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ORIGINAL ARTICLE

The associations of parental under-education and unemployment on the risk of preterm birth: 2003 Korean National Birth Registration database

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Abstract
Objectives This study aimed to investigate the associations of combined parental low educational level and combined parental unemployment on the risk of preterm birth (PTB) in Korea.
Methods Data on 427,857 singleton births were obtained from the National Birth Registration (NBR) database in 2003 and analyzed. Parental education and parental employment status were combined as exposure for analysis. Place of birth, sex, marital status, parental age and parity were included for analysis of unconditional multiple logistic regressions. PTB was defined as birth before a gestational age of 37 complete weeks.
Results Group of the lowest educational level, below high school, had the highest odds of PTB in both father and mother in multivariable analysis [odds ratio (OR) 1.15 and 1.16, respectively]. After combining parental educational status for the multivariable analysis, the highest probability of PTB was in families where both parents had below college level education (OR 1.22). As for paternal employment, the multivariable analysis showed an increased rate of PTB occurred where the father was unemployed (OR 1.11). After combining the employment status of both parents, the multivariable analysis revealed that PTB was only significant in families where both parents were unemployed (OR 1.09).
Conclusions We found that combined parental low educational level and combined parental unemployment increased the likelihood of preterm birth.

Keywords Preterm birth · Education · Employment · Socioeconomic status

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Introduction

Preterm birth (PTB) is an important cause of perinatal mortality and morbidity (Goldenberg et al. 2008; Kim 2008; Kim et al. 2005; Lee et al. 2004). Despite efforts to understand and prevent PTB, its prevalence has not decreased (Demissie et al. 2001). Several previous studies have demonstrated that smoking (Andres and Day 2000), maternal periodontal disease (Matevosyan 2011), low pregnancy body-mass index, high level of psychological stress or social stress and unstable family environment were associated with preterm delivery (Goffinet 2005; Goldenberg et al. 2008). Moreover, an increasing number of studies have reported links between PTB and maternal

factors of socioeconomic status (SES), including level of education, employment status, marital status and place of birth (Dickute et al. 2004; Koupilova et al. 1998; Larson et al. 1992; Messer et al. 2008; Qin and Gould 2006; Rodrigues and Barros 2008). However, even though both parents play an important role in a family's SES, few studies have considered the combined effects of paternal and maternal SES on PTB. One reason is that information on paternal characteristics is not readily available, whereas pregnant women generally make frequent prenatal care visits to their physician or a hospital, thereby facilitating the collection of information on maternal characteristics that might affect birth outcomes (Chen et al. 2008). In addition, it is traditionally believed that maternal influences are more important for birth outcomes than paternal influences (Chen et al. 2008). However, previous studies in other countries suggest that paternal SES might also have significant associations with birth outcomes (Cole et al. 1983; Gould et al. 2003; Habib et al. 2008; Lamy Filho et al. 2007). A study in northeast Tanzania reported that paternal social characteristics, such as the educational level, appear to have a stronger influence on perinatal mortality than maternal characteristics do (Habib et al. 2008). In the UK, it was reported that paternal unemployment is associated with reduced birthweight (Cole et al. 1983).

However, little is known about combined maternal and paternal SES effects on birth outcomes, especially in eastern countries. Our study aims to investigate the associations of combined parental low educational level and combined parental unemployment on the risk of PTB using the 2003 Korean National Birth Registration (NBR) database.

Methods

Data on 492,570 births in 2003 were obtained from the NBR database. In Korea, birth registration within a month following the birth is mandatory and it includes information on the maternal residential address at the time of birth, gestational age, date of birth, parental ages, parental education, parental occupations, sex, birth order, parity, and total number of births. Also included is a physician- or nurse-completed birth certificate. The personal identification number used for data linkage was deleted, and this study was a secondary data analysis. For these reasons, this study was inapplicable to the review from the ethical review panel.

Multiple births (14,141, 2.9%) and post-term births (50,344, 10.2%) were excluded. Data for birthweight below 500 g and over 5,500 g were also excluded (228, 0.05%). In Korea, birthweight of <500 g is still a gray zone for active resuscitation in the delivery room, which could create a selective bias in birth registration. So, we excluded data registering birthweight under 500 g. Macrosomia, one of major complications of diabetic pregnancies is also a risk factor for preterm delivery (Qin and Gould 2006; Wildschut and Peters 1991). So, we also excluded extreme macrosomia with birthweight of over 5,500 g. Consequently, we excluded 228 cases of births with extreme birthweight. As a result, we ended up with data for 427,857 births, which accounted for 86.9% of raw data (Fig. 1).

