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Associations of Night Shift Status During Pregnancy With Small for Gestational Age and Preterm Births

Se Jin Lee [1], **Chorong Kim** [1], **Eun Ju Lee** [2], **Myoung-Nam Lim** [2], **Sunghun Na** [1], **Woo Jin Kim** [2] **and Ko-CHENS Study Group**

[1]Department of Obstetrics and Gynecology, Kangwon National University Hospital, School of Medicine, Kangwon National University, Chuncheon, Korea
[2]Department of Internal Medicine and Environmental Health Center, School of Medicine, Kangwon National University, Chuncheon, Korea

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Address for Correspondence:
Sunghun Na, MD
Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, Kangwon National University Hospital, School of Medicine, Kangwon National University, 156 Baengnyeong-ro, Chuncheon 24289, Republic of Korea.
Email: lahun@kangwon.ac.kr

Woo Jin Kim, MD
Department of Internal Medicine and Environmental Health Center, School of Medicine, Kangwon National University, 1 Kangwondaehak-gil, Chuncheon 24341, Republic of Korea.
Email: pulmo2@kangwon.ac.kr

ORCID iDs
Se Jin Lee
https://orcid.org/0000-0002-8626-6250
Chorong Kim
https://orcid.org/0000-0002-5403-9862
Eun Ju Lee
https://orcid.org/0000-0001-6395-7182

ABSTRACT

Background: Shift work, including night shift work, during pregnancy has been associated with adverse birth outcomes such as small for gestational age (SGA) infants and preterm births. This study, conducted in South Korea using the Korean CHildren's ENvironmental health Study (Ko-CHENS) cohort, aimed to investigate the association between shift work and night shift status during pregnancy and adverse birth outcomes.
Methods: The Korean Ko-CHENS is a nationwide prospective birth cohort study of children's environmental diseases, conducted by the Ministry of Environment and the National Institute of Environmental Research. This study included pregnant women recruited from 2015 to 2020 for Ko-CHENS Core Cohorts, and 4,944 out of a total of 5,213 pregnant women were selected as final subjects. A logistic regression model was used to identify the risk factors affecting SGA births, preterm births, and low-birth-weight infants, and the odds ratio (OR) was adjusted. This was confirmed by calculating ORs. Maternal age, infant sex, maternal educational status, body mass index, smoking status, alcohol consumption status, parity, gestational diabetes mellitus, preeclampsia, and abortion history were used as adjusted variables.
Results: No statistically significant differences were observed in the birth outcomes or maternal working patterns. There were no significant differences in the adjusted odds ratios (aORs) of SGA and preterm births between the non-worker, day worker, and shift worker. However, there was a significant difference in the aORs of SGA between non-workers and night shift workers. (aORs [95% confidence interval], 2.643 [1.193–5.859]).
Conclusion: Working during pregnancy did not increase the risk of SGA or preterm birth, and night shift work did not increase the risk of preterm birth. However, night-shift work increases the risk of SGA.

Keywords: Pregnancy; Small for Gestational Age; Shift Work Schedule

INTRODUCTION

Low birth rate is a serious problem worldwide. In particular, the Republic of Korea became a low-birthrate country with a total fertility rate of less than 2.1 in 1984 and entered an era of ultra-low birthrates with a total fertility rate of less than 1.3 in 2001. According to the Korean

Myoung-Nam Lim
https://orcid.org/0000-0003-3562-0667
Sunghun Na
https://orcid.org/0000-0002-2803-8356
Woo Jin Kim
https://orcid.org/0000-0003-2927-370X

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Disclosure

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Lee SJ, Kim C, Na S, Kim WJ. Data curation: Lee EJ, Lim MN, Ko-CHENS study group. Formal analysis: Lee EJ, Lim MN, Na S, Kim WJ. Methodology: Lee SJ, Lee EJ, Lim MN, Na S, Kim WJ. Software: Lee SJ, Kim C, Lee EJ, Lim MN, Na S, Kim WJ. Supervision: Na S, Kim WJ. Validation: Lee SJ, Kim C, Na S, Kim WJ. Investigation: Lee SJ, Kim C, Lee EJ, Lim MN, Na S, Kim WJ. Writing - original draft: Lee SJ, Kim C, Lee EJ, Lim MN. Writing - review & editing: Lee SJ, Kim C, Lee EJ, Lim MN, Na S, Kim WJ.

