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보건학박사학위논문

**Impact of Voucher Program on the
Incidence and Income-based Disparity of
Major Obstetric Complications: from the
Korean National Health Insurance Cohort
Data**

임신출산진료비 바우처 프로그램이 주요 모성
합병증의 발생률과 불평등에 미친 영향:
국민건강보험공단 코호트 자료 연구

2016년 2월

서울대학교 보건대학원

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최 승 아

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ABSTRACT

Objective:

Maternal morbidity during pregnancy and childbirth has been a leading contributor to the burden of disease among women aged 15-44 years worldwide. There have been growing evidences which indicate socioeconomic disparities in the obstetric complications. To reduce the occurrence and disparities in the maternal morbidities, a number of demand-side financing interventions were introduced and implemented worldwide. In Korea, a universal voucher program (*Goeun-mom* card) for antenatal care and birth services was initiated in December 2008 to improve total fertility rate. Since there is no study which addresses the socioeconomic disparities in health of mothers and the effect of the universal voucher scheme on maternal health, the purposes of this study are followings:

First, to identify associated factors and trends of incidence of two major obstetric complications - preeclampsia and postpartum hemorrhage.

Second, to explore the incidence and disparities in the major maternal complications according to household income level.

Third, to evaluate the effect of the universal voucher program on the risk of preeclampsia and postpartum hemorrhage.

Methods:

- (1) A population-based cohort data from the Korean National Health Insurance (NHI) Service from 2002 to 2013 was used for analyses. Individuals with live birth in the year were identified by combined diagnostic criteria. The occurrences of preeclampsia or postpartum hemorrhage were determined by the diagnostic code and specific treatment for these conditions. Social determinants such as household income level, being in paid work were included in the multivariable model.
- (2) Using regression analysis, annual age-adjusted incidences of preeclampsia and postpartum hemorrhage were calculated, respectively. The temporal change of annual incidences was analyzed with annual percentage change (APC) and average annual percentage change (AAPC) using the Joinpoint Regression Program (Version 4.1.1.4 - February 2015; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute).
- (3) The study population was divided into three groups (lower, middle and higher) according to the level of relative household income. Based on the household income gradient, inequality indices such as slope index of inequality (SII) and Kunst and Mackenbach relative index of

inequality (RII_{KM}) of predicted incidences were calculated using Health Disparities Calculator (HD*Calc, Version 1.2.4 - October 29, 2013; Division of Cancer Control and Population Sciences, Surveillance Research Program and Applied Research Program, National Cancer Institute).

- (4) For the maternal conditions which show significant income-based disparities during the study period, changes after the introduction of voucher program (from 2009 to 2013) were evaluated. To estimate the impact of universal voucher program on the occurrence of major obstetric complications, generalized linear model (GLM) was adopted while controlling for the effect of potential confounding factors including calendar year.

Results:

- (1) In the aggregated data of live births in the NHI cohort, the risk of postpartum hemorrhage requiring blood transfusion was higher in lower household income groups than higher income group (P for trend = 0.046). The frequency of preeclampsia was not different among the three groups.
- (2) With multivariable analyses, women in lower household income showed higher risk of preeclampsia and postpartum hemorrhage,

respectively. For postpartum hemorrhage, being in paid work increased the odds of postpartum hemorrhage. Maternal age between 35 and 39, presence of diabetes, and multiple gestation were observed to increase the risk of preeclampsia. Risk of postpartum hemorrhage was higher in women aged between 15-19 and over 30 years and nulliparity. Occurrence of postpartum hemorrhage was positively associated with induction of labor and Cesarean delivery.

- (3) During the study period, there was no significant change in the annual age-adjusted incidence of preeclampsia requiring MgSO₄ treatment in all three income groups. On the other hand, annual age-adjusted incidences of postpartum hemorrhage decreased over time (AAPC = -3.58, P = 0.01 for the lower income group; AAPC = -3.86, P = 0.02 for the higher income group).
- (4) The estimates of SII's and RII_{KM}'s indicated no significant disparities in preeclampsia and/or postpartum hemorrhage among the study population considering each income group share. The RII_{KM} of the age-adjusted incidences of preeclampsia across the household income gradient showed a generally decreasing trend over time when the study period were divided into three parts (2002-2005, 2006-2009 and 2010-2013). However, the change was not statistically significant. For RII_{KM} of postpartum hemorrhage, the temporal change was not unidirectional.

- (5) When the effects of multiple covariates are controlled, the risks of preeclampsia and postpartum hemorrhage among mothers were reduced after implementation of the voucher program. However, with controlling for effects of calendar year, the risk of preeclampsia was reduced only in 2013. For postpartum hemorrhage, the risk was reduced since 2011. In this multivariable models, the higher risks of preeclampsia and postpartum hemorrhage remained significant in the lower and middle income than in the higher income group.

Conclusions:

- (1) The temporal trend of the major maternal complications could be different according to the level of household income. In Korea, the incidence of postpartum hemorrhage decreased in the lower and higher income groups during the past decade.
- (2) The relative inequality indices for the three maternal morbidities showed no unidirectional change during the study period. Considering the differential trend of postpartum hemorrhage according to household income, attempts to monitor and reduce the disparities in maternal health across different economic status would be necessary.
- (3) Women who delivered in the post-voucher period showed lower risk of preeclampsia and postpartum hemorrhage, respectively. This may

suggest that a voucher program for antenatal care and birth services covering all mothers would be associated with the lower risk of maternal complications even in the setting of national health insurance system.

Key words: Incidence, Disparity, Preeclampsia, Postpartum hemorrhage, Voucher; National Health Insurance, Korea.

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LIST OF ABBREVIATIONS

AAPC	Average Annual Percent Change
APC	Annual Percent Change
DRG	Diagnosis-related Groups
GLM	Generalized Linear Model
HELLP	Hemolysis, Elevated liver enzymes, Low platelet count
HTN	Hypertension
ICD	International Classification of Diseases
IUGR	Intrauterine growth restriction
KRW	Korean Republic Won
LBW	Low Birth Weight
MMR	Maternal Mortality Ratio
NHI	National Health Insurance
NOS	Not Otherwise Specified
OBGY	Obstetrics and Gynecology
PPROM	Preterm Premature Rupture of Membrane
RII_{KM}	Kunst and Mackenbach Relative Index of Inequality
SES	Socioeconomic status
SII	Slope Index of Inequality

CHAPTER 1. INTRODUCTION

1-1. Public Health Implication of Maternal Health

Obstetric complications during labor or delivery is defined as a condition that adversely affects a woman's health during childbirth beyond what would be expected in a delivery process. The prevalence of any type of maternal morbidity during labor and delivery is ranged from 13% (severe morbidity) (Say, Pattinson et al. 2004) to 43% (all cases defined by International Classification of Diseases codes)(Danel, Berg et al. 2003). Among the complications, preeclampsia, postpartum hemorrhage and infections have been the most common causes of maternal mortality worldwide. In the countries with low maternal mortality, the most common maternal complications are preeclampsia (and/or eclampsia), gestational diabetes, postpartum hemorrhages and severe sepsis (Danel, Berg et al. 2003, Berg, Mackay et al. 2009, Nair, Kurinczuk et al. 2015).

Preeclampsia is a multi-organ disorder that occurs from 2 % to 8 % of pregnancies after 20 weeks' pregnancy (Duley 2009). Well-known risk factors include age older than 40 years, nulliparity, multiple gestation, previous and/or family history of preeclampsia, underlying diabetes, hypertension, renal diseases, smoking (Conde-Agudelo, Althabe et al. 1999), low education (Silva, Coolman et al.

2008), and deficiency of several micronutrients (Bodnar and Simhan 2010).

Affected mothers are more likely to experience emergency operative delivery and subsequent increased risk of mortality or morbidities such as postpartum hemorrhage and infections (Chauhan, Beydoun et al. 2014, Gibbons, O'Herlihy et al. 2014). With continuously increasing mother's age, the burden of these conditions is expected to be rising in many countries (Cavazos-Rehg, Krauss et al. 2014).

Postpartum hemorrhage is generally defined as blood loss greater than or equal to 500 ml within 24 hours after birth which is the most common cause of maternal death worldwide (World Health Organization 2009). Asian ethnicity, obesity, previous postpartum hemorrhage, multiple pregnancy, anemia, large baby, age over 40, induction of labor, prolonged labor, placental abruption, and Caesarean delivery are associated with high risk of developing postpartum hemorrhage. It may occur in women without identifiable risk factors.

The maternal morbidities that result from or are aggravated by pregnancy and have a life-long effect on a woman's health. Based on recent trends, this burden has been steadily increasing (Division of Reproductive Health 2014). The consequences of the increasing maternal complication rate are higher health service utilization, additional medical costs, extended hospitalization stays, and long-term sequelae requiring rehabilitation (Division of Reproductive Health 2014). In addition, occurrence of maternal complications is closely associated with adverse birth outcomes such as include preterm birth, low birth weight and birth trauma.

