



# Analysis of Pregnancy Outcomes among Interracial Couples in Korea

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## INTRODUCTION

Interracial marriages in Korea have become common in the past two decades due to “wife shortages” (1). In 2015, 21,274 interracial marriages were registered, with 14,677 (69%) foreign wives and 6,597 (31%) foreign husbands. A total of 302,828 Korean spouses were recorded; therefore, 7.0% of all marriages in Korea were interracial in 2015 (2).

Racial differences in various aspects of health and disease pertaining to birth outcomes have been reported, (3) but little is known regarding pregnancy outcomes in interracial marriages in Korea. Based on studies in the USA, significant differences were found in birth outcomes among biracial infants (black and white parents) compared with those in same-race couples (3-5). Migone et al. (4) and Gold et al. (6) reported adverse pregnancy outcomes, related more to the race of the mother than of the father. However, results have been conflicting. Collins and

Although the prevalence of interracial marriages in Korea is increasing, little is known regarding the pregnancy outcomes of interracial couples. The aim of this study was to investigate the differences in pregnancy outcomes between Korean and interracial Korean-foreign couples. Data for infants born in 2011 and 2012 were obtained from the national birth registry of the Korean Statistical Office. The couples were subdivided into Korean father-Korean mother, Korean father-foreign mother, and foreign father-Korean mother groups. Pregnancy outcomes included neonates with low birth weight (< 2,500 g) and those with high birth weight (> 4,000 g). In 2010 and 2011, 888,447 Korean father-Korean mother, 36,024 Korean father-foreign mother, and 4,955 foreign father-Korean mother neonates were delivered in Korea. After adjustment for parental age, educational level, parity, gestational age at delivery, and neonatal sex, the birth weights were found to be different between groups, with the highest number of foreign father-Korean mother and lowest number of Korean father-foreign mother pregnancies. Based on multivariate logistic regression analysis, the risk of low and large birth weights was higher in the Korean father-foreign mother and foreign father-Korean mother groups, respectively, compared with that in the Korean father-Korean mother group. There are significant differences in pregnancy outcomes including birth weights between Korean and interracial Korean-foreign couples.

**Keywords:** Interracial Marriage; Pregnancy Outcome; Birth Weight; Korea

David (7) reported that residential environment is an important risk factor for poor birth outcomes.

We aimed to improve understanding of maternal versus paternal contributions to ethnicity-related differences in birth weight by comparing the offspring of same-ethnic versus mixed-ethnic unions among Koreans and non-Koreans.

## MATERIALS AND METHODS

We conducted a retrospective cohort study of all neonates born in 2011 and 2012. Parental demographic data, including age, ethnicity, educational level, and parity, and pregnancy outcomes, including neonatal sex, birth weight, and gestational age at delivery were also obtained from the national birth registry of the Korean Statistical Office. Parental ethnicity was divided into three categories: Korean father-Korean mother (KFKM), Korean father-foreign mother (KFFM), and foreign father-Korean mother

(FFKM). In all cases, race was self-reported in the national birth registry of the Korean Statistical Office.

Pregnancy outcomes included low birth weight (LBW), large birth weight (LGA), preterm birth, and multiple pregnancy. LBW and LGA were defined as birth weights of < 2,500 g and > 4,000 g, respectively. Preterm birth was defined as gestational age < 37 weeks.

Data are expressed as mean ± standard deviation (SD) for continuous variables, and percentage for categorical variables. Characteristics among groups were compared using the one-way analysis of variance for differences in continuous variables, and the  $\chi^2$  test was used for categorical variables. Multivariate logistic regression analysis was used to estimate the adjusted odds ratio (OR) and 95% confidence interval (CI). All tests were two sided, and a *P* value < 0.05 was considered statistically significant. Statistical analysis was performed using the SPSS package ver. 17 (SPSS Inc., Chicago, IL, USA).

**RESULTS**

In 2010 and 2011, 888,447 KFKM, 36,024 KFFM, and 4,955 FFKM deliveries were recorded in Korea. Table 1 presents the basic characteristics of the study population by parental ethnicity. Significant differences were found between the groups in maternal

**Table 1.** Basic characteristics of the study population by parental ethnicity

Parameters	Ethnicity			P value
	KFKM (n = 888,447)	KFFM (n = 36,024)	FFKM (n = 4,955)	
Maternal age, yr	31.03 ± 3.90	26.89 ± 5.43	32.15 ± 4.30	< 0.010
Maternal age, %				< 0.010
< 25 yr	4.3	39.7	3.4	
25–34 yr	78.1	50	67.8	
≥ 35 yr	17.7	10.3	28.9	
Paternal age, yr	33.35 ± 4.30	39.50 ± 5.66	34.47 ± 6.11	< 0.010
Paternal age, %				< 0.010
< 25 yr	1.5	0.6	3.7	
25–34 yr	61.2	17.4	51.2	
≥ 35 yr	37.3	82.1	45.1	
Maternal education level, %				< 0.010
≤ 9 yr	1.0	28.0	3.0	
10–12 yr	28.9	45.5	18.5	
≥ 13 yr	70.1	26.5	78.6	
Paternal education level, %				< 0.010
≤ 9 yr	1.4	13.7	3.0	
10–12 yr	27.1	55.5	16.3	
≥ 13 yr	71.6	30.8	80.7	
Maternal parity, %				< 0.010
0	50.0	62.0	61.4	
1	38.9	32.3	31.7	
2	9.7	4.7	5.7	
≥ 3	1.3	1.0	1.2	
Multiple pregnancy, %	2.9	2.2	2.8	< 0.010