Preterm birth is defined as birth before a gestational age of 37 complete weeks. There was no information about the method used for estimation of gestational age in NBR database. This study included data of PTB between 22 and 37 complete weeks of gestational age and full-term births between 38 and 41 complete weeks of gestational age. The independent variables considered were place of birth, sex, marital status, maternal age, paternal age, parental employment status, parental education level, and parity. Marital status was simply divided into married and unmarried. Place of birth was divided between urban and rural according to government-designated geocodes. Maternal age was categorized as ≤19, 20–34, and ≥35 years. Paternal age was categorized as ≤19, 20–29, 30–39, and ≥40 years. Employment status was shown as employed or unemployed. Furthermore, we combined the parental employment status and categorized this into four groups: both employed, only mothers unemployed, only fathers unemployed, or both unemployed. In the NBR database, time of job leave is not concerned in registration. Educational level was divided into three groups: below high school (≤9 years of education), high school (10–12 years) and college or higher (≥13 years). For investigating the combined effect of parental educational level, we further sorted the educational level as below college (<13 years) and college or higher (≥13 years), thus categorizing them into four groups: both college or higher, only father below college, only mother below college, or both below college. Parity was defined as primiparity and multiparity.

The adjusted ORs along with their 95% confidence intervals (CIs) were derived through unconditional multiple logistic regressions with adjustment for potential confounding variables such as place of birth, sex, marital status, maternal age, paternal age and parity. All data were analyzed using STATA, version 10.

Results

Demographic characteristics of the study population

Preterm birth occurred in 17,749 (4.2%) of the 427,857 singleton births. Table 1 shows the characteristics of the

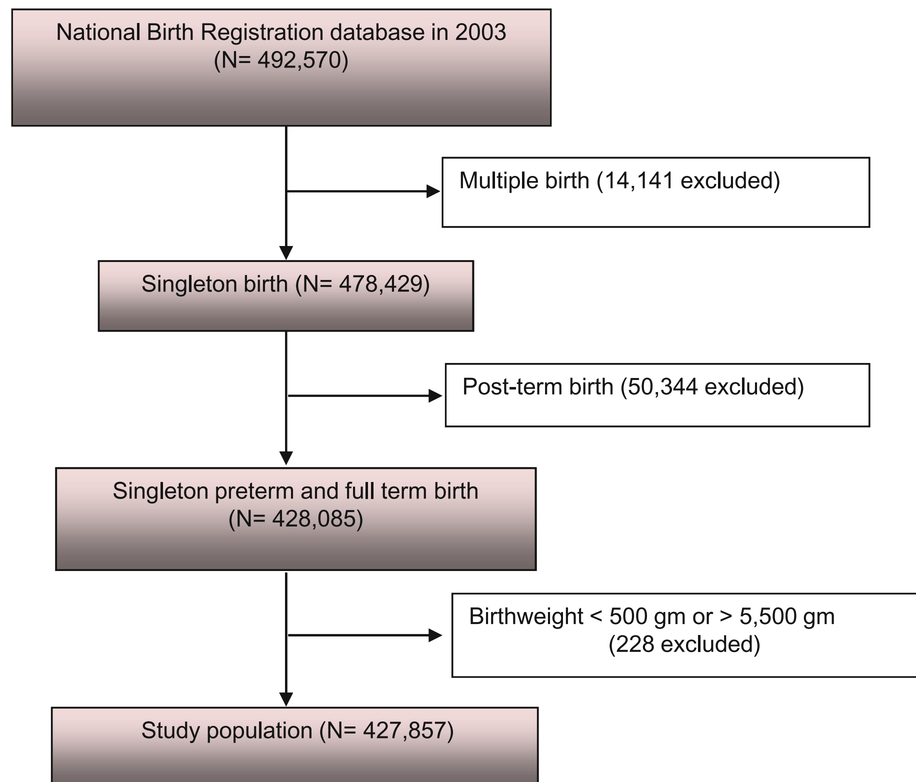

Fig. 1 The study population framework

study population. Most births took place in urban areas, and only 1.2% of the mothers were unmarried. Further, 0.5% were teenage mothers and 8.9% were mothers aged ≥35 years. In the study population, 4.2% of births occurred in families with an unemployed father and 81.2% with an unemployed mother. The correlation coefficient between paternal and maternal employment status was 0.02 ($p < 0.001$). Regarding paternal schooling, 55.5% of fathers had college degree or higher and 3.6% were below high school level of education. Regarding maternal schooling, the proportion with a college level degree or higher was similar to the number of mothers with high school level education (48.3 and 49.0%, respectively). The correlation coefficient between paternal and maternal education level was 0.58 ($p < 0.001$). The correlation coefficients were 0.03 ($p < 0.001$) between paternal education level and employment status and 0.22 ($p < 0.001$) between maternal education level and employment status.

