

Effects of Smoking Behaviors on Maternal Conditions and Conditions Arising during the Perinatal Period among Women of Reproductive Age

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Purpose: This study analyzes the effects of smoking behaviors of women of reproductive ages in terms of maternal conditions and conditions arising during the perinatal period in Korea. **Methods:** We used the National Health Insurance Corporation's medical panel data. Subjects included 382 individuals suffering from maternal conditions and conditions arising during the perinatal period from 2013 to 2014. A t-test was used to analyze the individual differences between maternal conditions and conditions arising during the perinatal period. A hierarchical regression analysis was performed in two steps to measure the effects of smoking behaviors on diseases. **Results:** The amount and duration of smoking are significant factors causing maternal conditions and conditions arising during the perinatal period. In the regression analysis, the explanatory power of model was significantly increased by adding smoking behavior to the maternal conditions and conditions arising during the perinatal period. Smoking behavior during pregnancy displayed a significant influence on diseases. **Conclusion:** Results of this study showed that the effects of smoking behavior on maternal conditions and conditions arising during the perinatal period were significant. Therefore it is necessary to develop a smoking cessation education program for pregnant women in Korea.

Key words: Smoking, Behavior, Pregnant women, Smoking prevention

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INTRODUCTION

Since 2000, smoking rates across most Organization for Economic Cooperation and Development (OECD) countries have declined. On average, smoking rates in the OECD have decreased since 2000, from 26% to 20% in 2013 [1].

The smoking rate of adult women in Korea has remained relatively constant for the past 16 years from 6.5% in 1998 to 5.7% in 2014 [2]. Interestingly, however, through urine nicotine measurements the smoking rate of domestic women was 13.9%, which was higher than the reported self-reported smoking rate of 5.9% [2]. This is because the smoking rate of Korean women has been under reported since women tend to hide their smoking habits for cultural reasons [2]. According to the trend of the smoking rate in Korea in 2016, the smoking rate was the highest in high school students, and the rate constantly increased among women in the 20s to 40s age-range, with one in ten women of reproductive age (20s~40s) being a smoker [3].

It is true that smoking causes health problems for both men and women, though women have different risks of tobacco-related health problems than men. Not only is tobacco exposure during pregnancy dangerous to the immediate health

of the baby and its mother, it could potentially contribute to serious health problems during the child's entire life [4]. Since women are responsible for pregnancy, childbirth and child care, women's smoking could affect their fetus and family members, not to mention their own bodies, and this tends to create social problems [5]. Problems associated with women's smoking include a decrease in the pregnancy rate, and increases in cervical cancer, osteoporosis, menstrual irregularities and premature menopause; smoking among pregnant women is associated with miscarriages, premature births, low birth weights, fetal anomalies, stillbirths, placenta previa, placental abruptions, delayed growth of infants and respiratory distress [6]. Women's smoking is also with a greater likelihood of ectopic pregnancies. It has been estimated that women who smoke more than 20 cigarettes a day are 4 times more likely to have an ectopic pregnancy compared to non-smokers [7]. As another concern, babies born to smoking women are at greater risk of exposure to respiratory or development of mental illness. Up to 10% of neonatal deaths and 20~30% of low birth weights are reported to be caused by smoking during pregnancy [8].

Despite such health risks few institutions in Korea provide smoking cessation programs for women, and women-specific factors are insufficiently reflected in current anti-smoking policies. In addition, most studies exploring the relevance of smoking to adult illnesses merely focus on the mortality and disease risks, regardless of gender, with few studies conducted on the effects of smoking on conditions arising in both the mother and fetus during the perinatal period.

We expect our study set a benchmark for the development prevention policies to address maternal conditions, conditions arising during the perinatal period, the establishment of as well as smoking cessation education programs for women of reproductive age.

1. Objectives

The purpose of this study is to analyze the effects of smoking behavior of women of reproductive age in Korea in terms of maternal conditions and conditions arising during the perinatal period.

- To benchmark the current status of maternal conditions and conditions arising during the perinatal period.
- To determine the difference of maternal conditions and conditions arising during the perinatal period status according to the general characteristics and smoking behaviors.
- To determine the effect of smoking behavior on maternal conditions and conditions arising during the perinatal period.