Statistical Information Service database, the total fertility rate has steadily decreased since then, and the most recent total fertility rate in 2022 is 0.78, which is once again the lowest ever. Currently, the work environment and welfare issues of pregnant women are in the spotlight.

In modern society, the proportion of women of reproductive age working is increasing, and the number of women continuing to work during pregnancy is also increasing.[1] There have been several studies previously reported on the birth outcomes of pregnant workers. Working long hours, working night shifts, standing for long periods, and lifting heavy objects can be hazardous to pregnant women.[2,3] A previous meta-analysis reported that physically demanding work can significantly increase a woman's risk of poor pregnancy outcomes.[4]

According to several studies, nightshift work causes sleep loss due to changes in sleep patterns and disrupts the circadian rhythm driven by the circadian clock located in the suprachiasmatic nuclei of the hypothalamus. As a result, sleep disturbances and chronic fatigue occur, which are also associated with type 2 diabetes, obesity, cardiovascular disease, stroke, and cancer.[4-6] These changes in the body due to night shifts appear equally in pregnant women. It can also adversely affect the fetus. In 2019, a meta-analysis study was published in the United States on shift work and working hours during pregnancy on health outcomes, and as a result of combining the results of various studies in the paper, women who work long hours, work at night, or work shifts are considered to have standard work hours. There is a higher risk of experiencing negative pregnancy outcomes compared to working hours or a regular daytime job.[7] Cai et al.[7] found that working more than 55.5 hours per week increased the odds of preterm birth by 10% compared to working less than 40 hours per week. Adverse health outcomes, such as preterm delivery and SGA, are associated with long-term neurodevelopmental deficits and chronic health problems in offspring. Taken together, long hours and shift work can have significant impacts on maternal short- and long-term health.[7] In particular, there are studies showing that it has an effect on the growth of the fetus.[7-9] Pathophysiological mechanisms may be related to circadian rhythm disturbances, which pose serious challenges to pregnant women and fetuses through related neuroendocrine, vascular, and immune pathways.[7] Shift work can cause circadian disruption and sleep deprivation, which can increase stress, alter lockdown gene expression, and reduce melatonin production. There is evidence that stress-induced low aldosterone and improved cortisol availability may have reciprocal effects on placental growth and function. Changes in lock gene expression are associated with dysregulation of fetal growth hormones, which can impair placental and fetal growth.[7-9]

However, studies based on the Korean population have not yet been reported. The working environment in each country is different. The study aimed to evaluate the association between shift work and night shift status during pregnancy in small for gestational age (SGA) infants and preterm births in the Korean population, and to provide policies tailored to Korean conditions supported by Korean research.

METHODS

Study subjects

The data used in this study were for mothers from 2015 to 2020 in the Korean CHildren's ENvironmental health Study (Ko-CHENS), which was established for the study of children's environmental diseases by the Ministry of Environment and the National Institute of

Environmental Research.[10] This is a core cohort of questionnaires from pregnancy (recruitment) to childbirth and delivery results as a database. The 5,213 participants in the core cohort were required to complete detailed baseline questionnaires containing 79 items in 13 categories. Analysis and quality control of all collected data from the birth cohort study, including questionnaires, biological samples, clinical tests, and indoor environmental measurements, were performed by the National Institute of Environmental Research. Data collectors receive uniform and comprehensive training, along with quality management guidelines, to control data quality and minimize missing data. Statistical tests were also performed to minimize errors. In this paper, questionnaire data were mainly used, and biological samples, clinical tests, and indoor environmental measurements were not used. The collected data has already been published as a protocol paper.[10] The occupation questionnaire included the follows; Occupation, period of work, working hours (daily average) and type of work (day work, shift work, night work).