KFKM = Korean father-Korean mother, KFFM = Korean father-foreign mother, FFKM = foreign father-Korean mother.

and parental age and educational level. Similarly, significant differences were found in maternal parity between the groups.

Table 2 shows birth weights at term by parental ethnicity. Birth weights were different between the groups after adjustment for parental age, educational level, parity, gestational age at delivery, and neonatal sex.

Table 3 represents the risk of LBW at term by parental ethnicity. After adjustment for gestational age at delivery, parental age, educational level, maternal parity, and neonatal sex, the KFFM group had an increased risk for LBW at term compared with the KFKM group. However, no difference was found between the KFKM and FFKM groups.

Otherwise, the risk of HBW was increased in the FFKM group,

**Table 2.** Adjusted\* birth weights at term based on parental ethnicity

	Ethnicity			P value
	KFKM (n = 888,447)	KFFM (n = 36,024)	FFKM (n = 4,955)	
Birth weight, kg	3.31 ± 0.01	3.29 ± 0.01	3.36 ± 0.01	< 0.001

KFKM = Korean father-Korean mother, KFFM = Korean father-foreign mother, FFKM = foreign father-Korean mother.

\*Adjusted for gestational age at delivery, parental age, educational level, maternal parity, and neonatal sex.

**Table 3.** OR for the risk of LBW at term by parental ethnicity

Parent group	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
KFKM	1	1
KFFM	1.465 (1.363–1.575)	1.102 (1.002–1.212)
FFKM	0.972 (0.768–1.230)	0.826 (0.646–1.055)

OR = odds ratio, LBW = low birth weight, CI = confidence interval, KFKM = Korean father-Korean mother, KFFM = Korean father-foreign mother, FFKM = foreign father-Korean mother.

\*Adjusted for gestational age at delivery, parental age, educational level, maternal parity, and neonatal sex.

**Table 4.** OR for the risk of HBW at term by parental ethnicity

Parent group	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
KFKM	1	1
KFFM	0.907 (0.854–0.964)	0.928 (0.863–0.998)
FFKM	1.557 (1.373–1.765)	1.564 (1.376–1.778)

OR = odds ratio, HBW = high birth weight, CI = confidence interval, KFKM = Korean father-Korean mother, KFFM = Korean father-foreign mother, FFKM = foreign father-Korean mother.

\*Adjusted for gestational age at delivery, parental age, educational level, maternal parity, and neonatal sex.

**Table 5.** OR for the risk of preterm birth

Parent group	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
KFKM	1	1
KFFM	1.002 (0.951–1.055)	1.029 (0.539–1.964)
FFKM	1.009 (0.880–1.158)	1.022 (0.242–4.326)

OR = odds ratio, CI = confidence interval, KFKM = Korean father-Korean mother, KFFM = Korean father-foreign mother, FFKM = foreign father-Korean mother.

\*Adjusted for gestational age at delivery, parental age, educational level, maternal parity, and neonatal sex.

**Table 6.** OR for the risk of multiple pregnancy by parental ethnicity

Parent group	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
KFKM	1	1
KFFM	0.763 (0.710–0.819)	1.104 (1.009–1.207)
FFKM	0.957 (0.806–1.135)	0.977 (0.809–1.181)

OR = odds ratio, CI = confidence interval, KFKM = Korean father-Korean mother, KFFM = Korean father-foreign mother, FFKM = foreign father-Korean mother.

\*Adjusted for gestational age at delivery, parental age, educational level, maternal parity, and neonatal sex.

compared with that in the KFKM group (Table 4). No difference was found between the KFFM and KFKM groups.

Table 5 shows the risk of preterm birth by parental ethnicity. No differences were found in the risk of preterm birth between the three groups.

The risk of multiple pregnancy was increased in the KFFM group compared with the KFKM group (Table 6). However, no difference was found between the KFKM and FFKM groups.