METHODS

1. Research Design

The data used in this study was obtained from medical panel data of the National Health Insurance Corporation from 2009 to 2014. The data survey was carried out at the consortium of the Korea Institute for Health and Social Affairs and the National Health Insurance Corporation, and is a government-designated statistical survey approved by the National Statistics Office (NSO) (Approval No. 33110). The survey was initially conducted twice a year to ensure data accuracy and efficient management of panel households, but since 2012, the survey frequency was reduced to once per year.

The survey of the panel data was conducted from April 2008 for 24,616 household members from 7,866 households in Korea using the second step probability proportional stratified population extraction method. Using the Korean medical panel data, it is possible to identify individuals' diagnosed diseases and their health examination data, and the data is also linked to a questionnaire on their usual health behavior. The subjects included in this study were 382 individuals suffering from maternal conditions and conditions that have arisen during the perinatal period from 2013 to 2014, based on smoking behavior information from 14,213 household members who remained in the same households for six years from 2009 to 2012. This data was obtained from the Korea Institute for Health and Social Affairs, Korea Bioethics Committee (IRB No. 2017-04).

2. Study Population

This study investigates the effects of smoking on maternal conditions and conditions arising during the perinatal period that may occur at birth for women aged 15 to 44. Thus, the questionnaire for the study was focused on the effects of smoking on maternal conditions (e.g. maternal hemorrhage, sepsis, gestational hypertension, dystocia, abortion, etc.) and conditions arising during the perinatal period (e.g. low birth weight, newborn asphyxia and birth injury), using diagnosed codes based on the World Health Organization (WHO) International Code for the Classification of Diseases (ICD-10) for measuring the 'Global Burden of Disease'.

Using this data, we selected our subjects from women ranging from 15 to 44 years of age who had visited medical institutions for the above-mentioned diseases. It could be counted with duplication. Because they could visit hospitals with two more diseases. We used the number of diagnosed diseases as a dependent variable. We then measured the subjects' smoking behavior to discover the independent influence of

smoking on maternal conditions and conditions arising during the perinatal period (Figure 1).

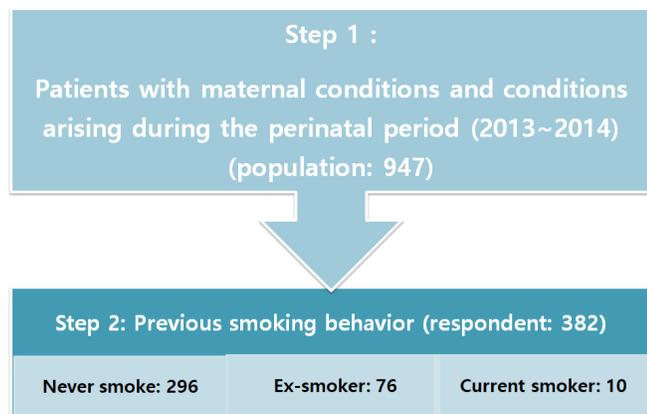


Figure 1. Target population.

3. Data Collection and Analysis

In this study, we used the health behaviors questionnaire for our subjects in order to identify their smoking habits. In the ‘Do you smoke now?’ question, subjects were classified as either non-smokers or smokers. Smokers were then sub-classified as either smokers smoking half pack per day or those smoking more than half pack per day. To adjust for possible confounding variables, characteristics of age group and Body Mass Index (BMI) were calculated as constants and percentages; blood pressure and smoking-related behaviors were calculated as mean and standard deviation. A t-test was used to analyze the individual differences between the number of maternal conditions and conditions arising during the perinatal period. For correlations of major variables, we used the spearman correlation coefficient. For categorization, we coded their smoking status as ‘0=never smoked’, ‘1=ex-smokers’, and ‘2=current smokers’. Finally, a hierarchical regression analysis was performed in two steps to measure the effects of smoking behavior on diseases number; in the first model, we measured the effects of personal characteristics on disease pattern and in the second model, we added certain variables related to smoking behavior. Data were analyzed using SPSS/WIN 18.