The study sample was selected from 5,213 women who participated in the Ko-CHENS study between 2015 and 2020, excluding women for whom the following information was not available: Multiple pregnancies (n = 227), abortions (n = 8), non-birth records and questionnaires (n = 7), foreigners of unknown ethnicity (n = 27), and unknown gestational age (n = 1). This study recruited 4,944 out of a total of 5,213 pregnant women, who were selected as final subjects (**Fig. 1**).

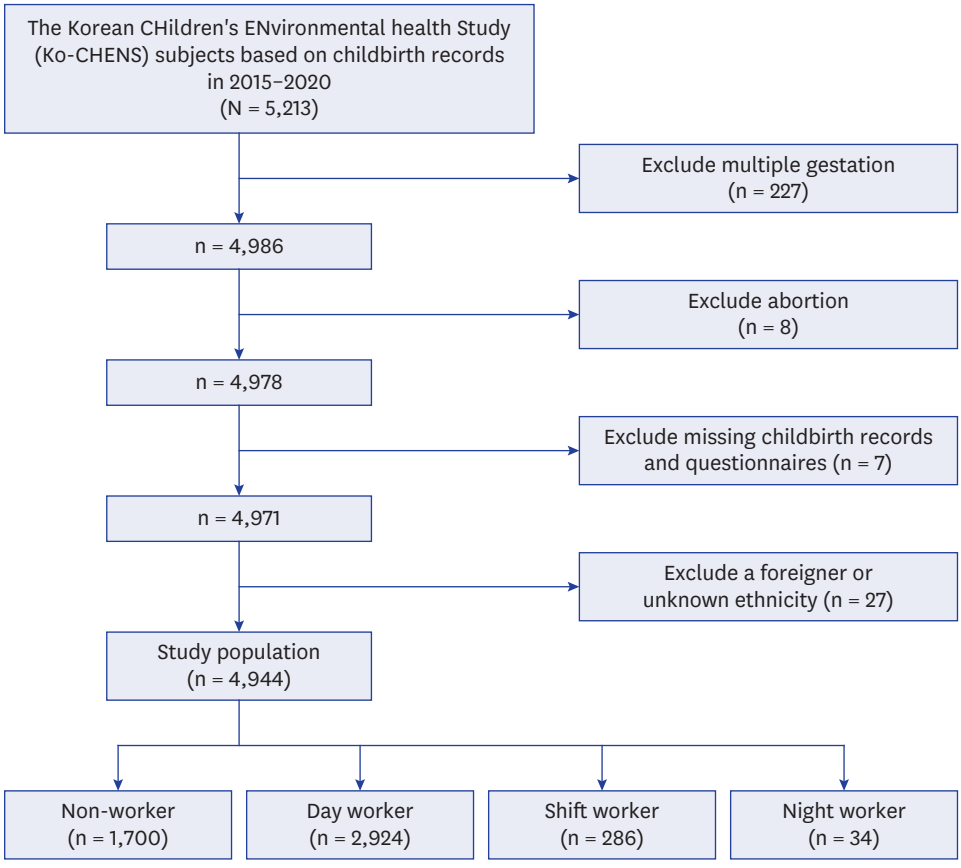

Fig. 1. Study population.

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We classified the pregnant women's occupational activities into non-workers and workers according to the presence or absence of a job within the last year of the detailed pregnancy questionnaire. In the questionnaire, those who answered "no" to the question about whether they had had a job within the past year were defined as non-workers. (n = 1,700). Among pregnant women who engaged in occupational activities during pregnancy, daytime workers without shift work were defined as "day workers" (n = 2,924), and among shift workers, those who only worked during the day were defined as "shift workers" (n = 286). Among those who worked shifts, the group that answered that they worked at night was classified as "night worker" (n = 34). Maternal education status, body mass index (BMI), smoking status, alcohol consumption status, gestational diabetes mellitus (GDM), preeclampsia, and abortion were referred to in the questionnaire, and maternal age at birth and infant sex were referenced in the delivery records. Preterm birth was considered when the delivery was less than 37 weeks. SGA is a term in which the fetal weight, according to the number of weeks of gestation, is less than 10 percentiles. In this study, a chart suggested by Fenton in line with the World Health Organization (WHO) growth standard was used.[11]