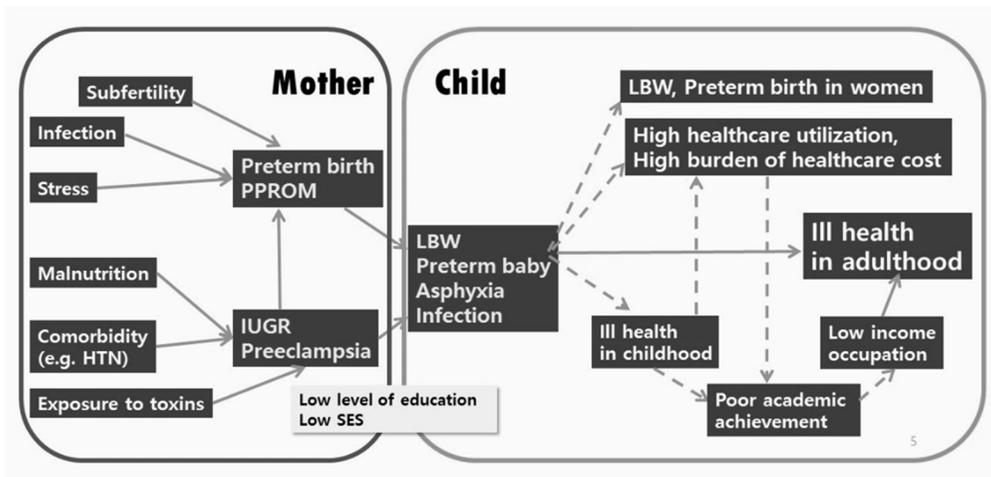
Interventions to promote maternal health are known to improve fetal and neonatal survival as well (Judith R. Bale 2003).

1-2. Income-based Differentials in Maternal Conditions during Pregnancy and Delivery

Relative socioeconomic disadvantages has been suggested to play an independent role in occurrence of maternal morbidities (Lindquist, Knight et al. 2013, Lindquist, Noor et al. 2014). Adverse birth outcomes such as birth complication, low birth weight, preterm or early term birth have been known to be worse in low income group than higher income group with adjusting for maternal age (Starfield, Shapiro et al. 1991, Borders, Grobman et al. 2007). Even in developed countries, studies have suggested that socioeconomic position would be a risk factor for poorer maternal health outcomes (Lee, Khang et al. 2005). The women in routine/manual occupations are more likely to experience severe morbidity during pregnancy and labor than ‘managerial/professional’ group according to a report from UK (Lindquist, Knight et al. 2013). The study suggested social gradient of severe maternal morbidity and the results could be independent of ethnicity, BMI and age (Lindquist, Knight et al. 2013). In a Finnish study, mothers in low socioeconomic status were more likely to undertake cesarean deliveries than those in higher status (Raisanen, Gissler et al. 2014). Living in the most disadvantaged area are suggested

to be an independent risk factor for severe maternal morbidity also in Australia (Lindquist, Noor et al. 2014). Therefore, monitoring the temporal trends of these complications would be important for evaluating policy, programs and interventions aimed at reducing maternal morbidity and mortality (Savard, Auger et al. 2013). The possible mechanism of increase risk of maternal complications in socioeconomically disadvantaged group are presented in Figure 1-1.

Figure 1-1. Mechanism of increase risk of maternal complications in socioeconomically disadvantaged group



PPROM, preterm premature rupture of membrane; IUGR, intrauterine growth restriction; HTN, hypertension; LBW, low birth weight; SES, socioeconomic status.

1-3. Voucher Program and Inequalities in Health

Equality in health is described as ‘the absence of systematic or potentially remedial differences in one or more aspects of health across populations or population groups defined socially, economically, demographically or geographically (Gagnon, Small et al. 2014). Inequality in maternal health could be defined as systemic or remedial differences in maternal health during pregnancy, delivery, and the postpartum period across different population groups.

The issue of socioeconomic equalities in health is an important public health goal. For reducing the inequalities, evaluation and comparison of various interventions is critical. However, limited number of studies assessed the impacts of these interventions on inequalities in health, and thus little is known about which interventions reduced those inequalities (Ensor 2004, Yang, Platt et al. 2014). A wealth of evidence has suggested that the poor and vulnerable often benefit less from public health interventions than wealthier income groups (Ensor 2004). The impact of supply side interventions such as spending on primary clinics, on health outcomes remains inconclusive (Filmer, Hammer et al. 2000). Weaknesses on the supply side have led to some interest in consumer-led demand side financing as a way to improve the targeting of specific groups and as an instrument for promoting provider efficiency. Interest has been increased recently by the reported success of demand side financing in several countries (Amendah, Mutua et al. 2013).

Recent systemic review regarding the effect of interventions on maternal child health revealed that incentive interventions such as conditional cash transfers

and voucher programs significantly increase health facility delivery and antenatal coverage rate (Malqvist, Yuan et al. 2013). There are the two basic approaches to reduce the inequalities - universal coverage of health care interventions and targeted interventions directed at marginalized population groups. And it has been known that policies proactively promoting health of the disadvantaged with modulation of the root mechanisms causing inequality is known to be more effective than universal supporting system in achieving equitable health (Gagnon, Small et al. 2014).

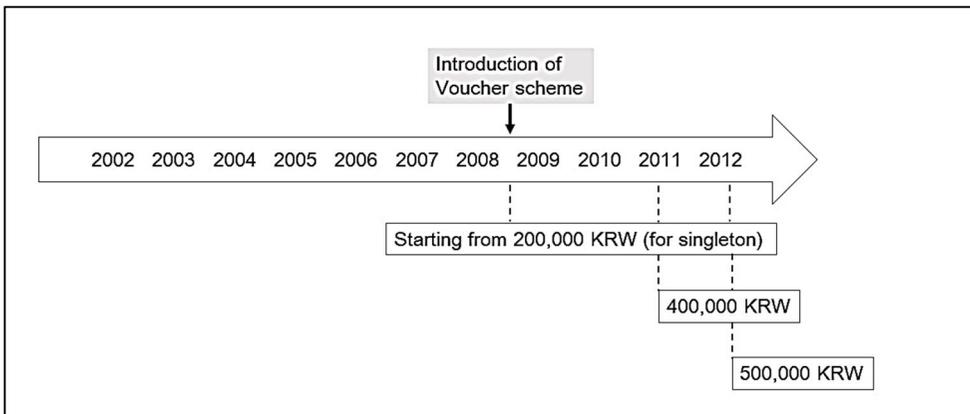
1-4. Introduction of the Universal Voucher Program for Antenatal Care and Birth Services in the Republic of Korea (*Goeun-mom* card)

In Korea, a universal voucher program for antenatal care and birth services (*Goeun-mom* card) was initiated in 2008 December to promote fertility (Social Security Information Service 2013). Starting from 200,000 KRW (Korean Republic Won) for singleton pregnancy, the coverage has steadily increased. Since the year of 2012, the voucher started to cover 500,000 KRW and upto 700,000 KRW of antenatal care and birth services for all pregnant women depending on the plurality (Figure 1-2).

According to a recent analysis, the goal of fertility promotion was not achieved with the introduction of this voucher program as it was expected (Eun

2015). In addition, the medical cost involved in antenatal care which is not covered by the NHI has increased since the implementation of the voucher program (Ministry of Health & Welfare 2015). Considering the potential effect of universal voucher systems on maternal health service utilization, the health impact of the voucher program should be assessed. Until now, there are no researches which evaluate the impact of this universal voucher program on maternal health in Korea.

Figure 1-2. Introduction and changes in the coverage of the universal voucher program for antenatal care and birth services



1-5. Study Objectives

This study was to identify the temporal trend of incidences, disparities in the two major maternal complications – preeclampsia and postpartum hemorrhage- and the

change after introduction of the universal voucher program. The objectives are as follows:

First, identify the trend of incidence of two major obstetric complications (preeclampsia and postpartum hemorrhage) and associated factors.

Second, explore the incidence and disparities in the risk of preeclampsia and postpartum hemorrhage according to relative household income level.

Third, evaluate the effect of the universal voucher program for antenatal care and birth service on the age-adjusted incidence and disparities in preeclampsia and postpartum hemorrhage in Korea.

CHAPTER 2. STUDY MATERIALS

2-1. Data sources

We used a sample cohort data provided by the National Health Insurance (NHI) Service. The Korean NHI program was initiated in 1977 and achieved universal coverage of the entire national population by 1989. The original database included health care utilization claims and health insurance/medical aid beneficiaries' qualifications for the whole Korean population (i.e., 97% covered by national health insurance and the 3% covered by medical aid). The NHI cohort database is a population-based cohort data which corresponds around 2 % of all Korean citizens, including details on diagnoses, prescribed medications, and procedures (treatments) which are covered by NHI. The cohort database includes individually-linked data which reflects level of household income. The representativeness of this cohort data was reported previously (Lee 2014). The individual data in the cohort is anonymized for Private Information Protection law.

From the perspective of social epidemiology, the relative income distribution has an independent effect on the risk of poorer health outcomes (Chiavegatto Filho ADP et al., 2012). The Korean NHI cohort database included individually-linked data of household income which is reflected in the insurance contributions. The household income deciles of individual data were divided into

three groups (lower for 1-4 deciles; middle for 5-7 deciles; and higher for 8-10 deciles) for analytical convenience. The household income was estimated by salary for employee, income and property for self-employers.