RESULTS

Among our 382 subjects, 30.6% suffered from 3 maternal conditions and 2.6% from 5 diseases. In terms of perinatal conditions, 16.8% had 1 disease and 9.7% had 2 diseases. The 15 to 34 age group accounted for 47.4% of the total group, with the

35 to 44 age group accounting for the remaining 52.6% of the total. The mean BMI of subjects was 21.2 kg/m² and the mean blood pressure was 120/75 mmHg. Most subjects had never-smoked (77.5%). Among the smokers, most of them smoked for less than 5 years (69.8%), smoked less than a half-pack per day (68.6%), and 7 packs per year (81.6%) (Table 1).

We found differences between the groups according to the number of diseases arising from individual characteristics. In particular, women over 35 years of age were often affected by more maternal conditions and conditions arising during the perinatal period than the younger group. The smokers (both ex smokers and current smokers) got more diseases than never smokers. The duration of smoking had group differences in number of diseases. The smoking pack year was significantly correlated with the number of diseases (Table 2). The number of diseases was positively correlated to the major variables, except for the quantity of smoking (Table 3).

Table 4 presents the results of the regression analysis in which we used the number of maternal conditions and conditions arising during the perinatal period as dependent variables and added age, BMI, systolic and diastolic blood pressure, and smoking behavior in a stepwise manner. The addition of smoking behavior to maternal conditions and conditions arising during the perinatal period significantly increased the explanatory power of the model ($F=7.01, p=.002$). Smoking status and the duration of smoking were found to be significantly influenced by maternal conditions and conditions arising during the perinatal period. In the case of age, the effects of smoking displayed changes as the smoking behavior was added (Model 1: $B=0.08, p<.001$, Model 2: $B=-1.03, p<.001$); the smoking behavior of younger women had more influence on their maternal conditions and conditions arising during the perinatal period. In addition, the systolic blood pressure had a significant effect on diseases due to smoking behavior ($B=1.17, p=.008$). According to Model 1, the adjusted R square was .278 and F was 1.62 at a p-value of .054. And in Model 2, the R square was increased to .659 and F was 7.01 at a p-value of .002.

DISCUSSION

This study analyzed the effects of smoking behavior of women of reproductive age in terms of maternal conditions and conditions arising during the perinatal period using the National Health Insurance Corporation medical panel data. Our goal was to use these results as the foundation for establishing pregnancy and childbirth-related disease prevention policy and as a basic reference for developing smoking cessation education programs for women.

The number of diseases among older women was signifi-

Table 1. State of Patients with Maternal Conditions and Conditions Arising during the Perinatal Period in 2013~2014 (N=382)

Variables	Categories	n (%) or M±SD	
Maternal conditions*	Maternal hemorrhage	O20, O44, O45, O46, O67, O72 165 (43.2)	
	Maternal sepsis	O85, O753 157 (41.1)	
	Hypertensive disorders of pregnancy	O10, O11, O12, O13, O14, O15, O16 217 (56.8)	
	Obstructed labor	O64, O65, O66 72 (18.8)	
	Abortion	O00, O01, O02, O03, O04, O05, O06, O07, O08 39 (10.2)	
Conditions arising during the perinatal period*	Low birth weight	P07, P22, P25, P26, P27, P28, P612, P77, P52, H351 164 (42.9)	
	Birth asphyxia and birth trauma	P11, P21, P91 134 (35.1)	
Number of diseases	Maternal conditions	1	65 (17.0)
		2	57 (14.9)
		3	117 (30.6)
		4	32 (8.4)
		5	10 (2.6)
	Conditions arising during the perinatal period	1	64 (16.8)
	2	37 (9.7)	
Age group (year)	Age in years	46.97±6.05	
	15~34	181 (47.4)	
	35~44	201 (52.6)	
BMI (kg/m ²)		21.2±0.03	
Blood pressure (mmHg)	Systolic	120 (8.42)	
	Diastolic	75 (3.00)	
Smoking behavior	Smoking status (n=382)	Never smoke	296 (77.5)
		Ex-smoker	76 (19.9)
		Current smokers	10 (2.6)
	Duration of smoking (n=86)	Below 5 years	60 (69.8)
		Over 5 years	26 (30.2)
	Quantity of smoking (n=76)	Below half pack per day	59 (77.6)
		Over half pack per day	17 (22.4)
	Smoking pack year (n=76)	Below 7 pack-year	62 (81.6)
Over 7 pack-year		14 (18.4)	