Statistical analysis

To confirm the general characteristics of the SGA infants and normal groups, a χ^2 test was performed for categorical variables, and a *t*-test was performed for continuous variables. A logistic regression model was used to identify the risk factors affecting SGA births, and odds ratios (ORs) were confirmed using crude and adjusted odds ratios (aORs). Statistical model adjusted for maternal age, infant sex, education, BMI group, smoking, drinking, parity, gestational diabetes, pre-eclampsia, abortion, history of previous preterm birth, gain weight, working hours. All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Ethics statement

The present study protocol was reviewed and approved by the Institutional Review Board of Kangwon National University Hospital (approval No. KNUH-2021-10-003) and the National Institute of Environmental Research (approval No. NIER-2015-BR-005–01). Informed consent was submitted by all subjects when they were enrolled.

RESULTS

Of the 4,944 final study subjects, 1,700 were non-workers, 2,924 were non-shift workers, and 320 were shift workers. In the demographics of the study population, there were statistically significant differences among the three groups in terms of maternal age, maternal education status, BMI, smoking status, drinking status, parity, GDM, preeclampsia, and abortion (**Table 1**). Working women were younger than non-workers. In particular, there were many younger women among shift workers than among non-shift workers. Women aged between 30 and 34 years accounted for the largest percentage of all groups. Educational status showed the same trend in non-workers and shift workers; however, the proportion of graduate school graduates was higher in workers without a shift work group.

A comparison of the BMI of the three groups showed that non-worker and night worker had a relatively higher BMI, and the proportion of overweight workers was also higher in non-workers. Weight gain during pregnancy is highest in night worker and lowest in day worker. Shift workers had the highest average daily working hours. Regarding smoking, the percentage of pregnant smokers was significantly lower in all three groups; however, the

Table 1. Demographic characteristics of pregnant women in the Korean Children's Environmental health study, 2015–2020

Variables	Non-workers (n = 1,700)	Day worker (n = 2,924)	Shift worker (n = 286)	Night worker (n = 34)	*P* value
Maternal age, yr	33.34 ± 3.90	32.65 ± 3.73	31.56 ± 3.75	33.15 ± 5.50	< 0.001
19–29	266 (15.7)	562 (19.2)	79 (27.6)	7 (20.6)	< 0.001
30–34	750 (44.1)	1,475 (50.4)	152 (53.2)	12 (35.3)	
35–39	605 (35.6)	786 (26.9)	50 (17.5)	12 (35.3)	
40+	79 (4.7)	101 (3.5)	5 (1.8)	3 (8.8)	
Infant sex					0.353
Male	884 (52.0)	1,476 (50.5)	152 (53.2)	21 (61.8)	
Female	816 (48.0)	1,448 (49.5)	134 (46.9)	13 (38.2)	
Weight gain, kg	12.46 ± 5.05	11.88 ± 5.14	12.67 ± 4.84	13.71 ± 6.10	< 0.001
Working hours (daily average)	-	8.11 ± 1.99	8.93 ± 2.18	8.29 ± 2.68	< 0.001
Education					0.393
Middle & High	286 (16.8)	251 (8.6)	42 (14.7)	12 (35.3)	
College	1,297 (76.3)	2,210 (75.6)	220 (76.9)	20 (58.8)	
Graduate school+	117 (6.9)	463 (15.8)	24 (8.4)	2 (5.9)	
BMI group, kg/m^2	22.34 ± 3.71	21.87 ± 3.35	21.83 ± 3.55	22.46 ± 5.09	< 0.001
Underweight (< 18.5)	164 (9.7)	322 (11.0)	36 (12.6)	7 (20.6)	0.004
Normal weight (18.5–24.9)	1,217 (71.6)	2,172 (74.3)	203 (71.0)	12 (61.8)	
Overweight (≥ 25)	319 (18.8)	430 (14.7)	47 (16.4)	6 (17.7)	
Smoking					0.002
Non-smokers	1,452 (85.4)	2,586 (88.4)	241 (84.3)	24 (70.6)	
Former smokers	235 (13.8)	325 (11.1)	44 (15.4)	10 (29.4)	
Pregnancy smokers	13 (0.8)	13 (0.4)	1 (0.4)	-	
Drinking					0.007
Never	443 (26.1)	616 (21.1)	63 (22.0)	5 (14.7)	
Former[a]	1,230 (72.4)	2,254 (77.1)	220 (76.9)	28 (82.4)	
Current	27 (1.6)	54 (1.9)	3 (1.1)	1 (2.9)	
Parity					< 0.001
0	840 (49.4)	2,330 (79.7)	226 (79.0)	22 (64.7)	
1	705 (41.5)	485 (16.6)	49 (17.1)	10 (29.4)	
2+	155 (9.1)	109 (3.7)	11 (3.9)	2 (5.9)	
Gestational diabetes					0.018
No	1,655 (97.4)	2,875 (98.3)	285 (99.7)	34 (100.0)	
Yes	45 (2.7)	49 (1.7)	1 (0.4)	-	
Preeclampsia					0.018
No	1,686 (99.2)	2,914 (99.7)	283 (99.0)	33 (97.1)	
Yes	14 (0.8)	10 (0.3)	3 (1.0)	1 (2.9)	
Abortion					< 0.001
No	1,184 (69.7)	2,256 (77.2)	223 (78.0)	23 (67.7)	
Yes	516 (30.4)	668 (22.9)	63 (22.0)	11 (32.4)	
Previous preterm birth					0.003
No	1,650 (97.1)	2,882 (98.6)	283 (99.0)	33 (97.1)	
Yes	50 (2.9)	42 (1.4)	3 (1.1)	1 (2.9)	

