Late Childbearing and Changing Risks of Adverse Birth Outcomes in Korea

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Abstract

Objectives
This study aimed to examine whether the relative importance of maternal age as a correlate of adverse birth outcomes has changed and to investigate if social inequalities in birth outcomes have widened during the past decade when the marriage and fertility related social environment has undergone tremendous change in Korea.

Methods
Probabilities of adverse birth outcomes (prematurity and IUGR) were estimated by multinomial logistic regression models, utilizing the Korean birth registration data of 1995 and 2005. Main effects of this research (maternal age and parental socioeconomic characteristics) were compared between two study years, net of infant sex, birth order, and plurality.

Results
The role of maternal age in determining adverse birth outcomes, relative to the maternal and parental social characteristics, has clearly diminished between 1995 and 2005. During this period, differences in prematurity and IUGR by maternal age have also diminished, while those by parental social characteristics, particularly maternal education, have substantially widened.

Conclusions
The intensified overall socioeconomic polarization since the economic crisis of the late 1990s is mainly attributable to the increased social inequality of adverse birth outcomes in Korea. A massive structural change in macro-economic conditions and culture during the study period may have modified the relationship between maternal age and birth outcomes as the biosocial perspective suggests.

Key Words: adverse birth outcome, maternal age, socioeconomic conditions, inequality

Words counts: Abstract: 211; Text: 3,204

Introduction

In recent years, the mean age of first childbearing has substantially increased in South Korea (from 26.5 years old in 1995 to 29.1 in 2005, Korea hereafter). While the total number of births in the country has gradually decreased since 1985, the share of births born to mothers aged 35 or above has increased from 2.1% in 1985 to 8.4% in 2003 (1). Active female labor force participation due to increased educational attainments, late marriage, increases in infertility treatment technology, and extended employment insecurity due to the economic crisis of the late 1990s have been reported as contributors to delayed childbearing (2-4). The reduced number of births and increase in the average maternal age of childbirth have resulted in the very low total fertility rate (TFR) in Korea. During the past decade, the TFR plummeted from 1.65 in 1995 to 1.08 in 2005.

Very low fertility, mainly caused by delayed childbearing, has generated a national concern, because it has been well documented that advanced maternal age is one of the critical risk factors for adverse birth outcomes and/or delivery-related complications (5-7). A few Korean studies (8-10), mostly based on hospital clinical records, have also provided empirical evidence that delayed delivery of first child is significantly associated with maternal prenatal complications (such as hypertensive diseases, gestational diabetes, premature rupture of membranes, and uterine myoma during pregnancy), delivery complications (such as NICU admission, breech presentation and cesarean section), and adverse birth outcomes (such as low birth weight, intrauterine growth retardation, congenital anomalies, and perinatal mortality).

Although such observations are pertinent, one should not ignore the fact that postponement of childbearing in Korea is related to various social factors. That is,

having a first child at an advanced age (e.g., 30 and over) today implies the same elevated risk of adverse birth outcomes as compared to a decade ago from a biological perspective. However, from a social perspective, it may imply very different meanings today as compared to the past. For example, Korean culture once considered late marriage and childbearing as abnormal or something that had to be avoided, whereas no such culture exists anymore in recent Korea due to the prevalence of delayed marriage and childbearing. For instance, Korean society used to stigmatize unmarried women over the desired age of marriage (e.g., 26 to 27) as "Old Miss," but it now respects unmarried professional women in their 30s by calling them "Gold Miss." (11)

Given such changes in the social meaning of childbearing at advanced ages during the past decade, along with improved medical technologies regarding prenatal care, it is presumable that the importance of maternal age for adverse birth outcomes relative to other *social* risk factors may have been diminished over time in Korea. Indeed, there have been quite a few international studies that examined advanced maternal age as a main cause of an increased prevalence rate of adverse birth outcomes (12-15). However, there has been scarce research that looks at the changes in the magnitude of risk factors, including maternal age, for adverse birth outcomes during a period when norms and culture vis-à-vis childbearing were substantially modified due to various social causes.