*Duplicated count; O20=Haemorrhage in early pregnancy; O44=Placenta previa; O45=Premature separation of placenta (abruptio placentae); O46=Antepartum haemorrhage, not elsewhere classified; O67=Labour and delivery complicated by intrapartum haemorrhage, not elsewhere classified; O72=Postpartum haemorrhage; O85=Puerperal sepsis; O753=Other complications of labour and delivery, not elsewhere classified; O10=Pre-existing hypertension complicating pregnancy, childbirth and the puerperium; O11=Pre-existing hypertensive disorder with superimposed proteinuria; O12=Gestational (pregnancy-induced) oedema and proteinuria without hypertension; O13=Gestational (pregnancy-induced) hypertension without significant proteinuria; O14=Gestational (pregnancy-induced) hypertension with significant proteinuria; O15=Eclampsia; O16=Unspecified maternal hypertension; O64=Obstructed labour due to malposition and malpresentation of fetus; O65=Obstructed labour due to maternal pelvic abnormality; O66=Other obstructed labour; O00=Ectopic pregnancy; O01=Hydatidiform mole; O02=Other abnormal products of conception; O03=Spontaneous abortion; O04=Medical abortion; O05=Other abortion; O06=Unspecified abortion; O07=Failed attempted abortion; O08=Complications following abortion and ectopic and molar pregnancy; P07=Disorders related to short gestation and low birth weight, not elsewhere classified; P22=Respiratory distress of newborn; P25=Interstitial emphysema and related conditions originating in the perinatal period; P26=Pulmonary haemorrhage originating in the perinatal period; P27=Chronic respiratory disease originating in the perinatal period; P28=Other respiratory conditions originating in the perinatal period; P612=Anaemia of prematurity; P77=Necrotizing enterocolitis of fetus and newborn; P52=Intracranial nontraumatic haemorrhage of fetus and newborn; H351=Retinopathy of prematurity; P11=Other birth injuries to central nervous system; P21=Birth asphyxia; P91=Other disturbances of cerebral status of newborn.

Table 2. Differences of the Number of Diseases by General Characteristics and Smoking Behaviors (N=382)

Variables	Categories	Number of maternal conditions and conditions arising during the perinatal period		
		M±SD	t (p)	
Age group	15~34 (n=181)	2.14±0.41	1.09 (.044)	
	35~44 (n=201)	4.49±0.52		
Smoking behavior	Smoking status (n=382)	Never smoke (n=296)	1.82±0.53	1.53 (.002)
		Experience (ex and current) (n=86)	4.85±0.44	
	Duration of smoking (n=86)	Below 5 years (n=60)	2.10±0.38	1.44 (<.001)
		Over 5 years (n=26)	4.89±0.22	
Quantity of smoking (n=76)	Below half pack (n=59)	3.16±0.26	2.86 (.217)	
	Over half pack (n=17)	3.58±0.31		
Smoking pack year (n=76)	Below 7 pack-year (n=62)	2.62±0.29	1.91 (.005)	
	Over 7 pack-year (n=14)	3.33±0.18		

Table 3. Correlation between the Number of Diseases and Major Variables

Variables	1	2	3	4	5	6	7	8
	r	r	r	r	r	r	r	r
1. Age	1							
2. Blood pressure	.40**	1						
3. BMI	-.07	.64**	1					
4. Smoking status	.21**	.55*	-.19	1				
5. Duration of smoking	.23**	.17	-.22	.28**	1			
6. Quantity of smoking	.11	.31**	.32	.11*	-.76	1		
7. Smoking pack year	.14**	.18**	.20	.08*	.19	.33**	1	
8. Number of diseases	.59**	.24**	.43**	.14*	.22**	.65	.11*	1

*p < .005; **p < .001; BMI=Body mass index.