Data are presented as numbers (%) or mean ± standard deviation.
BMI = body mass index.
[a]Former drinker (abstinence during pregnancy).

percentage of former smokers was higher in the night worker group than in the other groups. A comparison of drinking showed that the non-worker group had a higher percentage of non-drinkers. A higher proportion of '0' parity women was seen in the working group (day worker, shift worker and night worker) compared to non-workers (49.4% vs. 79.7%, 79.0 and 64.7, respectively), and a higher proportion of non-workers had multiparity. The rates of GDM were higher in the non-workers, and the rate of preeclampsia was highest in the night worker. We also found a highest abortion rate in the night worker group (**Table 1**).

There were no statistically significant differences in birth outcomes or maternal working patterns. There were no significant differences in the aORs of SGA and preterm births between the non-worker group, day worker group, and shift worker group (**Table 2**). However,

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Table 2. Adjusted odds ratios for the association between birth outcome and maternal working pattern

Variables	Working pattern			
	Non-worker	Day worker	Shift worker	Night worker
SGA[a]	1.000 (Reference)	1.101 (0.903–1.342)	1.085 (0.736–1.601)	2.643 (1.193–5.859)
Preterm birth[b]	1.000 (Reference)	0.819 (0.620–1.081)	0.485 (0.230–1.023)	1.388 (0.405–4.755)

SGA = small for gestational age.
[a]Adjusted maternal age, infant sex, education, body mass index group, smoking, drinking, parity, gestational diabetes, pre-eclampsia, abortion, history of previous preterm birth, gain weight, working hours., preterm birth
[b]Adjusted maternal age, infant sex, education, body mass index group, smoking, drinking, parity, gestational diabetes, pre-eclampsia, abortion, history of previous preterm birth, gain weight, working hours.

