers, and three of high school + mothers in 1982; the numbers decreasing to four, three, and two in 1988.

The result showed the reversal pattern in higher SRB from higher SEP mothers in early 1980s to lower SEP mothers in 1990s. This could be explained by the changes in the characteristics of induced abortion. There have been mixed results about individual socioeconomic position, the son preference, and the rate of induced abortion experience in Korea, according to time points, the place, or methodology. The discussion could be very limited with previous studies depending on the samples of certain groups, apart from the privacy of abortion or sexuality issues. This current study covers all the births in Korea - from 1981 to 2005 and could suggest the implication of national trends in socioeconomic differentials in SRB transition. The National Fertility Survey in Korea with married women showed a similar trend in experiences of abortion over the past three decades according to geographic variations.

This diffusion hypothesis in the study could be also supported by the spread of ultrasound machines in Korea (Chun et al., 2009). The medical technology was firstly imported to SNU hospital (2 machines) and to Choongang hospital (1 machine) in 1978. The Korean-made ultrasound was successfully developed by GS in 1983. After the Medicine Co. initiated its business in Korea in 1985, cheap, domestic ultrasound machines became widespread. No specific data is available regarding the increase in the number of ultrasound machine in Korea. The

Korean Radiological Society shows rough information; from about a thousand machines nationwide in 1984 to about 10,000 in 1995, perhaps supporting the diffusion of the study result.

In conclusion, this unique South Korean phenomenon of a social and geographical reversal pattern in SRB supports the diffusion theory of populations adopting medical technology for sex selective abortion. The study can therefore conclusively surmise that the results shown in Korea can serve as a model to predict the future trends in countries exhibiting an imbalance in SRB such as China, India, and Vietnam.

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Table 1. Numbers of births, SRB, and male proportions of mother's aged 20-49, Vital Statistics Birth, Korea, 1981-2005

	Study population of mother's aged 20-49			Korean National Statistical Office
	No of births	SRB ((M/F)*100)	Male proportions (m/total)	TFR
1981	833,329	107.0	0.517	2.57
1982	817,998	106.7	0.516	2.39
1983	742,644	107.3	0.518	2.06
1984	651,375	108.2	0.520	1.74
1985	666,078	109.4	0.522	1.66
1986	616,476	111.8	0.528	1.58
1987	607,697	108.7	0.521	1.53
1988	619,343	113.4	0.531	1.55
1989	595,863	112.9	0.530	1.56
1990	639,954	116.6	0.538	1.57
1991	699,368	112.5	0.529	1.71
1992	720,359	113.7	0.532	1.76
1993	705,863	115.4	0.536	1.65
1994	711,581	115.3	0.536	1.66
1995	705,281	113.3	0.531	1.63
1996	650,401	111.8	0.528	1.57
1997	636,806	108.5	0.520	1.52
1998	631,243	110.1	0.524	1.45
1999	605,970	109.6	0.523	1.41
2000	627,781	110.2	0.524	1.47
2001	548,665	109.0	0.522	1.30
2002	487,053	109.9	0.523	1.17
2003	485,674	108.6	0.521	1.18
2004	471,678	108.1	0.519	1.15
2005	433,891	107.6	0.518	1.08
Total	15,912,371			

Fig 1. Social and spatial diffusion: Trends in male proportions according to mother's education, mother's occupation, and district level: three year moving average, 1981-2005