Parental education and PTB

A higher proportion of PTB was observed in cases where the parents had a lower level of education (Table 2). In multivariable analysis for maternal education, the odds of PTB was highest with mothers below high school level education relative to mothers of college or higher (OR 1.16; 95% CI 1.05 and 1.28). The same was applicable to fathers with level below high school level education, with adjusted odds ratio as 1.25 relative to fathers of college or higher (95% CI 1.15 and 1.37). After combining the parental educational status for multivariable analysis, the highest probability of PTB was found in families where both parents had below college level education relative to both of college or higher (OR 1.22; 95% CI 1.18 and 1.27). We conducted a sensitivity test without excluding extreme birthweight (<500 and >5,500 g) in logistic regression, by analyzing only urban population, and then by analyzing only primiparity, respectively; each of the result did not lose their statistical significance (data not shown).

Parental employment status and PTB

As shown in Table 3, unemployed fathers created a higher odds of PTB in the univariable analysis compared to employed fathers (OR 1.14; 95% CI 1.06 and 1.23). In multivariable analysis, PTB was still significantly associated with paternal unemployment relative to employed father (OR 1.11; 95% CI 1.03 and 1.19). However, the employment status of the mother did not affect the odds of PTB. When the employment status of both parents was combined in the univariable analysis, PTB was associated with families where only the mother was unemployed and also with families where both the parents were unemployed. However, the multivariable analysis showed that

Table 1 Characteristics of study population, Republic of Korea, 2003 (*n* = 427,857)

Variables	*N*	%
Birth place		
Urban	391,748	91.6
Rural	36,109	8.4
Sex		
Female	202,716	47.4
Male	225,141	52.6
Marital status		
Married	422,561	98.8
Unmarried	5,250	1.2
Paternal age		
≤19	550	0.1
20–29	107,332	25.1
30–39	297,287	69.5
≥40	22,688	5.3
Maternal age		
≤19	2,082	0.5
20–34	387,857	90.7
≥35	37,918	8.9
Paternal employment		
Employed	399,606	95.9
Unemployed	17,320	4.2
Maternal employment		
Employed	78,537	18.8
Unemployed	338,754	81.2
Paternal education		
College or higher (≥13)	236,271	55.5
High school (10–12)	174,485	41.0
Below high school (≤9)	15,317	3.6
Maternal education		
College or higher (≥13)	206,288	48.3
High school (10–12)	209,101	49.0
Below high school (≤9)	11,497	2.7
Parity		
Primiparous	203,947	47.7
Multiparous	223,712	52.3

PTB was significantly associated with families where both parents were unemployed only relative to both employed (OR 1.09; 95% CI 1.00, and 1.19). We also conducted a sensitivity test without excluding extreme birthweight (<500 and >5,500 g) in logistic regression and the OR for both unemployed in combined parental employment status showed borderline significance (OR 1.09; 95% CI 1.00 and 1.19). Analyzing only cases of urban population also showed higher odds in both unemployed for PTB compared to both employed with statistical significance (data not shown).

Discussion

In this nationally representative survey of the 2003 Korean NBR data, we found that combined parental low educational level and combined parental unemployment increased the likelihood of PTB. This association was not due to confounding factors such as place of birth, sex, marital status, paternal and maternal ages and parity.

Many previous studies have shown that education is a valuable dimension of SES, strongly and consistently predicting health status, especially for women and their children (Bloomberg et al. 1994). PTB, in common with other adverse pregnancy outcomes and consistent with our study, was also proven to be strongly influenced by maternal education (Kim et al. 2005; Koupilova et al. 1998; Lamy Filho et al. 2007; Qin and Gould 2006; Rodrigues and Barros 2008). In several studies, paternal low educational level was also reported to be an important predictor of PTB (Gould et al. 2003; Lamy Filho et al. 2007). There was a report that in Washington, although maternal schooling has lost its statistical significance regarding low birthweight, which could be adjusted by different race groups, paternal schooling remains significant for low birthweight irrespective of race (Nicolaidis et al. 2004). These findings suggest that not only maternal but also paternal educational status is an important predictor of PTB. Consistent with these results, both paternal and maternal levels of education were significantly associated with likelihood of PTB in our study. As there was a moderate correlation between paternal and maternal education level in our data, we categorized paternal and maternal educational level into four groups, and we found that the families where both parents received below college level education showed a higher probability of PTB.