Table 3. Adjusted ORs for the association between SGA and maternal work

Variables	SGA, OR (95% CI)	
	Model 1[a]	Model 2[b]
Maternal working status		
Non-worker	1.000 (Reference)	1.000 (Reference)
worker	1.074 (0.885–1.304)	1.174 (0.919–1.357)
Working pattern		
Non-worker	1.000 (Reference)	1.000 (Reference)
Day work	1.064 (0.874–1.296)	1.101 (0.903–1.342)
Shift work	1.002 (0.681–1.474)	1.085 (0.736–1.601)
Night shift	2.431 (1.101–5.367)	2.643 (1.193–5.859)

OR = odds ratio, CI = confidence interval, SGA = small for gestational age.
[a]Adjusted maternal age, infant sex, education, body mass index group, smoking, drinking, parity, gestational diabetes, pre-eclampsia, abortion.
[b]Adjusted maternal age, infant sex, education, body mass index group, smoking, drinking, parity, gestational diabetes, pre-eclampsia, abortion, history of previous preterm birth, gain weight, working hours.

the aOR for night shift workers was higher than that for non-workers in SGA (**Table 3**). There was no difference between non-workers and day workers or shift workers who did not include night work (non-workers vs. day workers vs. shift workers vs. night shift workers, aORs [95% confidence interval], 1.000 vs. 1.101 [0.903–1.342] vs. 1.085 [0.736–1.601] vs. 2.643 [1.193–5.859]) (**Table 3**).

DISCUSSION

The principal findings of the present study are as follows: 1) Working during pregnancy did not increase the risk of SGA or preterm birth. 2) Night shift work does not increase the risk of preterm birth. 3) Night-shift work increased the risk of being SGA.

In previous studies, the American Journal of Obstetrics & Gynecology (AJOG) systematic review and meta-analysis by Cai et al.[7] found that, compared to working a fixed-day shift, shift work increased the risk of preterm birth by 13%, SGA infants by 18%, and preeclampsia by 75%. Compared to fixed-day shifts, fixed-night shifts increased the risk of preterm birth by 21% and miscarriage by 23%. Compared to standard working hours, longer working hours were associated with a 21% increased risk of preterm birth, 38% of miscarriage, 43% of low birth weight infants, and 16% of SGA infants.[7] Kader et al.[8] reported that night shifts increased the risk of preterm birth, and frequent night shifts or quick returns from night shifts (< 28 hours) during the 1st trimester showed a 3–4-fold increased risk of preterm birth.[8] Moreover, a study by Suzumori et al.[9] found that women who worked during pregnancy in Japan had an increased risk of miscarriage and preterm birth, and that women who worked night shifts had increased gestational hypertension and SGA.[9] In Korea, a study on maternal occupation and birth outcome was published in 2013. According to this study, the highest rates of low birth weight and fetal growth retardation were observed with maternal work in

agricultural, forestry, and fishery jobs, whereas the highest rates of preterm birth and preterm-low birth weight were observed when both fathers and mothers engaged in manual work.[10]

However, in contrast to these studies, this study found no difference in the rate of preterm births between working and non-working groups; in fact, the abortion rate was higher in the non-working group. This may be due to differences in work environments between countries. In Korea, the number of workplaces that consider working mothers has increased, and the intensity of the work differs from that in other countries. In South Korea, Article 74 (Protection for Maternity) of the Labor Standards Act protects pregnant women from working. In addition, Article 70 (Restrictions on Night Work and Holiday Work) shows that employers must not allow pregnant women, women who have given birth, and persons under the age of 18 to work during the hours of 10 p.m. to 6 a.m. and on holidays, provided that this shall not be the case in any of the following cases if authorized by the Minister of Employment and Labor, one of which is a clear claim by a pregnant woman. Because these things are stipulated by law and because they are enforced in the workplace, relatively few women worked night shifts, and we think the rate of preterm labor or abortion among working women was low compared to other previous studies. Despite these considerations for pregnant women, the results of this study (**Table 1**) show that one of the characteristics of Korean mothers is that a high proportion of non-workers have more than one child. This implies that working mothers have a greater household childcare burden. This may be because of the difficulty of handling work and childcare when raising two or more children. In addition, this study found that the rate of miscarriage was higher in the non-working group than in the working group, which showed a similar incidence to that in a study recently published on Koreans. In previous studies, the rates of miscarriages, stillbirths, and live births were similar among employed and unemployed women. Although the incidence of abortion outcomes was similar, employed women were younger and generally healthier than unemployed women. Adjusting for protective factors negatively changed the direction of the association between employment and abortion outcomes. When comparing the seven common job categories, the risk of live births was higher in the other six job categories than in the finance/insurance jobs. In our study, the results differed because we did not subdivide jobs, only shift work, and did not subdivide abortions.