This paper addresses two research questions. First, have the relative risks of adverse birth outcomes across maternal age categories in Korea changed during a time period (1995-2005) in which the maternal age distribution of childbirth, as well as the overall level of Korean fertility, has experienced tremendous fluctuations? Second, during this same time period, has the relative risk of adverse birth outcomes become

wider across social status categories (e.g., maternal education, paternal education) in Korea?

Materials and Methods

We use the Korean birth registration data of 1995 and 2005. All births are required by law to be registered by parents, family members, or a legal guardian at a community administrative office. Information required at birth registration includes the demographic profiles of parents (i.e., address, education, occupation, age, marital status, marriage date, and marriage duration), maternity-related characteristics (parity of all births and parity of all live births), and demographic and biological profiles of the infant (i.e., gestational age, birth weight, birth order, birth plurality, birth date, and place of birth). Information on the biological profiles of infants is recorded based on the birth certificate issued by an obstetrician, and over 99% of all births from 1995 to 1997 were delivered at clinics (16). There were 727,556 and 438,062 births in 1995 and 2005, respectively. After omitting births with missing information on variables used in the analysis and births by mothers aged less than 20 or greater than 50 years old, 710,056 and 428,544 births, respectively, are analyzed here. We do not include births of teenage mothers here since they are a selective group with a high risk of adverse birth outcome. Less than one percent of total births were to teenage mothers in each year studied here.

Birth outcome is classified into three groups by the combination of gestational age and birth weight: premature (<37 weeks and <2,500g), intrauterine growth retardation (IUGR, $\geq$ 37 weeks and <2,500g), and normal ($\geq$2,500g). The usefulness of such a classification of birth outcome has widely been reported (17-19). We divide maternal age into four categories: 29 or lower, 30 to 34, 35 to 39, and 40 and over. Since parity and plurality are important risk factors of adverse birth outcomes, they are

included in the analyses here. Social risk factors considered in this study are maternal and paternal educational attainments and occupations. Information on marital status is available in the birth registration file but not used here since unmarried childbearing is very rare in Korea. Educational attainments are classified into three levels: less than 10 years (junior high or less), 10-12 years (at least some high school), and 13 or more years (at least some college). For occupation, we use the following four categories: professionals, white collar workers, blue collar workers, and other occupations. We include mother's occupation only in the descriptive analysis, but not in the regression results due to the following reasons. In Korea, women tend to choose to leave their occupation when they become pregnant. This was more so the case in 1995 than in 2005. Changes in occupational status due to pregnancy may obscure the relationship between maternal occupation and adverse birth outcomes. Further, housewife was not considered as a single independent occupational category in the 1995 birth registration; it was combined with another occupational category that included the unemployed and those not in the job market. Thus, for the descriptive analysis, housewives were classified together with "other" occupations.

Multinomial logistic regression analysis is used for the multivariate analyses to take into account the trichotomous nature of the dependent variable. Our multivariate results are analyzed in two ways: the first focuses on the predicted probabilities of each adverse birth outcome from models progressively including control variables; and the second examines the effect of risk factors on birth outcomes from the most saturated model, paying particular attention to the changing importance of each risk factor during the study period.