Education is the most stable indicator of SES, reflecting a person's ability to access and use health care information (Yang et al. 2008). In a systematic review of factors affecting the utilization of antenatal care in 2008, better educated mothers were reported to be more likely to receive appropriate antenatal care, as were better educated fathers (Simkhada et al. 2008). To some degree, education might also impart feelings of self-worth and confidence as well as reduce the power differential between service providers and clients, thereby reducing reluctance to seek care (Babalola and Fatusi 2009). In addition, a low level of education is thought to limit a person's access to jobs and other social resources, which in turn limits the capacity to integrate within the society and thereby increases the risk of subsequent poverty (Kramer et al. 2000). Mothers with a low level of education, low income, and without permanent employment are also more frequently malnourished, have unhealthy habits (smoking, alcohol consumption, and drug abuse), inadequate antenatal care and chronic diseases, all

Table 2 Association of education level with preterm birth, Republic of Korea, 2003 ($n = 427{,}857$)

Variables	% of PTB	Univariable OR	95% CI	Mutivariable OR[a]	95% CI
Maternal education					
College or higher	3.8	1.0 (reference)		1.0 (reference)	
High school	4.4	1.18	1.15, 1.22	1.11	1.07, 1.16
Below high school	6.0	1.64	1.52, 1.78	1.16	1.05, 1.28
Paternal education					
College or higher	3.8	1.0 (reference)		1.0 (reference)	
High school	4.4	1.15	1.12, 1.19	1.08	1.03, 1.12
Below high school	5.9	1.59	1.48, 1.70	1.25	1.15, 1.37
Combined status					
Both college or higher	3.7	1.0 (reference)		1.0 (reference)	
Only father below college	4.0	1.09	1.02, 1.16	1.09	1.02, 1.16
Only mother below college	4.2	1.13	1.08, 1.18	1.12	1.07, 1.17
Both below college	4.6	1.25	1.21, 1.30	1.22	1.18, 1.27

PTB preterm birth, *OR* odds ratio

[a] Adjusted for birth place, sex, marital status, paternal and maternal age, paternal and maternal employment and parity

Table 3 Association of employment status with preterm birth, Republic of Korea, 2003 ($n = 427{,}857$)

Variables	% of PTB	Univariable OR	95% CI	Mutivariable OR[a]	95% CI
Mother					
Employed	4.0	1.0 (reference)		1.0 (reference)	
Unemployed	4.2	1.03	0.99, 1.08	0.99	0.95, 1.03
Father					
Employed	4.1	1.0 (reference)		1.0 (reference)	
Unemployed	4.7	1.14	1.06, 1.23	1.11	1.03, 1.19
Combined status					
Both employed	4.0	1.0 (reference)		1.0 (reference)	
Only mothers unemployed	4.1	1.04	1.00, 1.08	0.99	0.95, 1.03
Only fathers unemployed	4.5	1.14	0.94, 1.39	1.13	0.94, 1.38
Both unemployed	4.7	1.19	1.09, 1.30	1.09	1.00, 1.19

PTB preterm birth, *OR* odds ratio

[a] Adjusted for birth place, sex, marital status, paternal and maternal age, paternal and maternal education level and parity

of which are well-known risk factors of PTB (Dickute et al. 2004; Goldenberg et al. 2008). One interesting notion is that maternal behavior during the first pregnancy is more likely to be swayed by paternal attitudes and expectations in the first pregnancy, which is associated with the educational level (Lekea-Karanika et al. 1999). Moreover, the combined effect of low educational level of both parents has a stronger effect than low educational level of just one of the parents.

Interestingly, we found that paternal unemployment was independently associated with increased odds of PTB, whereas maternal employment status alone had no significant association on PTB. There have been inconsistent results from studies of the links between maternal employment status and the risk of PTB (Saurel-Cubizolles and Kaminski 1986). Some researchers have shown that maternal unemployment was significantly associated with PTB (Hanke et al. 2001; Rodrigues and Barros 2008). Others, however, like our study, reported no increase of PTB among unemployed women (Jansen et al. 2009; Saurel-Cubizolles and Gestin 1991). To resolve the debate about the effect of maternal employment status on PTB, there have been several studies concerning the effect of working conditions on PTB. Compared to low-strain jobs, which did not demand high level of psychological pressure and physical workload at work, unemployment and high strain jobs led to an increased risk of PTB (Brett et al. 1997). A meta-analysis based on 160,988 women in 29 studies and reported that there were significant positive associations between physically demanding work and PTB (Mozurkewich et al. 2000). Unfortunately, our data did not include information about the working conditions for

mothers, and further research is needed to clarify these associations.