In this study, women working night shifts were found to be at an increased risk of being SGA, which has been linked to previous studies. In a previous study by Specht et al.,[12] melatonin stimulated progesterone production, which is essential for maintaining pregnancy. It has been hypothesized that working in a light environment at night may increase the risk of preterm birth by reducing the concentration of melatonin in the blood.[12,13] The AJOG systematic review and meta-analysis by Cai et al.[7] showed that repeated disruption of the circadian rhythm and exposure to light in night workers led to decreased melatonin secretion and sleep deprivation, which may interfere with maternal and fetal hormone homeostasis, placental implantation, and fetal growth. Maternal melatonin is transmitted from the placenta to the embryo and is involved in placental function. Studies in rats have suggested that the association between melatonin and miscarriage may be due to the role of melatonin in weakening uterine contraction by decreasing the production of prostaglandins and in the prevention of immunological rejection of trophoblasts by stimulating the production of prostaglandins. In the nonpregnant population, long working hours may increase fatigue, sleepiness, and stress. This can lead to the dysregulation of biochemical and neurophysiological functions, including increased catecholamine release. Increased catecholamine levels during long working hours may increase uterine contractility and the risk of premature birth and miscarriage.[7]

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In the same way as previous studies, our study included various variables such as work shift pattern, maternal age, maternal BMI, smoking status, drinking alcohol status, GDM, preeclampsia, abortion, and preterm birth. However, these results differed from those of previous studies. Previous studies were mainly composed of Western data, and there is a possibility that the results may differ due to the different working environment in South Korea. In addition, previous studies were mainly conducted in the 2000s (at least ten years ago), and there is a difference between the times of our study and the working environment. In addition, compared with other countries, South Korea is more likely to receive early diagnosis and treatment when preterm labor occurs because of low medical costs and good access to medical care,[14,15] which may have lowered the preterm birth rate. In fact, while the rate of preterm birth in the United States in 2010 was 12%, the rate in South Korea in 2010–2012 was lower at 6.06%.[16,17] In addition, according to a WHO survey, the rate of low birth weight babies in 2000–2008 was 4% in South Korea and lower than 8% in the United States.[18]

The strength of this study is that it is the first to analyze data on birth outcomes according to maternal work patterns in South Korea. The data used in this study were from a nationwide, prospective birth cohort for children's environmental diseases conducted by the Ministry of Environment and the National Institute of Environmental Research, which includes all women working in various regions. Therefore, it has an advantage in that it is data that takes into account various regional characteristics of South Korea. This thesis showed different results from previous studies because there is a difference in the intensity of work in each country as well as ethnic characteristics. Therefore, these data are of great strength because of their characteristics in South Korea.

However, this study has several limitations. First, the information on work intensity was incomplete. Second, the data used in this study were from a survey of pregnant women, and the exact working hours were not measured. A significant shortcoming of this study would require a more detailed analysis of the work environment if one were to study the effects of shift work and night work on pregnancy outcomes. However, this paper did not focus on a detailed analysis of shift work and work environments at the time of design. Therefore, these work intensities have not been investigated and may be inappropriate to describe the relationship between SGA infants for work intensities.

However, the association of SGA with night shift has been mentioned in several papers in other countries,[7-9] but I would like to focus on the fact that such research has not yet been conducted in Korea. Therefore, with this study as the starting point, we present the meaning so that studies can be conducted that enable detailed analysis of the work environment for the intensity as well as the type of work such as shift work and night shift, and this paper can be said to be meaningful.

Therefore, additional studies on the relationship among working hours, work intensity based on factors such as gestational age, night shift frequency or duration, and type of continuous night work, and also examining factors such as living without a partner and birth outcomes using South Korean data are needed.

Working during pregnancy did not increase the risk of SGA or preterm birth, and night-shift work did not increase the risk of preterm birth. However, night-shift work increases the risk of SGA in South Korea.