Table 4. Factors Affecting the Number of Maternal Conditions and Conditions Arising during the Perinatal Period of Smoking Behaviors (N=382)

Variables	Model 1			Model 2			
	B	β	t (p)	B	β	t (p)	
Age	.08**	.13**	0.66 (<.001)	-1.03**	-.77**	1.01 (<.001)	
BMI	.22**	.53**	1.71 (.004)	0.32	.60	1.12 (.145)	
Blood pressure	Systolic	-.02	-.11	1.01 (.149)	1.17**	.45**	2.36 (.008)
	Diastolic	.14	.20	2.31 (.221)	1.02	.25	2.91 (.317)
Smoking habit	Smoking status			1.78**	.92**	1.92 (.001)	
	Duration of smoking			1.10**	.33**	0.08 (.019)	
	Quantity of smoking			1.35	.79	2.42 (.701)	
	Smoking pack year			1.44	.27	1.21 (.122)	
Adjusted R ²	.278			.659			
F (p)	1.62 (.054)			7.01 (.002)			

BMI=Body mass index.

cantly higher than for younger women. In elderly pregnancies, it was reported that the incidence of negative pregnancy outcome is higher compared to pregnancies under 35 years of age [9]. Several studies have reported on the negative effects of maternal aging on fetal and maternal outcomes, such as increased occurrence of low birth weight infants, severe maternal defects, high fetal and neonatal defects and mortality [9-12]. In particular, the average age of marriage and reproductive aging has been increasing steadily since the 21st century due to economic factors such as employment status, housing, and child care costs, and social structural factors such as work-family compatibility and gender discrimination [13]. The average marriage age of Korean women increased from 26.5 years in 2000 to 30.2 years in 2017, while the reproductive aging of primiparous mothers increased from 27.7 years in 2000 to 31.4 years in 2017 [13].

In Korea, the rate of premature and low birth weight infants is increasing due to the age of women becoming pregnancy, the smoking rate during pregnancy, the increase of multiple births, and changes in the social environment [14]. Smoking is an important risk factor for premature and low birth weight infants. Because nicotine and cadmium in cigarettes contracts blood vessels and reduces intrauterine blood flow, they adversely affect fetal and placental development. Indeed, it is difficult to sustain a pregnancy if the fetus becomes hypoxic if blood vessels contract due to nicotine, placental blood flow becomes restricted due to the pathology of placental blood vessels, and the oxygen supply decreases due to elevation of the carboxyhemoglobin level [15-17].

In Korea, women tend to hide their smoking behavior due to social taboos against women smoking [2]. In this study, only 40.3% (382 of 947) of the subjects who experienced maternal conditions and conditions arising during the perinatal period responded to our smoking behavior survey, with only 19.9% (76 of 382) of the respondents answering that they had smoked. Women smoking is perceived very negatively in East Asian countries such as South Korea, Japan, and China which have been influenced by Confucianism [18]. Therefore, women tend to under-report their smoking behavior in surveys. These countries' self-reported surveys (SRs) tend to produce results that underestimate the number of women smokers, owing to the social desirability response bias. Therefore, it is necessary to compare the results of SRs with the urinary cotinine samples in order to obtain a more accurate smoking rate [18].

In the panel data, health behaviors were surveyed using a self reported questionnaire during a regular health examination. To ensure the accuracy of our data, a nicotine test using urine was performed in parallel with the survey. Asian women are more affected by social structural influences and envi-

ronmental factors than men, such as having close friends or other people recommending tobacco use, are also affected, especially when smoking is perceived as normal by women [8]. In addition, since reasons for first smoking, reason for continuing to smoke, and the process of smoking cessation are different between women and men, a practical smoking cessation program is needed to reduce smoking rates, by taking factors that affect women's smoking into account [14].