Compared to maternal employment status, there were fewer studies that focused on the effect of paternal employment status on PTB. A study reported that paternal unemployment was associated with reduction in birthweight and that families where the father was unemployed had lesser income leading to a fall in the standard of living and increase in financial and marital stress (Cole et al. 1983). A community-based study in Karachi also showed significant association between paternal unemployment and intrauterine growth retardation (Fikree and Berendes 1994). The roles of mothers and fathers in the family are different and involuntary unemployment, particularly among men, could involve psychological deprivation for the family, in addition to economic deprivation (Daltveit et al. 1998).

Furthermore, in terms of the effect of combined employment, in cases where both the parents were unemployed, there was significantly increased likelihood of PTB. This population is financially vulnerable because of lack of regular income and the higher burden of maintaining their health insurance status (NHIC 2003). Almost all Koreans are covered by the universal health insurance system, which has two categories in a single payment system: employee-insured and self-employed insured (Kwon 2009). Insurance contributions are proportional to the income and are shared equally by the employer and the employee in the case of employees, whereas the self-employed bear the whole burden of insurance contribution (Kwon 2003). The system uses family based membership with dependents becoming members of the scheme in which their household head is enrolled (Kwon 2009). However, in cases where both spouses are unemployed, they are categorized as self-employed insured, and they have to pay the whole health insurance fee to maintain their medical coverage. Therefore, contribution evasion occurs more frequently in this population, thereby increasing the likelihood of inadequate healthcare service including prenatal care, which could lead to the increased risk of PTB (Heaman et al. 2008; Simkhada et al. 2008). Most of all, financial stress is often considered as the most important consequence of unemployment of both parents with regard to the health of the unemployed individual or the family members (Sweeting and West 1995). Even though it is rather difficult to distinguish between the stress caused by economic hardship and stress caused by other factors of unemployment, unemployment of both parents could have negative associations with PTB (Conger et al. 1992; Goldenberg et al. 2008).

For resolving these health-related inequalities, there should be an effective and practical approach for socioeconomically deprived population. Firstly, for prenatal education such as adequate prenatal visit and avoiding risk behavior, stratified education protocols according to the parental educational level would be more effective for compliance. Voucher programs or mobile clinics for this vulnerable population would be necessary to overcome the economic and time-related barrier in antenatal care. Secondly, the social network and referral system should be well established. Evidence indicates that preterm infants are more likely to survive if they are born in hospitals with neonatology expertise, neonatal intensive care unit capacity (Phibbs et al. 2007; Phibbs et al. 1996; Warner et al. 2004), and higher patient volumes, and that transport of a preterm infant after delivery is not an effective substitute for delivery in such a setting (Lasswell et al. 2010). So improving perinatal regionalization for preterm deliveries in socioeconomically deprived population is also important (Bronstein et al. 2011).

Given that this was an observational study using the NBR database, there were some specific limitations. Firstly, there were some inevitable difficulties associated with using this type of database. The birth registration database does not contain sufficient information on potential confounders of maternal factors like body-mass index, smoking, previous pregnancy history, working condition and other medical condition, which are known risk factors for preterm delivery (Goffinet 2005; Kramer et al. 2000). Information on the income level of the family is also omitted in NBR data. Secondly, the time of job leave is not specified in the NBR registration. So, we could not differentiate maternity leave from unemployment ever. Extended antenatal maternity leave has been reported to have reduced rates of prematurity (Mamelle et al. 1989). Unfortunately, there are no data on rates of maternity leave so far in Korea. Thirdly, it is also important to note that because newborns with missing gestational age data are more likely to be at higher risk, those records with missing gestational age might have resulted in creating a systematic bias. Moreover, there was no information about method used for estimation of gestational age in NBR database. In Korea, last menstrual period has been used for estimation of gestational age usually, but there could be misclassification in this method (Savitz et al. 2002). So, the results should be interpreted with caution. Above all, we used the 2003 Korean NBR database only, so further study using other wave of data is requested for validation of results of this study.

In this nationally representative survey of the 2003 Korean NBR data, combined parental low educational level and combined parental unemployment were found to increase the likelihood of PTB in Korea. To reduce the socioeconomic disparities in the risk level of PTB, further focus and more effective collaborative efforts by policymakers, health-plan administrators, third payers, and healthcare providers are required.

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