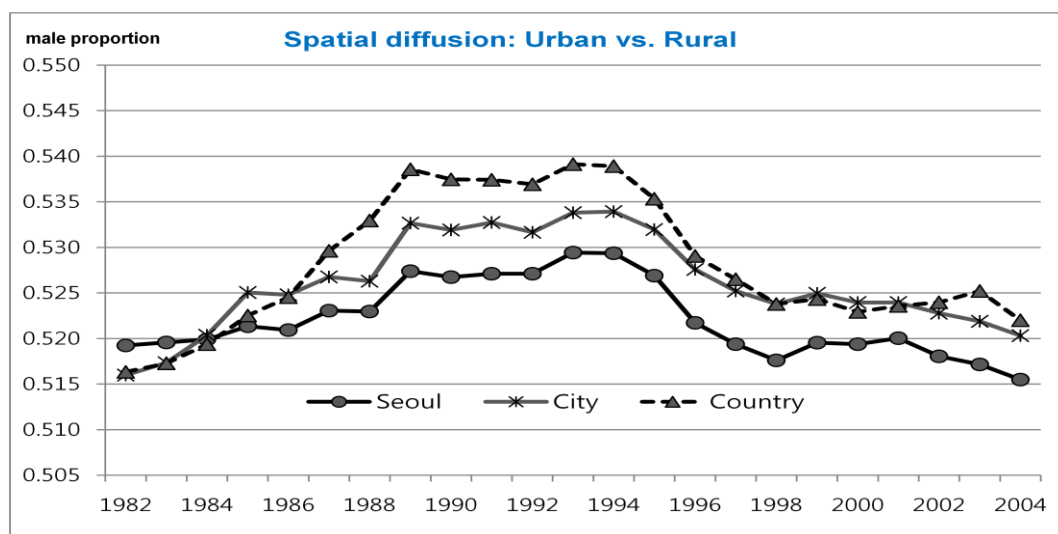
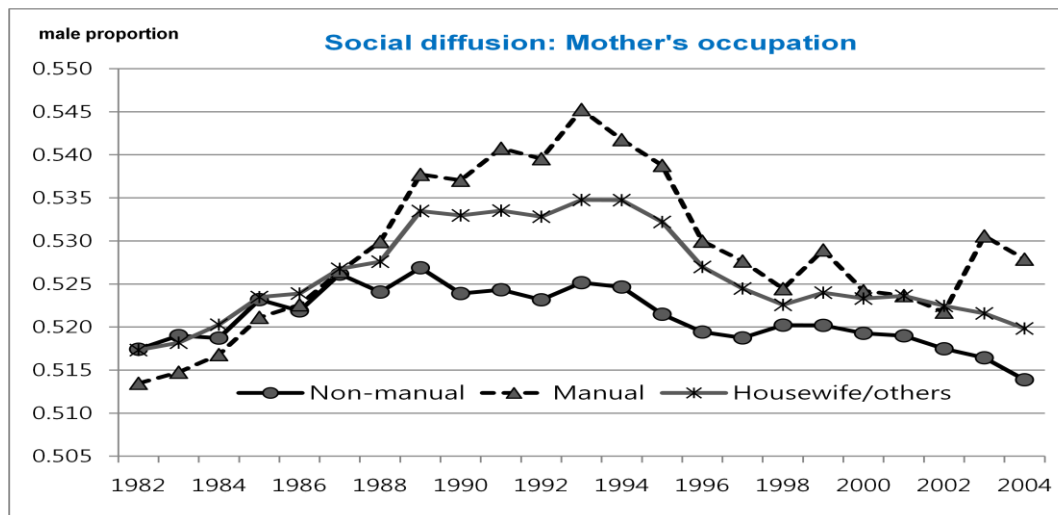
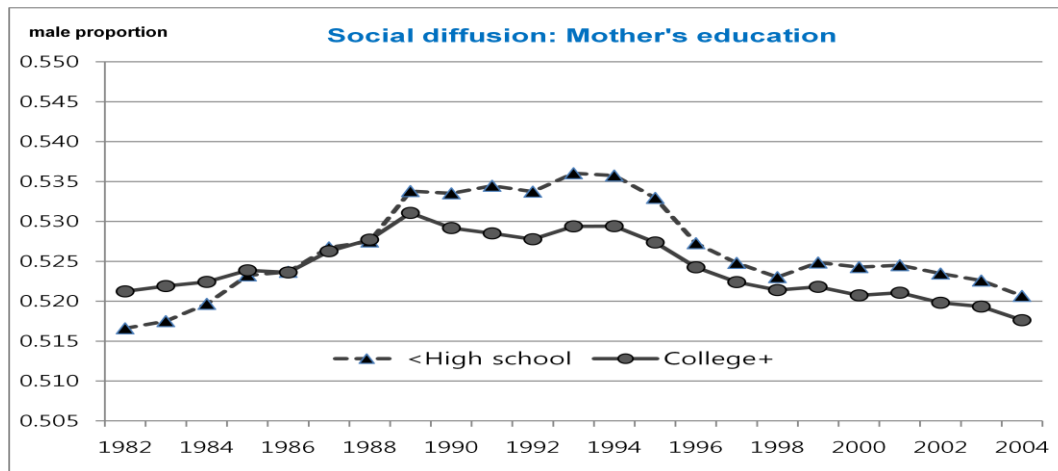