Findings

Table 1 presents the percentage distributions of risk factors by birth outcome for 1995 and 2005. Reflecting the recent trend toward very low fertility, there was a 39% reduction in the total number of births, roughly from 710,000 to 430,000, between the two study years. Further, the distribution of maternal age shows a substantial advancement toward higher maternal age in 2005. Over half of all births in 2005 were by mothers who were at least 30 years old, while this was the case for only about a quarter of all births in 1995. Such advancement in maternal age, however, has not been associated with a notable increase in the proportion of adverse outcomes in 2005 as compared to 1995. Proportions at the bottom of table indicate that the risk of premature birth has increased during the period (1.37% to 2.45%), while that of IUGR has decreased (2.01% to 1.84%). Overall, the proportion of adverse birth outcomes increased slightly from 3.38% in 1995 to 4.29% in 2005. Compared to the substantial delay of maternal age, the extent of the increase in the proportion of adverse birth outcomes during the study period is small. The pattern of increased risk of prematurity and slightly decreased risk of IUGR over time was also observable in all obstetric and social risk factors. Regarding parents' social characteristics, several changes over time were notable. Parents' overall educational attainments were much more favorable in 2005 compared to 1995. Mothers and fathers with some college experience comprised 26% and 41% of all births in 1995, respectively; these figures increased to 56% and 61% in 2005. The proportion of mothers with any types of occupation rose from about 13% to 22% during the study period. In sum, adverse outcomes became slightly worse and social conditions changed quite considerably during the decade-long study period.

-- Table 1 about here --

Table 2 depicts the predicted probability of each adverse birth outcome from multinomial logistic analyses based on models that progressively include control variables. The predicted probabilities in column (a) are from a baseline model that controls for infant sex, parity, and plurality. Column (b) shows the predicted probabilities when maternal age is added to the baseline model. Predicted probabilities in column (c) are calculated from a model with controls for parental social characteristics (mother's education, father's education, and father's occupation). Finally, the predicted probabilities in column (d) are from a full model that included all risk factors.

-- Table 2 about here --

Net of infant sex, parity, and plurality, the probability of a premature birth was higher in 2005 (1.88) than in 1995 (1.26). Additional considerations of maternal age in model (b) and parental social characteristics in model (c) reduced the predicted probability of prematurity in both years. However, the magnitude of reduction was greater when maternal age was controlled in 1995, whereas parental social characteristics played a substantial role in 2005. Even after controlling for all variables in a full model (d), the chance of premature birth was still greater in 2005 than in 1995. Regarding IUGR, parental social characteristics played a much more important role than did maternal age in reducing its predicted probability in both years. Note that the probability of IUGR was greater in 1995 than in 2005 throughout all models, unlike the case of prematurity. To sum, the importance of maternal age has decreased, while that of parental social characteristics increased in predicting premature birth between 1995 and 2005. Parental social characteristics were more important than maternal age in predicting IUGR births in both years.

Table 3 presents odds ratios (with their 95% confidence intervals) from the full model introduced in the previous table. This table allows us to see how the different risks of prematurity and IUGR changed across categories of each control variable. As observed from the descriptive analysis in Table 1, odds ratios increase with maternal age for both adverse birth outcomes and in both years. However, for both birth outcomes, the magnitude of the odds ratios decreased in 2005 compared to 1995, indicating a reduced disparity regarding prematurity across the four maternal age intervals. For instance, the odds ratios of prematurity and IUGR for mothers aged 30 to 34 decreased during the study period from 1.45 to 1.23 and from 1.17 to 1.09, respectively. Male and second or higher birth order infants were significantly less likely to be born premature or IUGR than their female and first birth counterparts in both years. The risk of adverse birth outcomes for plural births notably increased during the study period. This may be attributable to the improvement of neonatal care technologies which have increased the chances of survival for plural infants. Indeed, a similar trend was reported in the U.S. (20). Odds ratios for mother's educational attainment for both adverse birth outcomes increased in magnitude in 2005 compared to 1995. This indicates that disparities in birth outcomes by mother's education became wider and more significant during the study period. The same trend is also observable for father's educational attainment. Of importance is that infants born to mothers with a high school experience were at a significantly higher risk of adverse birth outcomes than those infants born to college educated mothers in 2005, which was not observable a decade ago. To sum, the risk of having a premature or IUGR birth became notably diminished among mothers of advanced ages relative to younger mothers over the study period, while risk for mothers with lower levels of education relative to highly educated mothers clearly grew.