2-2. Study setting

2-2-1. Identification of live birth cases in the NHI database

Adequate antenatal care is an essential part of prevention of maternal complications during pregnancy and childbirth. In Korea, most of essential prenatal services such as routine blood test, oral glucose tolerance test and two times of non-stress test have been included in the NHI's benefit package since late 1990s. In the case of maternal complications, most of medications and procedures to prevent and treat these conditions are covered by the NHI under corresponding diagnostic codes. The adequate antenatal care coverage and hospital-based delivery rate in Korea has been reported to be as high as 99% of all deliveries since 2000 (Korean Statistical Information Service 2013).

Kuklina et al developed an enhanced method to identify hospitalization cases involving obstetric deliveries from an annual nationwide representative survey database (Kuklina, Whiteman et al. 2008). They looked for the following information in a hierarchical manner: (1) outcome of delivery (ICD-10), (2) normal

delivery (ICD-10), (3) delivery codes, and 4) procedure codes for selected delivery-related procedures. In reference to this method, individuals with live birth in the year were identified from the NHI claim data following three steps: 1) treatment history in obstetrics and gynecology (OBGY) department with diagnostic code for delivery (starts with 'O8**' in ICD-10), 2) duration of admission under the delivery code for one day or more, and 3) women aged between 15 and 44 years. The elements in the identification method were selected by the author, an obstetrician-gynecologist, after a review of all diagnosis and procedure codes in the cohort data

2-2-2. Outcome and explanatory variables

As a maternal health measure, maternal mortality ratio (MMR) is the most widely used indicator. In the countries with very low maternal mortality, the MMR would not reflect the level of maternal health accurately. Therefore, in those circumstances, measuring the major maternal morbidities can be used as indicators for maternal health (Lindquist et al, 2013).

The outcomes of interest in this study were the two common complications in mothers – preeclampsia and postpartum hemorrhage. Well-known potential risk factors for these conditions were included as covariates in the analyses. Variables of interest were coded using the ICD-10 codes specified in Table 2-1. The presences of diabetes was determined by the ICD-10 codes among these obstetric delivery cases.

Procedure codes were used to determine parity (nulliparity or multiparity), plurality (singleton or multiple), mode of delivery (normal or cesarean) and induction of labor. To improve the validity of diagnostic code in the claim data, only the cases with the procedure code which is specific for the condition were included. For the cases definition of preeclampsia, in addition to the ICD-10 codes, cases with the procedure codes for inpatient prescription of MgSO₄ were considered to have preeclampsia among the study population (procedure codes which were used are presented in Appendix 3). For postpartum hemorrhage, procedure code of blood transfusion was used along with the ICD-10 codes for postpartum hemorrhage. All cases were included once, including only the first delivery event in the cohort database.

Table 2-1. International Classification of Diseases-10 (ICD-10) codes for covariates and outcome variables

Variables	ICD-10 codes
<i>Covariate</i>	
Diabetes mellitus	E10 (Type 1 diabetes mellitus)
	E11 (Type 2 diabetes mellitus)
	E12 (Malnutrition-related diabetes mellitus)

	E13 (Other specified diabetes mellitus)
	E14 (Unspecified diabetes mellitus)
	O24 (Diabetes mellitus in pregnancy)
<i>Outcome variables</i>	
	O14.0 (Mild to moderate pre-eclampsia)
Preeclampsia	O14.1 (Severe pre-eclampsia)
	O14.2 (HELLP syndrome)
	O14.9 (Pre-eclampsia, unspecified)
	O72.0 (Third-stage hemorrhage, hemorrhage associated with retained, trapped or adherent placenta, and retained placenta NOS)
Postpartum hemorrhage	O72.1 (Other immediate postpartum hemorrhage, hemorrhage following delivery of placenta, and postpartum hemorrhage NOS)
	O72.2 (Delayed and secondary postpartum hemorrhage, hemorrhage associated with retained portions of placenta or membranes, retained products of conception NOS)
	O72.3 Postpartum coagulation defects
HELLP, haemolysis, elevated liver enzymes, low platelet count; NOS, not otherwise specified.	

CHAPTER 3. SOCIAL DETERMINANTS MAJOR OBSTETRIC COMPLICATIONS IN KOREA

3-1. Background

Recent concerns on the social determinants of health, there is limited researches investigating the social factors involved in maternal health. Studies in developed countries have suggested that socioeconomic position may be a risk factor for poorer health outcomes in new mothers. A study in the UK showed that unemployed women and those in routine/manual occupations were six times more likely to die during pregnancy and labor compared to women who are at the highest socioeconomic group. The social risk factors for the obstetric conditions has been rarely explored in Asian countries.

The risk factors or determinants in the occurrence of obstetric complications could be different among ethnic groups. In addition, those studies on Asian mothers were from relatively small number of cases. This study was to explore determinants in the occurrence of major obstetric complications in Korean mothers using the National Health Insurance cohort data.

3-2. Methods

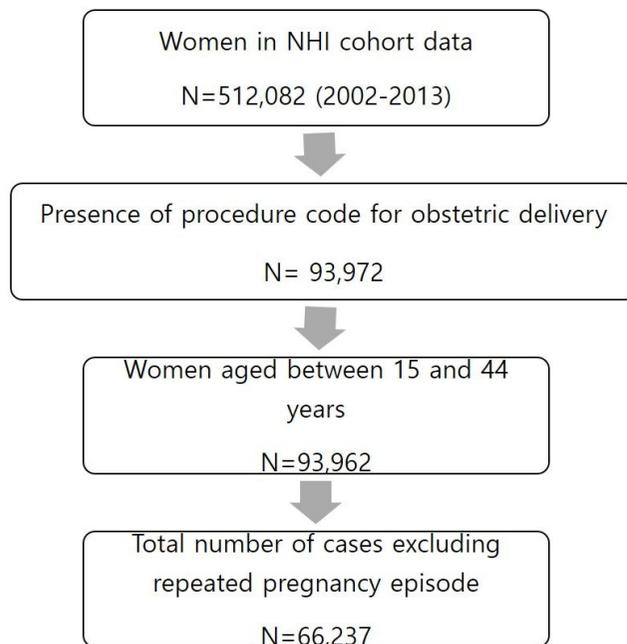
Stratification of study population

The proportion of OBGYN patients under DRG payment system has dramatically increased since 2004 (Table 3-1). In Korea, Diagnosis-Related Group (DRG) payment system was implemented on a voluntary basis from January 2002. The DRG payment system reimburses inpatient care fees using a DRG classification system. In this system, all hospitalized patients are classified by DRG. In order to categorize patients, attention is paid to their consumption of medical resources, clinical symptoms, diagnosis, surgery, age, etc. When a patient is hospitalized, a fixed amount of medical fee is reimbursed depending on which disease the patient has. This fee is reimbursed regardless of the type or amount of medical services, such as examination, surgery or medication, which are provided during hospitalization. As the reimbursed amount is fixed in advance, it is likely that healthcare input will be reduced, in order to increase the profit of the healthcare institution. In DRG payment system, problems such as upcoding and creeping would occur.

Since the cesarean section was one of the seven diseases of DRG system, only the women who had undertaken cesarean section were affected by this payment system. Therefore, in identification of determinants of obstetric complications in the NHI cohort data, the study population was divided into three groups according to the two criteria: 1) delivery mode (normal or cesarean), and 2) (among cesarean section

cases) under DRG payment system. Following this identification flow, a total of 41,721 normal delivery and 22,032 cesarean section cases were analyzed. Since there are possible upcoding or creeping in the cases under DRG payment system, the diagnoses of preeclampsia and postpartum hemorrhage were confirmed with coexistence of corresponding treatment code (MgSO4 and blood transfusion, respectively).

Figure 3-1. Identification flow for study population in the National Health Insurance cohort data from 2002 to 2013



Analysis

In each group, unadjusted and adjusted odds ratio for the occurrence of obstetric complications were calculated using uni- and multivariable logistic regression models. The variables included age group (15-19, 20-24, 25-29, 30-34, 35-39 and 40-44 years), being in paid work, multiple gestation (multiple [=1] or single gestation [=0]), nulliparity, presence of diabetes, induction of labor and presence of other major complications. The mother population was divided into three groups according to household income level (lower, middle and higher), following the reference of the national income deciles. Induction of labor was not included in the multivariable model for preeclampsia because they are the results of preeclampsia rather than causes.

Table 3-1. The annual data of total delivery cases, cesarean delivery, DRG cases (among Cesarean deliveries), total fertility rate and number of birth nationwide* .

Year	Total	Cesarean delivery	DRG cases	Total fertility rate	Total number of birth (x1,000)
2002	7,227	2,739 (37.9)	1620 (59.15)	-	-
2003	7,862	2,928 (37.24)	1734 (59.22)	1.18	490.5
2004	6,621	2,493 (37.65)	2439 (97.83)	1.154	472.8
2005	5,839	2,168 (37.13)	2102 (96.96)	1.076	435.0
2006	5,387	1,911 (35.47)	1908 (99.84)	1.123	448.2

2007	5,569	2,053 (36.86)	2051 (99.9)	1.25	493.2
2008	4,983	1,830 (36.72)	1828 (99.89)	1.192	465.9
2009	4,364	1,556 (35.66)	1543 (99.16)	1.149	444.8
2010	4,379	1,647 (37.61)	1627 (98.79)	1.226	470.2
2011	4,834	1,746 (36.12)	1741 (99.71)	1.244	471.3
2012	4,919	1,880 (38.22)	1874 (99.68)	1.297	484.6
2013	4,253	1,565 (36.8)	1565 (100)	1.187	436.6

*Information of total fertility rate and number of live birth are from Korean Statistical Information System.