Table 2. Numbers of births and the male proportion by mother's socioeconomic position and district level, 1981-1984, 1991-1994, and 2001-2004, Birth Vital Statistics, Korea

	1981-1984		1991-1994		2001-2004	
	Total-birth (N)	Male-births (N (%))	Total-birth (N)	Male-births (N (%))	Total-birth (N)	Male-births (N (%))
Mother's Education						
College+	222,062	115,889 (0.522)	649,143	342,858 (0.528)	923,850	479,687 (0.519)
< High school	2,822,973	1,459,905 (0.517)	2,161,671	1,155,509 (0.535)	1,059,533	553,998 (0.523)
Total	3,045,035	1,575,794 (0.518)	2,810,814	1,498,367 (0.533)	1,983,383	1,033,685 (0.521)
Mother's Occupation						
Non-Manual	63,995	33,250 (0.520)	208,040	108,976(0.524)	271,218	140,055 (0.516)
Manual	322,250	165,845 (0.515)	110,994	60,019(0.541)	64,981	33,994 (0.526)
Housewife/others	2,658,577	1,376,593 (0.518)	2,487,937	1,327,293 (0.534)	1,624,473	847,724 (0.522)
Total	3,044,822	1,575,688 (0.518)	2,806,971	1,496,288 (0.534)	1,960,672	1,021,773 (0.521)
District						
Seoul	734,042	381,127 (0.519)	708,306	374,027 (0.528)	410,393	212,354 (0.517)
City	1,147,749	593,083 (0.516)	1,132,719	603,537 (0.533)	1,384,027	722,469 (0.522)
Country	1,163,555	601,720 (0.517)	996,146	535,171 (0.537)	198,650	104,207 (0.525)
Total	3,045,346	1,575,930 (0.518)	2,837,171	1,512,735 (0.533)	1,993,070	1,039,030 (0.521)

Table 3. Trends in mother's age-adjusted odds ratio(and 95% confidence interval) of boy births from mothers aged 20-49 according to mother's SEP (education and occupation) and district level: 1981-1984, 1991-1994, and 2001-2004, Vital Statistics Birth, Korea

	1981-1984	1991-1994	2001-2004
Mother's Education			
College +	1	1	1
< High school	0.983 (0.975 - 0.992)	1.039 (1.033 - 1.045)	1.016 (1.010 - 1.022)
Mother's Occupation			
Non-Manual	1	1	1
Manual	0.981 (0.964 - 0.997)	1.069 (1.054 - 1.085)	1.019 (1.002 - 1.037)
Housewife/others	0.997 (0.981 - 1.012)	1.055 (1.045 - 1.064)	1.016 (1.008 - 1.024)
District			
Seoul	1	1	1
City	0.991 (0.985 - 0.997)	1.026 (1.019 - 1.032)	1.021 (1.014 - 1.028)
Country	0.992 (0.986 - 0.998)	1.048 (1.042 - 1.054)	1.033 (1.022 - 1.044)