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REFERENCES

1. Salihu HM, Myers J, August EM. Pregnancy in the workplace. *Occup Med (Lond)* 2012;62(2):88-97.
PUBMED | CROSSREF
2. Certenais T, Teysseire R, Garlantezec R, Brochard P, Manangama G, Delva F. Biomechanical and organisational constraints of pregnant women at work: definition of exposure levels using a consensus method (Delphi). *BMJ Open* 2022;12(3):e052474.
PUBMED | CROSSREF
3. Palmer KT, Bonzini M, Bonde JP, et al.; Multidisciplinary Guideline Development GroupHealth and Work Development UnitRoyal College of Physicians Pregnancy: occupational aspects of management: concise guidance. *Clin Med (Lond)* 2013;13(1):75-9.
PUBMED | CROSSREF
4. Costa G. Sleep deprivation due to shift work. *Handb Clin Neurol* 2015;131:437-46.
PUBMED | CROSSREF
5. Haus E, Smolensky M. Shift work and cancer risk: role of circadian disruption, sleep deprivation, and light at night as potential mechanisms. *Sleep Med Rev* 2013;17:273-84.
PUBMED | CROSSREF
6. Kecklund G, Axelsson J. Health consequences of shift work and insufficient sleep. *BMJ* 2016;355:i5210.
PUBMED | CROSSREF
7. Cai C, Vandermeer B, Khurana R, Nerenberg K, Featherstone R, Sebastianski M, et al. The impact of occupational shift work and working hours during pregnancy on health outcomes: a systematic review and meta-analysis. *Am J Obstet Gynecol* 2019;221(6):563-76.
PUBMED | CROSSREF
8. Kader M, Bigert C, Andersson T, Selander J, Bodin T, Skröder H, et al. Shift and night work during pregnancy and preterm birth-a cohort study of Swedish health care employees. *Int J Epidemiol* 2022;50(6):1864-74.
PUBMED | CROSSREF
9. Suzumori N, Ebara T, Matsuki T, Yamada Y, Kato S, Omori T, et al. Effects of long working hours and shift work during pregnancy on obstetric and perinatal outcomes: a large prospective cohort study-Japan Environment and Children's Study. *Birth* 2020;47(1):67-79.
PUBMED | CROSSREF
10. Jeong KS, Kim S, Kim WJ, Kim HC, Bae J, Hong YC, et al. Cohort profile: Beyond birth cohort study - the Korean CHildren's ENvironmental health Study (Ko-CHENS). *Environ Res* 2019;172:358-66.
PUBMED | CROSSREF
11. Fenton TR, Kim JH. A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants. *BMC Pediatr* 2013;13(1):59.
PUBMED | CROSSREF
12. Specht IO, Hammer PE, Flachs EM, Begtrup LM, Larsen AD, Hougaard KS, et al. Night work during pregnancy and preterm birth-a large register-based cohort study. *PLoS One* 2019;14(4):e0215748.
PUBMED | CROSSREF
13. Halabi D, Richter HG, Mendez N, Kähne T, Spichiger C, Salazar E, et al. Maternal chronodisruption throughout pregnancy impairs glucose homeostasis and adipose tissue physiology in the male rat offspring. *Front Endocrinol (Lausanne)* 2021;12:678468.
PUBMED | CROSSREF
14. Kim HR, Yeo J. A comparison of Korean health status and health care system performance with OECD countries. *Health Welf Policy Forum* 2013;2013(2):89-102.
15. Park HW. Improving quality of healthcare in Korea. *J Korean Med Assoc* 2012;55(10):969-77.
CROSSREF

16. Blencowe H, Cousens S, Oestergaard MZ, Chou D, Moller AB, Narwal R, et al. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *Lancet* 2012;379(9832):2162-72.
PUBMED | CROSSREF
17. Statistics Korea. *Birth Statistics in 2010*. Daejeon, Korea: Statistics Korea; 2010.
18. World Health Organization. *World Health Statistics 2010.* Geneve, Switzerland: World Health Organization; 2010.