3-3. Result

The general clinical and social characteristics of the study population according to household income level was summarized in Table 3-2. During the study period, the majority of women in the population were aged 30-34 years. The more than a third was in middle household income group. Only 23.7% of mothers were workers at the time of pregnancy. More than a half of the women were nulliparous. The proportion of induction of labor and cesarean section was 18.7% and 37%, respectively.

Premature rupture of membrane was present in 12.9%, preterm delivery in 1.6%, intra-anionic infection in 0.8% and diabetes in 1.6%. As for the outcome variables,

the percentage of preeclampsia was 1.0%, severe preeclampsia was 0.4%, puerperal infection was 8.1%, and premature rupture of membrane was 12.9%.

Table 3-2. Characteristics and proportion of obstetric complications according to household income level from the Korean NHI cohort data from 2002 to 2013

Variables	Number (proportion)
<i>Age group</i>	
15-19	313 (0.47)
20-24	3,817 (5.76)
25-29	24,306 (36.7)
30-34	28,596 (43.17)
35-39	7,905 (11.93)
40-44	1,300 (1.96)
<i>Household income level</i>	
Lower	16,257 (24.62)
Middle	29,053 (43.99)
Higher	20,731 (31.39)
Being a paid worker	15,705 (23.71)
<i>Obstetric variables</i>	
Multiple gestation	861 (1.3)
Nulliparity	41,654 (62.89)

Cesarean section	24,516 (37.01)
Induction of labor	12,354 (18.65)
Premature rupture of membrane	8,539 (12.89)
Preterm delivery	1,026 (1.55)
Intra-anionic infection	555 (0.84)
Diabetes	1,034 (1.56)
<i>Outcomes</i>	
Postpartum hemorrhage	3,408 (5.15)
Preeclampsia	690 (1.04)

¹Informations on nulliparity, multiple gestation, induction of labor and cesarean delivery were available from procedure code in NHI database.

²The Mantel-Haenszel chi-square tests were done for exploring a linear association between household income groups.

The association between each social and clinical factors with preeclampsia and postpartum hemorrhage were explored with multivariable analyses (Table 3-3). Lower household income was found to be common risk factor for preeclampsia and postpartum hemorrhage. The lower household income group showed an independently increased risk for preeclampsia (OR = 1.26, 95% CI = 1.01-1.57) and postpartum hemorrhage (OR = 1.21, 95% CI = 1.06-1.39), compared with the higher income group. Women who were paid workers at the time of pregnancy were less likely to experience postpartum hemorrhage than those who were not (OR =

0.87, 95% CI = 0.77-0.99). Among the clinical factors, maternal age ≥ 35 years, multiple gestation, and presence of diabetes increased the risk for developing preeclampsia. For postpartum hemorrhage, maternal age < 20 or ≥ 35 years, multiple gestation, presence of diabetes, Cesarean delivery, and induction of labor were risk factors.

On the contrary, nulliparity decreased risk of postpartum hemorrhage.

Table 3-3. Odds ratios (OR) for preeclampsia treated with MgSO₄ and postpartum bleeding requiring blood transfusion

Variables	OR [95%CI]	
	Preeclampsia	Postpartum hemorrhage
<i>Age group</i>		
15-19 vs 25-29	1.0 [0.3, 4.2]	3.0 [1.8, 5.0]
20-24 vs 25-29	0.9 [0.6, 1.4]	1.1 [0.9, 1.4]
30-34 vs 25-29	1.0 [0.8, 1.2]	1.1 [1.0, 1.3]
35-39 vs 25-29	1.3 [1.0, 1.7]	1.3 [1.1, 1.6]
40-44 vs 25-29	1.6 [1.0, 2.6]	1.9 [1.4, 2.5]
Worker	1.0 [0.8, 1.2]	0.9 [0.8, 1.0]
<i>Income groups</i>		
Lower vs Higher	1.2 [1.0, 1.5]	1.2 [1.1, 1.4]
Middle vs Higher	1.0 [0.9, 1.3]	1.1 [1.0, 1.3]
Nulliparity	0.9 [0.7, 1.0]	0.8 [0.8, 0.9]

Multiple gestation	4.4 [3.2, 6.2]	2.9 [2.2, 3.7]
Diabetes	3.6 [2.5, 5.1]	2.0 [1.5, 2.6]
Induction of labor		1.2 [1.0, 1.4]
Cesarean delivery	-	2.1 [1.8, 2.3]

3-4. Discussion

The findings of this study being in paid work revealed that the occurrence of postpartum hemorrhage requiring transfusion was associated with household income level and being in paid work. Women who are in lower household income level showed significantly higher risk of preeclampsia and postpartum hemorrhage. Being in paid work was negatively associated with the risk of development postpartum hemorrhage. As the first study on the social risk factors of major obstetric complications in Korean mothers, this study suggest possible role of relative level of household income especially in the occurrence of preeclampsia and postpartum hemorrhage.

In the study of Cho et al, the risk factors for development of preeclampsia in the multiparous women were maternal age > 35 years, multiple pregnancies, prior cesarean delivery and birth spacing for more than 3 years (Cho, Kim et al. 2015). Because Cho and colleague's study did not include the diabetes and intra-amnionic infection in their analyses, the relationships between these two conditions and

preeclampsia would have not been revealed. Although it has been well-known that nutritional deficiency is linked with development of preeclampsia, economic deprivation could have not been so severe and it did not increase the risk of preeclampsia in women at the lower income group.

In conclusion, there were income-based disparity in the risk of preeclampsia and postpartum hemorrhage. This finding prompts the needs of further study on the social risk factors in the obstetric complications and of policy development for more equitable maternal health.

CHAPTER 4. TREND OF ANNUAL INCIDENCE OF THE MAJOR OBSTETRIC COMPLICATIONS FROM 2002 TO 2013 IN KOREA

4-1. Background

Pregnancy is a crucial time to promote healthy behaviors for women. Adequate care for conditions during pregnancy and child birth links the woman and her family with the formal health system and contributes to maintaining good health through the life course (Lincetto, Mothebesoane-Anoh et al. 2006). Insufficient healthcare utilization during this time can break the continuum of care, and effects both women and babies. Pregnancy-induced hypertension (preeclampsia and eclampsia) and hemorrhage are directly related to inadequate care during pregnancy (Organization 2005).

Global economic recessions are likely to have a negative association with maternal outcomes particularly those in the lesser wealthy countries, although the effects vary across different systems (Ensor, Cooper et al. 2010). Even in the high income countries, the health status of disadvantaged members of society could have worsened with the recent global economic recession, thereby exacerbating health disparities (Bacigalupe and Escolar-Pujolar 2014). With negative economic growth,

household income is directly affected, which in turn affects a household's ability to cover out of pocket costs of services (Ensor, Cooper et al. 2010). In most of health systems, there are 'demand-side' costs in addition to those at the point of service delivery: transport, time taken away from work. Even in the high income country such as Italy, increased poverty and youth unemployment was associated with increased women's age at delivery which is at higher risk of birth complication (De Curtis 2014). For the last decade, Korea had also suffered from high rate of unemployment affected by the global economic crisis especially in younger generations who were also in reproductive age, as did many countries (Cho 2010). Even under the universal maternal health coverage by the NHI, the occurrence of maternal complications could have been affected depending on the income status.

Beyond the identification of health disparities, monitoring the temporal changes in disparities is also important for developing interventions to reduce it (Khang, Yun et al. 2008, Savard, Auger et al. 2013). Considering the lifelong impact of maternal conditions during pregnancy and birth, the change in the incidence of maternal complications during this period would be important. To elucidate the changes of incidence of major maternal morbidities in Korea from 2002 to 2013, the maternal data on NHI database were explored for the preeclampsia and postpartum hemorrhage.

4-2. Methods

Calculation of age-adjusted proportion

Adjustment of the outcome variables has been common practice in many social epidemiology researches. However, different adjustment methods can cause a change in the statistical significance of the association between the outcome variable and various socioeconomic factors (Milyo and Mellor 2003). Therefore only age-adjusted rates were analyzed in this study.

The incidence of each complication was estimated with Poisson regression models considering proportions of age group in each income group (i) of the period (k).

$$y \sim \text{Poisson}(\lambda)$$

$$\ln(\lambda)_k = \beta_0 + \sum_i \beta_{ik} \chi_{ik} \dots \dots \dots \text{Equation (1)}$$

(i^{th} age group: 15-19, 20-24, 25-29, 30-34, 35-39 and 40-44;

k^{th} period: 1=from 2002 to 2005, 2=from 2006 to 2009, and 3=from 2010 to 2013)

The count of each obstetric complications is y in each income strata and λ is the link parameter. When $\ln(\lambda)$ is assumed to have a linear relationship with the explanatory variables – proportion of each age group in each income tertile, the estimated incidence in each income tertile can be expressed as in the equation (1).

Calculations were done using SAS software, version 9.3 (SAS Institute Inc., Cary, North Carolina).