Discussion

This study aimed to examine whether the relative importance of maternal age as a correlate of adverse birth outcomes has changed and to investigate if social inequalities in birth outcomes have widened during the past decade when the marriage and fertility related social environment has undergone tremendous change in Korea. Comparison of predicted probabilities of each adverse outcome indicated that the role of maternal age, relative to the maternal and parental social characteristics, has clearly diminished between 1995 and 2005. Further, odds ratios from the most saturated model showed that differences in prematurity and IUGR by maternal age have diminished, while those by parental social characteristics, particularly maternal education, have substantially widened.

Given the universal health insurance system implemented since 1989, these findings pose several important public health implications for Korean society. As social interest in childbearing grows since the early 2000s due to very low fertility, the insurance coverage for prenatal care, delivery, and postnatal care services has also expanded. For instance, special prenatal care services (e.g., Rubella test and congenital anomaly test), most delivery costs, and the admission into NICUs associated with low birth weight became the subject of health insurance coverage in the early 2000s. Moreover, insurance coverage used to be applied only to two children per woman because of the Family Planning Policy to discourage childbearing in 1995. Of course, this policy does not exist anymore due to the current levels of very low fertility. Then why, despite the substantial increase in the quality and quantity of health insurance coverage for childbearing, has social inequality in birth outcomes widened over the

recent decade-long study period in Korea?

One possibility is that the intensified overall socioeconomic polarization since the economic crisis of the late 1990s is mainly attributable. When the Korean economy was shaken by the currency crisis and financial insecurity in 1997 and 1998, the Korean government accepted the neo-liberal market economic system as advised by the International Monetary Fund (IMF). This new economic system resulted in a reorganization of the Korean economic structure that included immediate enforcement of policies increasing flexibility in the labor market, a substantial opening of capital markets, and active attraction of overseas capital and installment of the Economic and Social Development Commission to control and systematize labor union movements (21, 22). Under this new system and subsequent legalization of layoffs during corporate restructuring, companies, regardless of their sizes, began to actively utilize human resource policies that replaced regular workers with non-regular workers. Increased insecurity in the job market and employment quickly resulted in the deterioration of the distribution structure by creating a sharp increase in the number and share of non-regular jobs and a rapid surge in the size of the working poor population apart from the traditional poor, which then gave rise to growing inequalities and socioeconomic upheaval among all poor Koreans (23, 24). During the economic crisis--toward the end of 1997 and beginning of 1998--Koreans with low educational attainment experienced larger drops in labor force participation rates and a sharper increase in unemployment rates, compared to their counterparts with higher levels of education. Even after the economic crisis, the unemployment rate for these populations failed to stabilize and continues to increase, which has resulted in a rapid polarization of socioeconomic conditions (25, 26). This situation was clearly evidenced by the *Gini* coefficient, an

index of income distribution, which increased in Korea from 0.283 in 1997 to 0.337 in 2006 (21).

Such intensified polarization of socioeconomic conditions may have affected birth outcomes through at least the following two ways. First, despite the overall improvement of universal health insurance coverage, a number of special prenatal care services, which particularly involve costly and sophisticated medical technologies (e.g., sonogram, amniocentesis, and pap-smear), had to be paid by patients, even in 2005. Economic polarization may have created unequal access to high-quality prenatal care services across socioeconomic groups. The function of advanced medical technology, when not comprehensively covered by health insurance, in widening socioeconomic disparity in health has already been documented (27). Second, the 'weathering effect', hypothesized by Geronimus (28, 29) to explain an increasing risk of low birth weight with advancing maternal age among blacks in the US, may have also played out in Korea among mothers with low educational attainment. As noted earlier, the advancement of maternal age is a clear fact in recent Korea. Under the circumstance of intensified socioeconomic polarization, delay of childbearing among mothers of low socioeconomic status may mean prolonged exposure to various risks for adverse birth outcome among the most socioeconomically disadvantaged segment of the population.