According to the WHO, over the past 20 years, 100,000 babies have lost their lives due to sudden infant syndrome, premature infant complications, and being underweight due to their parents' smoking [15]. Although many scientific studies have explored the negative effects of smoking on the fetus, 20~50% of pregnant women are still exposed to smoking or secondhand smoke, and there are signs that young women are increasingly smoking during pregnancy [16,17]. In the United States, about 10% of pregnant women smoked during the last 3 months of pregnancy, and the rate of smoking cessation during pregnancy was only about 20% [16,17]. Therefore, it is important that smoking education start before pregnancy [16, 17]. In Korea, a total of 1,090 self-reported surveys and 1,057 urine samples were analyzed. The percentage of smoking revealed by self-reporting was 0.55% and that revealed by urinary cotinine measurement (>100 ng/mL) was 3.03% [19], an almost 6 times discrepancy.

In the present study, we found differences between age groups in terms of maternal conditions and conditions arising during the perinatal period in the period of smoking. Especially, the amount and duration of smoking are proved to be significant factors causing pregnancy-related diseases. In our regression analysis, we added smoking behavior to find maternal conditions and conditions arising during the perinatal period significantly increase in the explanatory power of the model and that smoking status and smoking cessation affects the maternal conditions and conditions arising during the perinatal period; in particular, the systolic blood pressure of the subjects was significantly influenced by smoking behavior.

This study confirmed the association between maternal smoking during pregnancy and the risk of child birth-related diseases in mothers from all age groups. Smoking affects the growth of the fetus and the placenta compared to non-smokers, resulting in a low birth weight child [20]. However, in the previous Korean study, 25% of women smokers are reported to smoke during pregnancy, and 23~40% of smokers quit smoking during pregnancy, though 70% began again after giving birth [3]. Smokers are more likely to quit smoking if they have higher level of education, are provided with more support from their husbands and have more children; yet, the younger the age, the higher the percentage of smokers during

pregnancy [21]. Particularly, quitting smoking was especially difficult for pregnant women in the younger age group. In Norman, in an in-depth interview of 52 pregnant women, participants were found to naturally quit smoking at the beginning of pregnancy, but most of them smoked again during pregnancy [22]. In a different study of 534 adolescent mothers, the researchers analyzed the effects of smoking on the weight of newborn infants and found 46.2% of them smoked during pregnancy, also showed that smoking behavior has more influence on pregnant and childbirth-related illnesses in younger-age mothers [23], suggesting that a smoking cessation program for younger mothers is necessary.

Therefore, if a pregnant woman visits a counseling center for smoking cessation, she should be advised to receive medical care for prenatal care and also be provided education on how smoking affects the mother and fetus [14]. The Framework Convention on Tobacco Control (FCTC) recommends that smoking cessation programs take into account the characteristics of the population. Thus, 115 of the WHO Tobacco Counterparties are reporting that they are carrying out this provision, with 71% providing services for pregnant women [24]. However, in Korea, only a few institutions provide such pregnant women education programs, and despite some research on smoking cessation or support programs for emotional workers, little attention has been given to the development of a smoking cessation policy that reflects the needs of women [25]. In addition, most studies have assessed the mortality and risks arising from smoking or have looked at correlations between smoking and various diseases [26,27], regardless of gender. Few have studies, the effects of smoking on maternal conditions and conditions arising during the perinatal period. Therefore, it is necessary to develop a smoking cessation education program for pregnant women in Korea, a program in which the characteristics and age of women are given special consideration.

The purpose of this study was to analyze the effects of smoking behavior of pregnant women on maternal conditions and conditions arising during the perinatal period, using National Health Insurance Corporation medical panel data from 2009 to 2014. Overall, the results of this study showed that the effects of smoking behavior on maternal conditions and conditions arising during the perinatal period were significant.

Nonetheless, there is a limitation in the panel data of the National Health Insurance Corporation since various variables are not included in the smoking behavior of women who are pregnant. Therefore, in a follow-up study, a cohort study for the same persons need to be performed in order to integrate various factors in analysis, including interaction effects.

CONCLUSION

The purpose of this study was to analyze the effects of smoking behavior of pregnant women on maternal conditions and conditions arising during the perinatal period, using National Health Insurance Corporation medical panel data from 2009 to 2014. The results of this study showed that there are the effects to be significant. Therefore, it is necessary to develop a smoking cessation education program for pregnant women in Korea, a program in which the characteristics and age of women are given special consideration.

Conflict of interest

No potential or any existing conflict of interest relevant to this article was reported.

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