Statistical analysis

The Korean NHI cohort database includes individually-linked data of household income decile. The household income levels of individual data were divided into three groups (lower: 10–40%, middle: 40–80%, and higher: 80–100%) for analytical convenience. The incidences of preeclampsia and postpartum hemorrhage in each income group were estimated using regression models considering the mother's age in the corresponding year. The analyses were performed using SAS software (ver. 9.3; SAS Institute Inc., Cary, NC, USA).

To identify changes in incidences and inequalities over time, the study period was divided into three portions (2002–2005, 2006–2009, and 2010–2013). In each period, age-adjusted incidences in the three income groups were calculated. The income-based inequality was measured by the slope index of inequality (SII) and the Kunst and Mackenbach relative index of inequality (RII_{KM}), which are widely used indices in social epidemiology. Unlike traditional indicators, such as risk ratios and risk differences, the SII and RII_{KM} consider the distribution of socioeconomic advantage for the target population. As an absolute scale of disparity, SII can be interpreted as the difference between the bottom and top of the social group hierarchy. For a relative disparity scale, the RII_{KM} is estimated by dividing the health status of the least advantaged by that of the most advantaged, in terms of

the social group hierarchy (Mackenbach and Kunst 1995). Using the highest social rank as a reference, an RII_{KM} value > 1 indicates that the morbidity rate is higher among groups with lower social ranks (Mauricio Avendano 2010). Compared with traditional relative risk measures, these scales use data for all social groups and account for group size (Harper and Lynch 2005). The SII and RII_{KM} , and their 95% confidence intervals (CIs), were calculated using the Health Disparities Calculator (HD*Calc, ver. 1.2.4; October 29, 2013; Division of Cancer Control and Population Sciences, Surveillance Research Program and Applied Research Program, National Cancer Institute). Plotting of these inequality measures in the three periods was done with the 'R' software (ver. 3.0.3; R Development Core Team, Vienna, Austria). This study was reviewed and approved by the Seoul National University Institutional Review Board (IRB No. 1412/001-010).

4-3. Results

The clinical characteristics and outcomes among the three income groups are summarized in Table 4-1. During the study period, younger age, being in paid work, and nulliparity were more prevalent in the lower income group than in the others. The proportion of multiple gestations (1.76% in higher, 1.12% in middle, and 1.05% in lower income group) and diabetes (1.98% in higher, 1.38% in middle, and 1.33% in lower income group) were highest in the higher income group.

Among the two obstetric complications, postpartum hemorrhage occurred more frequently in women with lower and middle household income in the analysis of the aggregated data.

Table 4-1. Characteristics and proportion of obstetric complications according to household income level from the Korean NHI cohort data from 2002 to 2013

Household income level	Lower	Middle	Higher	P value (Df=1)²
	(N=27,258) Number (%)	(N=20,066) Number (%)	(N=18,155) Number (%)	
Variables				
Age group				
15-19 years	165 (1.01)	85 (0.29)	43 (0.21)	
20-24 years	1,733 (10.66)	1,453 (5)	602 (2.9)	
25-29 years	6,592 (40.55)	11,786 (40.57)	5,888 (28.4)	<.001
30-34 years	5,743 (35.33)	12,528 (43.12)	10,278 (49.58)	
35-39 years	1,683 (10.35)	2,784 (9.58)	3,400 (16.4)	
40-44 years	341 (2.1)	417 (1.44)	520 (2.51)	
Being a paid worker	4,411 (27.13)	7,417 (25.53)	3,877 (18.7)	<.001
Obstetric characteristics¹				
Nulliparity	10,543 (64.85)	18,882 (64.99)	12,135 (58.54)	<.001
Multiple gestation	171 (1.05)	325 (1.12)	364 (1.76)	<.001
Diabetes	217 (1.33)	400 (1.38)	411 (1.98)	<.001

Induction of labor	2,933 (18.04)	5,485 (18.88)	3,905 (18.84)	0.066
Cesarean delivery	6,157 (37.87)	10,680 (36.76)	7,593 (36.63)	0.018
<i>Treatment</i>				
Preeclampsia	153 (0.94)	235 (0.81)	174 (0.84)	0.332
Postpartum hemorrhage	420 (2.58)	701 (2.41)	469 (2.26)	0.046

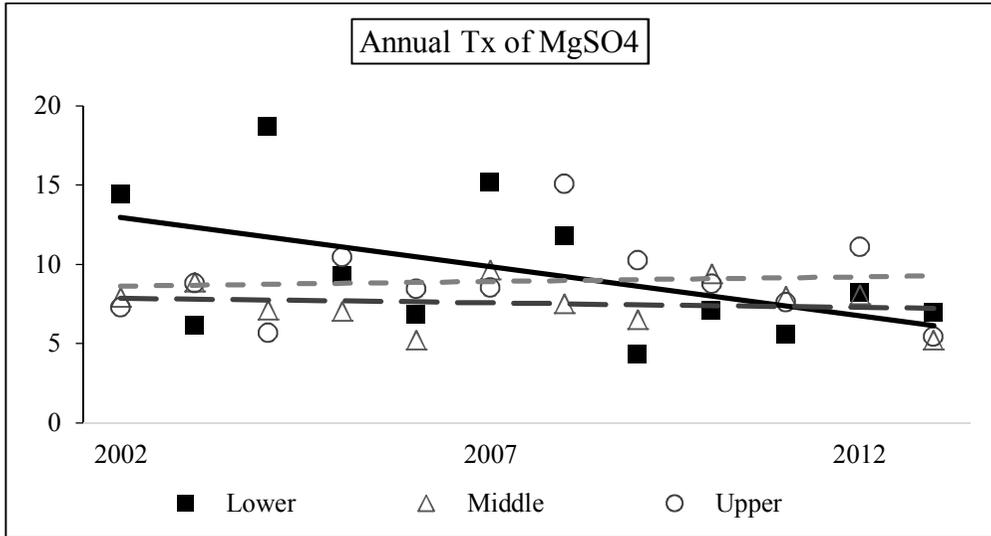
Values are presented as number (percentages in parentheses).

¹Informations on nulliparity, multiple gestation, induction of labor and cesarean delivery were available from treatment code in NHI database.

²The Mantel-Haenszel chi-square tests were done for exploring a linear association between household income groups.

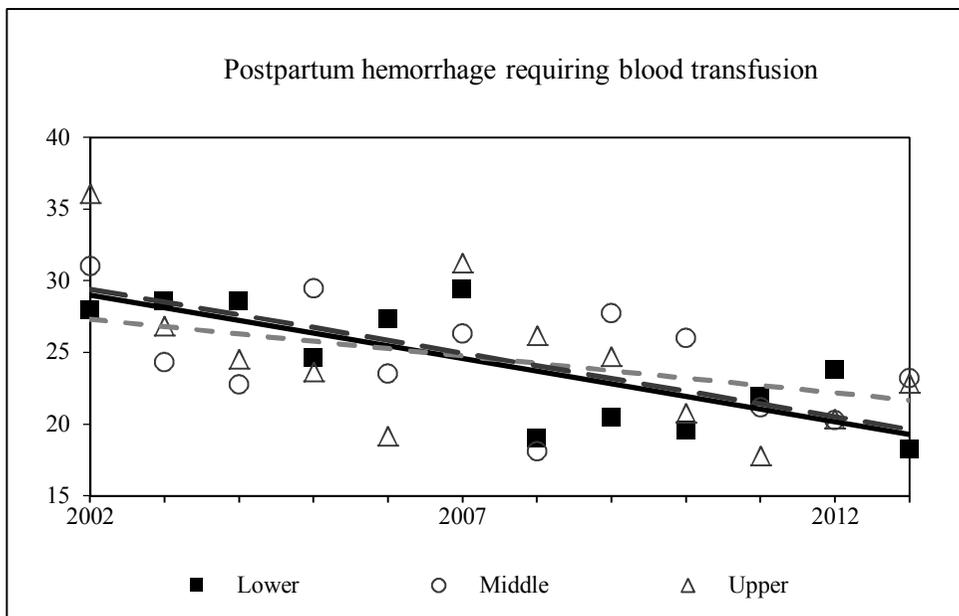
The incidence of postpartum hemorrhage was generally higher than that of preeclampsia. The incidence rate of preeclampsia was 7.2 in 2002 and 4.7 in 2013. Postpartum hemorrhage occurred in 34.0 cases in 2002, and 20.5 in 2013, per 1,000 women. The annual age-adjusted incidence of preeclampsia did not show a significant unidirectional trend (AAPC = 0.20, P = 0.941). Postpartum hemorrhage decreased during the study period (AAPC = -4.23, P = 0.001). When the change over time was analyzed according to household income groups, there was no significant unidirectional pattern in the annual incidence of preeclampsia in all income groups (Figure 4-1).

Figure 4-1. Trend of age-adjusted annual incidence rate of preeclampsia, from 2002 to 2013



The age-adjusted annual incidences of postpartum hemorrhage showed generally decreasing patterns. The decreasing trend was significant only for lower and higher income groups (Figure 4-2).

Figure 4-2. Trend of age-adjusted annual incidence rate of postpartum hemorrhage, from 2002 to 2013



For incidence of preeclampsia, the AAPC's were not significant for all the three income groups. The age-adjusted annual incidences of postpartum hemorrhage decreased by 3 – 4% on average (Table 4-2).