The finding of decreasing relative importance of maternal age for birth outcomes over the study period can be understood from a biosocial perspective. That is, physiological processes (e.g., aging or metabolism) are significantly affected by their interactions with social conditions such as culture and the social environment (30, 31). Although this study took place over a relatively short period of time (from 1995 to 2005), the Korean economic situation has undergone the aforementioned tremendous

structural changes. Further, the marriage and childbearing-related culture has been enormously altered, which was resulted in very low fertility. In fact, this fluctuation in economic conditions has been reported to be a main factor associated with the change toward both lower fertility and later childbearing (32, 33). Thus, a massive structural change in macro-economic conditions and culture during the study period may have modified the relationship between maternal age and birth outcomes in Korea. However, one should not ignore that maternal age is still one of the important risk factors of adverse birth outcomes in Korea, in spite of its decrease in relative importance.

Recently, the Korean government announced that they will implement a voucher system to help all pregnant women better access quality prenatal care services beginning in 2009. It is a need-based voucher (valued at about US $200) that can be used toward both co-payments for covered prenatal care services and out-of-pocket payments for non-covered services. It is clear that such a change is necessary, given the recent increases of social inequalities in risk for adverse birth outcomes. However, as several studies (34, 35) point out, improved access to prenatal care services may not be a sufficient condition for diminishing social inequalities in birth outcomes, because health-related behaviors and health status prior to and during pregnancy play a more important role in determining birth outcomes. Therefore, more academic and policy attention should be paid to the health promotion of women aged 20s and 30s, particularly those with a low educational attainment. Korean society should not ignore that to insure healthy childbearing is as important as to promote fertility for its future.

Acknowledgement

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Table 1. Percentage distributions of risk factors by adverse birth outcomes among Korean infants born in 1995 and 2005.

	1995 (N=710,056)				2005 (N=428,544)			
	Prematurity	IUGR	Normal	Sub total	Prematurity	IUGR	Normal	Sub total
Maternal Age								
<30	1.21	1.91	96.88	74.20	2.06	1.76	96.19	48.04
30-34	1.65	2.13	96.22	21.09	2.55	1.81	95.64	41.35
35-39	2.59	2.89	94.52	4.22	3.69	2.31	93.99	9.38
40 and up	3.36	3.44	93.20	0.49	4.73	2.56	92.71	1.22
Infant Sex								
Male	1.34	1.70	96.96	53.06	2.42	1.45	96.13	51.80
Female	1.41	2.35	96.24	46.91	2.48	2.26	95.27	48.20
Birth Order								
First	1.31	2.09	96.60	47.85	2.25	1.96	95.79	51.42
Second	1.36	1.81	96.83	43.42	2.52	1.65	95.83	38.91
Third or up	1.75	2.53	95.72	8.73	3.22	1.96	94.82	9.68
Plurality								
Singleton	1.15	1.78	97.07	98.68	1.78	1.47	96.75	97.80
Twin or more	17.91	18.81	63.28	1.32	32.13	18.15	49.72	2.20
Mother's Education								
Junior high or less	1.77	3.18	95.05	9.33	3.50	2.74	93.76	2.06
High school	1.34	1.92	96.73	64.74	2.58	1.92	95.50	41.93
At least some college	1.29	1.79	96.92	25.92	2.31	1.74	95.95	56.00
Father's Education								
Junior high or less	1.69	3.09	95.22	9.25	3.20	2.80	94.00	2.84
High school	1.39	2.01	96.59	49.92	2.58	1.94	95.48	36.26
At least some college	1.27	1.75	96.98	40.83	2.33	1.73	95.93	60.90
Mother's Occupation								
Professional	1.37	1.74	96.89	4.26	2.18	1.96	95.86	6.77
White collar	1.29	1.71	97.00	4.57	2.26	1.61	96.14	10.74
Blue collar	1.47	2.54	95.99	3.62	2.44	1.72	95.83	4.14
Other	1.37	2.01	96.62	87.55	2.50	1.87	95.64	78.35
Father's Occupation								
Professional	1.31	1.74	96.94	11.68	2.36	1.75	95.89	18.67
White collar	1.30	1.79	96.91	35.44	2.32	1.78	95.90	40.66
Blue collar	1.41	2.15	96.43	49.42	2.54	1.93	95.53	34.07
Other	1.65	2.94	95.41	3.46	2.98	1.99	95.03	6.60
Sub total	1.37	2.01	96.62		2.45	1.84	95.71	