## DISCUSSION

This study evaluated pregnancy outcomes according to parental ethnicity and found significant differences in birth weight between the study groups, with the highest birth weight in the FFKM group and the lowest birth weight in the KFFM group. Although the exact mechanisms accounting for different birth weights among the study groups are unclear, there are several possible explanations. First, the characteristics of marriages may contribute to this difference in birth weight. In Korea, most Korean men in an interracial marriage chose to marry Asian women, particularly those from Southeast Asia, who are generally smaller than Korean women; in contrast, most Korean women in an interracial marriage chose to marry Western men, who are generally taller than Korean men (2,8). Birth weight is known to be associated with parental genetic factors (9). In addition, our results suggest that foreign fathers generate a “promoting effect” on birth weight in the offspring of Korean mothers, whereas foreign mothers generate a “constraining effect” on birth weight in the offspring of Korean fathers, similar to the findings in a study by Wells et al. (10). Based on their study, the results of paternal ethnicity differences between two ethnic groups were asymmetrical, which suggests “paternal-promoting” and “paternal-restraining” effects. This asymmetry is difficult to interpret because it might indicate a combination of Mendelian genetic effects, parent-of-origin genetic effects, and epigenetic effects reflecting environmental differences. Despite these challenges in interpretation, our data indicate that paternal ethnicity differences inducing HBW neonates are “paternal-promoting” effects.

Second, environmental factors may also account for differences in birth weights of offspring. Several maternal factors reportedly lead to LBW, including socioeconomic status, educa-

tional level, and age (11-15). In our study, we also found that LBW was related to low parental educational level, younger maternal age, and older paternal age. Furthermore, the adjusted OR showed that the risk of LBW remained high even after controlling for confounding factors. Parental age and educational level are reportedly important risk factors for adverse pregnancy outcomes, including LBW (16). Thus, older paternal age and lower educational level in the KFFM group could have contributed to LBW. However, even after controlling for parental age and educational level, the birth weight was significantly lower in the KFFM group than in the KFKM group.

Infants with LBW have an increased risk of mortality and morbidity during infancy and childhood (3). In studies in the USA, black infants were twice as likely as white infants to die during their first month of life, and this high mortality rate was primarily related to the high incidence of LBW infants among black mothers (17,18). In addition to the association with prenatal and postnatal maternal complications, HBW is also associated with increased neonatal morbidity and mortality (19). Many authors have demonstrated that HBW is a significant risk factor for birth trauma, shoulder dystocia, injuries during delivery, fetal death, and low neonatal Apgar scores. In addition, women with HBW infants have a higher rate of cesarean sections (20-22). In our study, the birth weight of an infant born to a foreign mother was lower than that of an infant born to a Korean mother, a finding similar to the results from a previous study (23). Thus, there was a higher risk for LBW in KFKM pregnancies. Otherwise, the FFKM group had a higher birth weights, and thus a higher risk for HBW than the KFKM group. Therefore, the difference in birth weight by ethnicity is an important public health issue with significant individual, familial, and social impact.

In our study, the basic population data showed that paternal age in an interracial couple is older than in a Korean couple, and the preterm birth rate in interracial couples is higher than in Korean couples. Increased paternal age is related to a decrease in natural pregnancy outcomes (24). A recent review by Dain et al. (25) suggests that a significant decrease in blastocyst embryo formation is associated with increased paternal age. Similarly, based on Astolfi et al. (26), the influence of paternal age is stronger in very preterm births, but also influences moderate preterm births.

Our study has several limitations. First, the racial categorization of “foreign” inadequately reflects the genetic diversity of these broadly-defined groups. In Korea, the number of interracial couples is relatively small, but more information is needed regarding racial categories. This was a retrospective database study, and included self-reported information from the national birth registry of the Korean Statistical Office. Parental height and weight data were not available for this study, but would have been helpful in better understanding the reasons behind differences in birth weights among interracial parents compared with

Korean parents. Another limitation is that we did not have information on other pregnancy outcomes such as development of preeclampsia and gestational diabetes, because this is not available in the database. Further studies are needed to evaluate the differences in adverse pregnancy outcomes between Korean and Korean-foreign couples using linkage with Korea Health Insurance Review and Assessment data. Despite these limitations, our study indicates that Korean-foreign couples represent a population with distinct birth weights. Moreover, in most previous research referring to pregnancy outcomes, only maternal race was used, but our study used both maternal and parental race. To the best of our knowledge, our study is the first to have assessed the influence of paternal and maternal race in pregnancy outcomes in Korea.

Future studies should explore the interactions among social, demographic, and environmental factors as they are related to interracial couples, and perinatal outcomes should be based on foreign subgroups rather than an all-inclusive foreign group. In addition, an approach is needed to reduce adverse pregnancy outcomes. Furthermore, our findings can be used for counseling interracial couples regarding specific risks of perinatal outcomes demonstrated in this study.

## DISCLOSURE

The authors have no potential conflicts of interest to disclose.

## AUTHOR CONTRIBUTION

Conceptualization: Yang SY, Jung US, Cho GJ. Data curation: Oh MJ, Kim HJ, Cho GJ. Formal analysis: Hwang SY. Funding acquisition: Cho GJ. Investigation: Yang SY, Jung US, Hong HR. Writing - original draft: Yang SY, Jung US. Writing - review & editing: Oh MJ, Kim HJ, Cho GJ.

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