Table 4-2. Average annual percent changes (AAPC) across the three income groups, for age-adjusted annual incidences of preeclampsia and postpartum hemorrhage, respectively

Income groups	AAPC	Lower CI	Higher CI	F statistic ¹	P-value
<i>Preeclampsia</i>					

Lower	-6.16	-13.48	1.78	-1.75	0.11
Middle	-0.48	-4.00	3.17	-0.30	0.77
Higher	1.55	-3.60	6.98	0.66	0.53
<hr/>					
<i>Postpartum hemorrhage</i>					
<hr/>					
Lower	-3.58 [^]	-5.80	-1.30	-3.48	0.01
Middle	-2.01	-4.70	0.75	-1.63	0.13
Higher	-3.86 [^]	-6.79	-0.83	-2.83	0.02

¹The Average Annual Percent Change (AAPC) is significantly different from zero at alpha = 0.05.

4-4. Discussion

This study demonstrated that lower household income was an independent risk factor for developing preeclampsia and postpartum hemorrhage. During the study period, the inequality indices, considering each income group's population share, were insignificant for both preeclampsia and postpartum hemorrhage. Despite the global economic recession, there was no evidence of worsening in the absolute or relative disparities in the incidences of preeclampsia or postpartum hemorrhage in Korea. Our study showed both preeclampsia and postpartum hemorrhage would be

more prevalent in lower economic status populations, consistent with previous reports (Haelterman, Qvist et al. 2003, Lindquist, Knight et al. 2013, Lindquist, Noor et al. 2014). To the best of our knowledge, this is the first reported study on temporal changes in income-based disparities in preeclampsia and postpartum hemorrhage using population-based data.

Given the widening gap in overall health between the more and less deprived groups in many countries (Katikireddi, Niedzwiedz et al. 2012, Son, Cho et al. 2012, Bacigalupe and Escolar-Pujolar 2014), the finding of no significant disparities in preeclampsia and postpartum hemorrhage suggests that the presentation of disparities can differ, depending on health status and social class. According to Braveman et al., an income-based disparity was observed for lower birth weight and delayed antenatal visits, but not for unintended pregnancy (Braveman, Cubbin et al. 2001). In a US study, the risk of lower birth weight and preeclampsia was higher in African-Americans than in Hispanics while gestational diabetes was more prevalent in Hispanics than in African-Americans (Brown, Chireau et al. 2007). A study in the UK on temporal trends in adverse perinatal outcome according to socioeconomic disparities showed different patterns of disparities between preterm birth and low birth weight (Glinianaia, Ghosh et al. 2013). In research on a female Spanish population, maternal education gradients in adverse perinatal outcome were significant only for the period 2009–2011, suggesting a negative impact of the economic recession (Juarez, Revuelta-Eugercios et al. 2014). To confirm the insignificance of disparities in maternal complications,

studies assessing differences in the gradients of other socioeconomic factors, such as education and maternal health status would be needed.

The decreasing tendency toward postpartum hemorrhage seen in both the lower and upper income groups could be attributable to several different factors. Because essential antenatal services have been covered by the NHI since the late 1990s in Korea, utilization of the services has increased. With improved universal access to care, the frequency of antenatal visits is likely to rise, especially in the lower income group (Ahmed and Khan 2011). However, as the ‘inverse equity hypothesis’ argues, an increase in visits should also occur in women belonging to the upper household income group, because those with a higher socioeconomic status tend to respond to public health initiatives more quickly (Victora, Vaughan et al. 2000). More frequent perinatal visits in these two income groups could have resulted in more – and earlier – detection and management of obstetric hemorrhage, preventing severe hemorrhages requiring blood transfusions (Kim and Moon 2014). Income-based differences in changing patterns of postpartum hemorrhage underscore the need for monitoring of maternal health status according to household income level.

It is unclear why lower economic status would lead to a higher risk of obstetric complications (Murray, Lopez et al. 1998, Maharaj 2007). A study of Scottish women showed that the risk of bleeding during pregnancy was higher in lower social class women (Bhandari, Raja et al. 2014). Because they are more likely to have an underlying iron deficiency, a certain amount of bleeding could be more

risky for women in deprived groups (Bodnar, Cogswell et al. 2002). Furthermore, it is possible that, for a similar reason, emergency hysterectomies were more frequent in women with a lower socioeconomic status (Chestnut, Eden et al. 1985). Lower household income is closely linked with a lower level of education, unhealthy behaviors, a more stressful environment, limited access to adequate housing or utilities, increased maternal infection, and unwanted pregnancies, resulting in a lower commitment to prenatal care (Raisanen, Kramer et al. 2014). A study in Australia indicated that women belonging to the lowest socioeconomic group generally reported a poorer experience of care during pregnancy, while also having a higher risk of hospital admission or transfer during labor and delivery, in addition to being less likely to have had any antenatal care or postnatal visits (Yelland, Sutherland et al. 2012).

Several weaknesses due to the use of ICD-10 codes for case definition were unavoidable in this study. The lack of information on disease severity, a possible tendency toward over-reporting by physicians, and misclassification or miscoding might have affected the result of this study. The level and location (urban or rural area) of individual institutions might also have influenced the diagnosis and treatment of preeclampsia or postpartum hemorrhage. However, by using a stratified random sample and strict working definitions, these weaknesses could have been minimized. Validation of the presently used working definitions of preeclampsia and postpartum hemorrhage in the NHI dataset will be a subject of future studies.

Another limitation of this study was that mediating variables, such as healthcare utilization and disease severity, were not considered in the model. Because this study included cases covered by the diagnosis-related groups (DRG)-based payment system, the number of perinatal visits or length of stay could not be used in the analysis. In addition, preeclampsia generally resolves after delivery and the length of hospital stay can also be determined by gestational age. Due to the lack of information on gestational age, disease severity could not be evaluated by the length of hospital stay. As only severe cases that needed treatment (MgSO₄ or blood transfusion) were included in the study, an income-based disparity in the mild form of disease would confirm the findings of this study.

In summary, a lower level of household income was an independent risk factor for developing preeclampsia and postpartum hemorrhage. For both complications, trends in occurrence differed according to household income. Our findings suggest that income-based disparities in preeclampsia and postpartum hemorrhage may have been only minimally affected in Korea by the economic recession. Universal coverage of essential maternal care services and attempts to monitor and reduce disparities in health across different socioeconomic groups will be critical for maintaining equity in maternal health.

CHAPTER 5. INCOME-BASED DISPARITIES IN THE MAJOR MATERNAL COMPLICATIONS IN KOREA

5-1. Background

The socioeconomic status based disparities in health has been important issue in public health. Inequality in maternal health can be defined as systemic or remedial differences in maternal health during pregnancy, delivery, and the postpartum period across different population groups.

Complications during pregnancy or birth can involve the baby's health as well as the mother's. Recently the importance of the first few years in the life of a child for promoting healthy physical, emotional, social, and intellectual development are increasingly recognized. Closing the gap in the occurrence of birth complications is assumed to be the first step to improve population health and reduce inequalities in health (Karoly, Kilburn et al. 2005, Muennig, Robertson et al. 2011).

Substantial evidences indicate the socioeconomic disadvantages could play a role in the occurrence of maternal morbidities. Even in many countries with universal health coverage, relatively lower socioeconomic position may be an independent risk factor for poorer health outcomes (Braveman, Cubbin et al. 2001, Yelland, Sutherland et al. 2012, Lindquist, Noor et al. 2014). However, limited

evidences are available in the socioeconomic status-based disparities in maternal complications. Considering the long-term and profound impact of these perinatal event on families, this inequalities in perinatal outcome due to economic status should be minimized. Despite the universal coverage of NHI, there could be disparities in the occurrence of maternal complication in Korea. The purpose of this study was to explore the absolute and relative disparities in the major maternal complications according to household income level.

5-2. Methods

A population-based cohort data from Korean National Health Insurance (NHI) was used. As summary indices of inequality, slope index of inequality (SII) and Kunst and Mackenbach relative index of inequality (RII_{KM}) were measured in predicted incidence data according to relative household income tertiles (lower: 10-40%, middle: 40-80%, higher: 80-100%). As an absolute scale of disparity, the SII is defined as an estimated slope for the social disparity. For a relative disparity scale, the RII_{KM} is the estimated health of the least advantaged person by the estimated health of the most advantaged person of the social gradient (Mackenbach and Kunst 1995). With the highest social rank as reference, an RII_{KM} value greater than 1 means that the morbidity rate is higher among the group with lower social rank (Mauricio Avendano 2010). Compared to a traditional relative risk measure, this

scale uses the data on all social groups and accounts for the social-group sizes (Harper and Lynch 2005). The SII and RII_{KM} and their 95% confidence intervals were calculated using Health Disparities Calculator (HD*Calc, Version 1.2.4 - October 29, 2013; Division of Cancer Control and Population Sciences, Surveillance Research Program and Applied Research Program, National Cancer Institute) was used.

To identify temporal change, the study period was divided into three portions (2002-2005, 2006-2009 and 2010-2013). Age-adjusted proportion of each period was used in the subsequent analyses.