Table 2. Predicted probabilities of adverse birth outcomes with progressvely added control variables.

	Prematurity				IUGR			
	a	b	c	d	a	b	c	d
1995	1.26	1.16	1.18	1.05	2.32	2.25	1.99	1.90
2005	1.88	1.69	1.66	1.45	2.10	2.01	1.84	1.74

Note a: infant sex, parity, and plurality are controlled.

b: a + maternal age

c: a + parents' social characteristics

d: Full model (with all control variables)

Table 3. Odds ratios of maternal and paternal risk factors on the adverse
birth outcomes among Korean infants born 1995 and 2005

	1995 (All births)						2005 (All births)					
	Prematurity			IUGR			Prematurity			IUGR		
	OR	LCI	UCI	OR	LCI	UCI	OR	LCI	UCI	OR	LCI	UCI
Maternal age [<30 yr]												
m30_34	**1.45**	1.38	1.52	**1.17**	1.12	1.22	**1.23**	1.17	1.28	**1.09**	1.03	1.14
m35_39	**2.22**	2.05	2.41	**1.44**	1.34	1.55	**1.74**	1.63	1.86	**1.39**	1.29	1.50
m40over	**2.90**	2.39	3.52	**1.58**	1.31	1.91	**2.46**	2.14	2.83	**1.58**	1.32	1.89
Infant sex [female]												
male	**0.94**	0.90	0.98	**0.72**	0.70	0.74	**0.95**	0.91	0.99	**0.63**	0.60	0.66
Birth order [first]												
second	**0.83**	0.79	0.87	**0.75**	0.72	0.78	**0.88**	0.84	0.92	**0.70**	0.67	0.74
third or up	**0.73**	0.68	0.79	**0.80**	0.75	0.84	**0.85**	0.79	0.91	**0.69**	0.63	0.75
Plurality [singleton]												
twin or more	**24.89**	23.44	26.42	**17.20**	16.24	18.22	**36.27**	34.43	38.21	**26.19**	24.61	27.87
Mother's education [at least some college]												
junior high or less	**1.16**	1.05	1.28	**1.41**	1.30	1.52	**1.46**	1.27	1.67	**1.39**	1.19	1.63
high school	1.03	0.97	1.09	1.01	0.96	1.07	**1.10**	1.04	1.15	**1.08**	1.02	1.15
Father's education [at least some college]												
junior high or less	**1.19**	1.08	1.31	**1.42**	1.31	1.53	**1.23**	1.08	1.39	**1.54**	1.35	1.76
high school	**1.12**	1.05	1.18	**1.13**	1.08	1.19	**1.12**	1.06	1.18	**1.15**	1.08	1.22
Father's occupation [professional]												
white collar	0.99	0.92	1.07	0.99	0.93	1.05	1.02	0.96	1.08	1.03	0.97	1.10
blue collar	1.00	0.93	1.08	1.04	0.98	1.11	1.05	0.99	1.12	1.06	0.98	1.31
other	**1.29**	1.15	1.46	**1.59**	1.45	1.75	**1.35**	1.23	1.47	**1.14**	1.02	1.26

Note: **Bold** denotes statistical significance at a 95% confidence level.

LCI and UCI denote low confidence interval and upper confidence interval, respectively.