5-3. Results

Demographic and obstetric characteristics for the three periods are summarized in Table 5-1. The crude proportions of worker at the time of pregnancy, nulliparity, cesarean delivery and blood transfusion were decreased over time. On the other hand, the prevalences of multiple gestation, diabetes (gestational and non-gestational), number of outpatient visits and duration of admission were increased.

Table 5-1. Demographic, obstetric characteristics and outcomes for the three periods, the Korean National Health Insurance data from 2002 to 2013

	2002-2005 (N=16,257)	2006-2009 (N=29,053)	2010-2013 (N=20,731)	P value
	No (%)	No (%)	No (%)	
<i>Age group</i>				
15-19	123 (0.45)	75 (0.37)	115 (0.63)	<.001
20-24	1,896 (6.88)	1,027 (5.06)	894 (4.86)	
25-29	11,265 (40.89)	7,651 (37.68)	5,390 (29.32)	
30-34	11,310 (41.05)	8,416 (41.45)	8,870 (48.25)	
35-39	2,575 (9.35)	2,736 (13.48)	2,594 (14.11)	
40-44	380 (1.38)	398 (1.96)	522 (2.84)	
Being a paid worker	4,544 (16.49)	5,017 (24.71)	6,144 (33.42)	<.001
<i>Obstetric characteristics</i>				
Nulliparity	10,352 (37.58)	15,408 (75.89)	15,894 (86.45)	<.001
Multiple gestation	169 (0.61)	338 (1.66)	354 (1.93)	<.001
Diabetes	290 (1.05)	259 (1.28)	485 (2.64)	<.001
Induction of labor	4,099 (14.88)	4,078 (20.09)	4,177 (22.72)	<.001
Cesarean delivery	10,328 (37.49)	7,350 (36.2)	6,838 (37.19)	0.336
<i>Outcomes</i>				

Preeclampsia treated with MgSO ₄	246 (0.89)	181 (0.89)	139 (0.76)	0.332
Postpartum hemorrhage requiring blood transfusion	745 (2.7)	492 (2.42)	361 (1.96)	0.046
<i>Income groups</i>				
Lower	6,711 (24.4)	5,171 (25.54)	4,375 (23.92)	
Middle	12,315 (44.78)	8,916 (44.04)	7,822 (42.76)	<.001
Higher	8,478 (30.82)	6,159 (30.42)	6,094 (33.32)	

During the study period, significant income-based disparities which were measure by SII and RII were not observed for both complications. The SII and RII of preeclampsia and postpartum hemorrhage for the three study periods are presented in Table 5-2.

Table 5-2. The absolute inequality measure (Slope inequality index, SII) and relative inequality measure (Relative inequality index, RII) for the age-adjusted incidence rates of preeclampsia and postpartum hemorrhage, from 2002 to 2013

		2002-2005	2006-2009	2010-2013
Preeclampsia	Slope Index of Inequality (SII)	18.9 [-4.6, 42.4]	9.5 [-12.1, 31.2]	3.1 [-8.3, 14.4]
	Relative Index of Inequality (RII)	2.2 [0.2, 4.3]	1.1 [-1.2, 3.5]	0.3 [-0.9, 1.6]

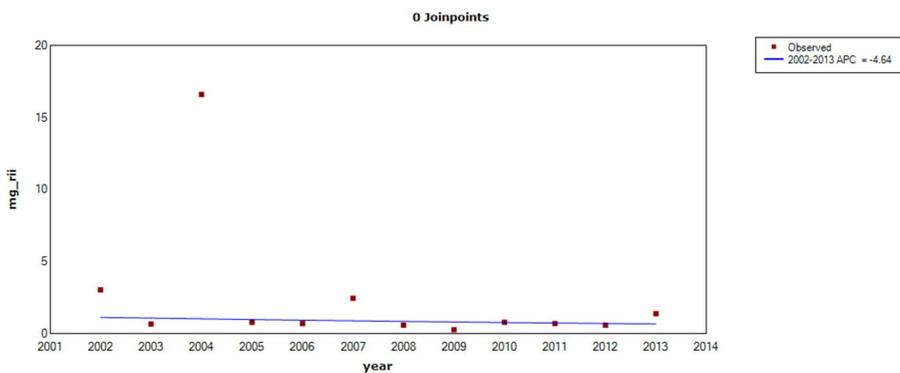
Postpartum hemorrhage	Slope Index of Inequality (SII)	0.0 [0.0, 0.1]	0.0 [0.0, 0.0]	0.0 [0.0, 0.0]
	Relative Index of Inequality (RII)	1.4 [0.4, 2.5]	0.5 [-0.9, 1.8]	0.5 [-0.7, 1.7]

The 95% confidence intervals of each measure are presented in square brackets.

The RII_{KM}'s along the household income gradient showed no unidirectional trend over the study period (Figure 5-1). Among the two complications, SII's of preeclampsia were higher than the postpartum hemorrhage.

Figure 5-1. Relative inequality index of age-adjusted incidence from 2002 to 2013

(A) Preeclampsia (AAPC = -4.64, P = 0.40)



(B) Postpartum hemorrhage (AAPC = 0.56, P = 0.82)

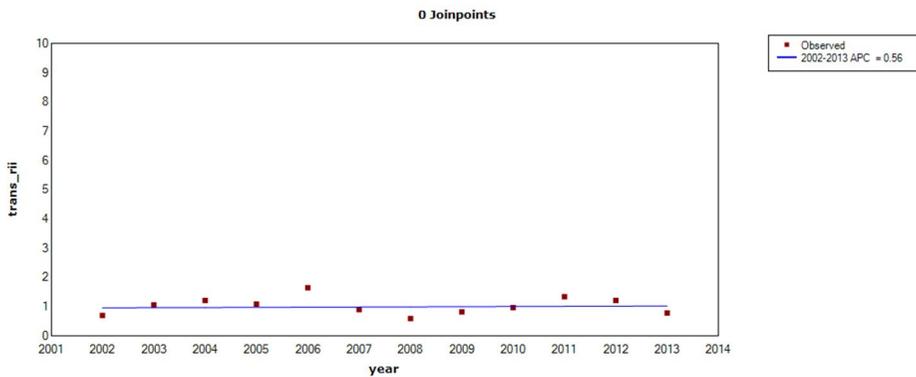


Figure 5-1 visualizes the temporal change of annual RII_{KM} 's for preeclampsia and postpartum hemorrhage.

5-4. Discussion

This study intended to demonstrate empirically the presence of maternal health disparities in Korea. With the NHI cohort data, we could trace the change of absolute and relative disparity of preeclampsia and postpartum hemorrhage. There were significant disparities in the crude incidence of postpartum hemorrhage and puerperal infection along the income gradient for women who had normal delivery. The annual predicted incidence of severe preeclampsia and puerperal infection decreased over time for low income level. We observed no significant income-based disparities in annual predicted incidences of preeclampsia, postpartum bleeding and puerperal infection during the study period except 2002. From 2002 to 2013, the relative inequalities showed no significant unidirectional change over time

for the three maternal morbidities. As far as we know, this is the first report of income-based disparity in maternal morbidities in Korea.

The presence of health disparity could vary depending on the pregnancy-related health outcomes of interest. According to the study of Braveman et al., income-based disparity was observed for low birth weight and delayed antenatal visit, but not for unintended pregnancy (Braveman, Cubbin et al. 2001). In a US study, the risks of low birth weight and preeclampsia were higher in African-American than in Hispanic while gestational diabetes was more prevalent in Hispanic than in African-American (Brown, Chireau et al. 2007). Our data shows that the decreasing incidence of postpartum hemorrhage was significant only in low and middle income groups. This suggests possible independent effect of relative level of household income on the occurrence of postpartum hemorrhage and the need of monitoring of maternal health disparities across the income gradient.

The difference in the crude frequency and age-adjusted incidence rate in this study could be partially explained by adjustment for age groups. In the study of mortality and SES, the associations between socioeconomic factors and mortality is sensitive to different adjustment methods (Milyo and Mellor 2003). In general, the adjusted values of outcome variable can reinforce the association (Wahlgren, Ahmed et al. 2008). The inequalities in crude rates would provide actual difference between the disadvantaged group and the others. On the other hand, with age-adjusted value, the age-independent part of inequalities which is potentially driven by income differentials could be identified. Considering the purpose of this study

was to identify the independent effect of household income, age-adjusted rate would be more suitable for calculation of inequality indices.

There is limited researches on the relationship between socioeconomic status and postpartum hemorrhage. In a study for Scottish women, antenatal bleeding from unknown origin which is closely linked with postpartum hemorrhage were more likely to be occurred to women who belong to a low social class (Bhandari, Raja et al. 2014). Certain amount of bleeding could be more risky for low income women because they are more likely to have iron deficiency (Bodnar, Cogswell et al. 2002). In a review of cases with peripartum hysterectomy, emergency hysterectomy was more frequent in women with low socioeconomic position (Chestnut, Eden et al. 1985).

In summary, the temporal trends of occurrence of postpartum hemorrhage could be different according to household income. Our finding suggests the income-based disparity of preeclampsia and postpartum hemorrhage would have been minimal in Korea which is characterized by single ethnicity and universal health coverage setting. Attempts to monitor and reduce the differentials in health of mothers across different income groups would be critical to achieve the equity in maternal health.

CHAPTER 6. EFFECT OF THE UNIVERSAL VOUCHER PROGRAM (GOEUN-MOM CARD) ON THE INCIDENCE OF PREECLAMPSIA AND POSTPARTUM HEMORRHAGE

6-1. Background

Voucher systems are defined as regimes in which individuals receive entitlements to a good or service which they are supposed to pay in cash at a set of defined suppliers. A funding institution then redeems the suppliers for money or the equivalent. Vouchers are used in the distribution of private goods and services as well as in public services (Cave 2001). Vouchers and other demand-side financing (DSF) methods have been used in many countries for a wide range of socially desirable services including health, education, public housing and essential food. Demand-side financing places purchasing power into the hands of consumers to spend on specific services. The objectives of voucher programs include the following (Ensor 2004): 1) as a means of targeting low income or other vulnerable people to pay for care, 2) to change behavior of voucher holders, and 3) to promote competition between providers and choice for the consumer. In the voucher program for antenatal care and birth services, pregnant women are given vouchers which can be used to pay for targeted health services either in part or in full. Although preliminary evidence indicates that the vouchers do increase the use of

maternal health services, little is known about the health impact of these programs (Ahmed and Khan 2011).

Several studies in developing countries indicated that maternal health voucher increased utilization of healthcare services in pregnant women (Amendah, Mutua et al. 2013). However, generalizations of health interventions are not always plausible because the resources and institutional capacity within countries vary substantially (Figueras and McKee 2012). Furthermore, the impact of this universal voucher system on inequality in maternal child health never has been explored. Evaluation of the change in maternal health after implementation of universal voucher program in Korea could contribute to the understanding of the impact of voucher program on maternal health in the setting of a universal health coverage.

Short interval between intervention and effect evaluation would be misleading because it would take more time to get the intended results than expected. Victora and colleagues proposed the “inverse equity hypothesis” to explain how inequities between rich and poor respond to public-health interventions. In their theory, new programs would reach peoples in higher socioeconomic status more easily and only later affect the poor, resulting worse health inequities in the initial stage (Victora, Vaughan et al. 2000). However, a study of voucher program in Bangladesh reported that the introduction of voucher for antenatal services were found to be positive even in the short run (Ahmed and Khan 2011). In addition, a study of Kenya’s reproductive voucher program reported that poor women who used vouchers for antenatal care services showed persistently improved

performance of facility-based delivery in the subsequent pregnancy (Amendah, Mutua et al. 2013). This suggests that studies for a short period to evaluate the effect of voucher program on health care utilization would be feasible.

Considering the scarcity of studies on effect of voucher program on health outcomes, elucidation of the changes in the maternal complications before and after the initiation of voucher program would have important epidemiologic and public health implications. We explored the changes in the risk of preeclampsia and postpartum hemorrhage before and after the implementation of the universal voucher program named ‘*Goeun-mom card*’.

6-2. Methods

Live birth cases from 2002 to 2013 from the NHI cohort data was used in this study. The outcome variable and covariates are summarized in Table 6-1. The variables in pre- and post-voucher period were compared using chi-square test.

Table 6-1. Summarized description of outcome variable and covariates in the National Health Insurance cohort data, from 2002 to 2013

Variable	Description	Min	Max
Preeclampsia	-	0	1

Postpartum hemorrhage	-	0	1
	Age of mother at delivery		
	1=15-19		
	2=20-24		
Maternal age group	3=25-29	1	5
	4=30-34		
	5=35-39		
	6=40-44		
Multiple gestation	0=Singleton	0	1
	1=Multiple gestation		
Nulliparity	0=Nullipara	0	1
	1=Primipara or multipara		
Diabetes	0=Absent	0	1
	1=Present		
Voucher	0=2002-2008	0	1
	1=2009-2013		
Year	2002-2013	2002	2013
Level of household income	1=Lower		
	2=Middle	1	3
	3=Higher		

N = 66,237

For the effect of the covariates in individual level, generalized regression was done. To measure the adjusted effects of voucher program, established risk factors for preeclampsia and postpartum hemorrhage were included in the explanatory models. The risk factors include proportion of nulliparity, multiple gestation, presence of diabetes and maternal age in the year of childbirth and effect of calendar year in reference to previous studies (Lee, Hsieh et al. 2000, Trogstad, Magnus et al. 2011). This would allow for a straightforward interpretation of the coefficient as the average effect of the voucher program (Cetorelli 2013). Multivariable generalized linear regression model for binary outcomes can be described as follows:

$$\begin{aligned} \text{LogitPr (Obstetric complication} = 1) &= \beta_0 + \beta_1 \text{Age group} + \beta_2 \text{ Multiple gestation} \\ &+ \beta_3 \text{ Nulliparity} \\ &+ \beta_4 \text{ Diabetes} + \beta_5 \text{ Voucher} + \beta_6 \text{ Income level} + \beta_7 \\ &\text{Being a paid worker} + \beta_8 \text{ Calendar year} \end{aligned}$$

In this model, the interactive function of year and income group and voucher and income group were explored by adding interaction terms. Estimates of this model for preeclampsia and postpartum hemorrhage were calculated with

GENMOD function. All the analyses were performed by SAS software, version 9.3 (SAS Institute, Inc., Cary, North Carolina).

6-3. Results

Comparison of covariates and outcome variables between pre-voucher (2002-2008) and post-voucher (2009-2013) period are described in Table 6-2. The number of births was larger in pre-voucher period than in post-voucher period. Compared to pre-voucher period, the proportion of advanced maternal age, nulliparity, multiple gestation, diabetes and induction of labor increased significantly. The frequency of preeclampsia was 9.1 per 1,000 women in pre-voucher period which is higher than post-voucher period (7.5 per 1,000).

Table 6-2. Comparison of clinical characteristics and outcome variables between 2002-2008 and 2009-2013 in the delivery cases from the Korean National Health Insurance cohort data

	Pre-voucher (2002-2008) N=43,488	Post-voucher (2009-2013) N=22,749	P value*
<i>Age group</i>			
15-19 years	178 (0.41)	135 (0.59)	<.001

20-24 years	2,716 (6.25)	1,101 (4.84)	
25-29 years	17,330 (39.85)	6,976 (30.67)	
30-34 years	17,870 (41.09)	10,726 (47.15)	
35-39 years	4,709 (10.83)	3,196 (14.05)	
40-44 years	685 (1.58)	615 (2.7)	
<i>Level of household income</i>			
Lower	10,785 (24.85)	5,472 (24.17)	
Middle	19,336 (44.55)	9,717 (42.92)	<.001
Higher	13,282 (30.6)	7,449 (32.9)	
Being a paid worker	8,378 (19.27)	7,327 (32.21)	<.001
Multiple gestation	439 (1.01)	422 (1.86)	<.001
Nulliparity	22,212 (51.08)	19,442 (85.46)	<.001
Diabetes	471 (1.08)	563 (2.47)	<.001
Induction of labor	7,227 (16.62)	5,127 (22.54)	<.001
Preeclampsia	396 (0.91)	170 (0.75)	0.030
Postpartum hemorrhage	1,130 (2.6)	468 (2.06)	<.001
<i>Healthcare utilization</i>			
No. of outpatient visits[†]	3.2±2.3	3.4±2.9	0.002

Duration of admission (days)	5.2±4.9	5.4±4.6	<.001
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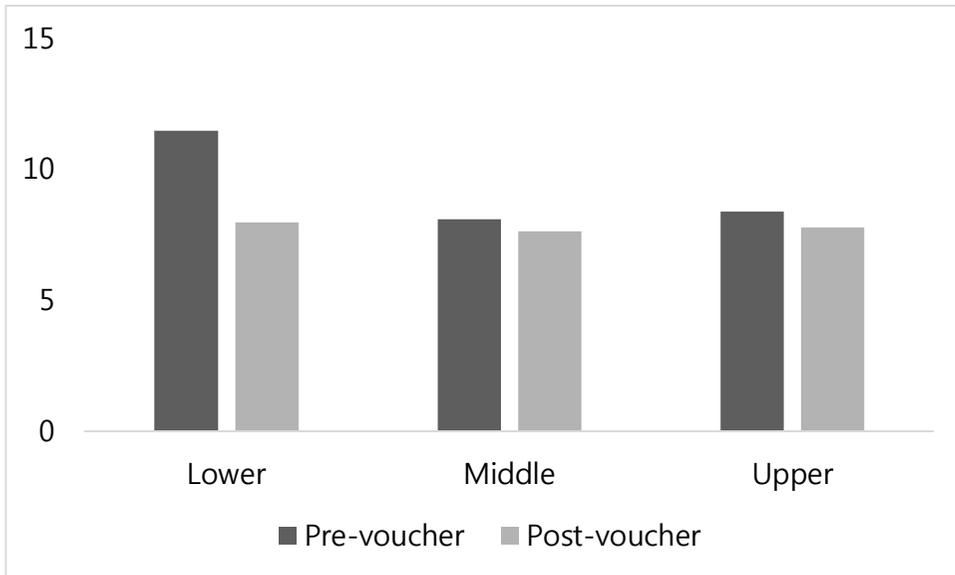
*P values were from chi-square test.

†The number of outpatient visits and average duration of hospital admission were calculated only in the year of childbirth

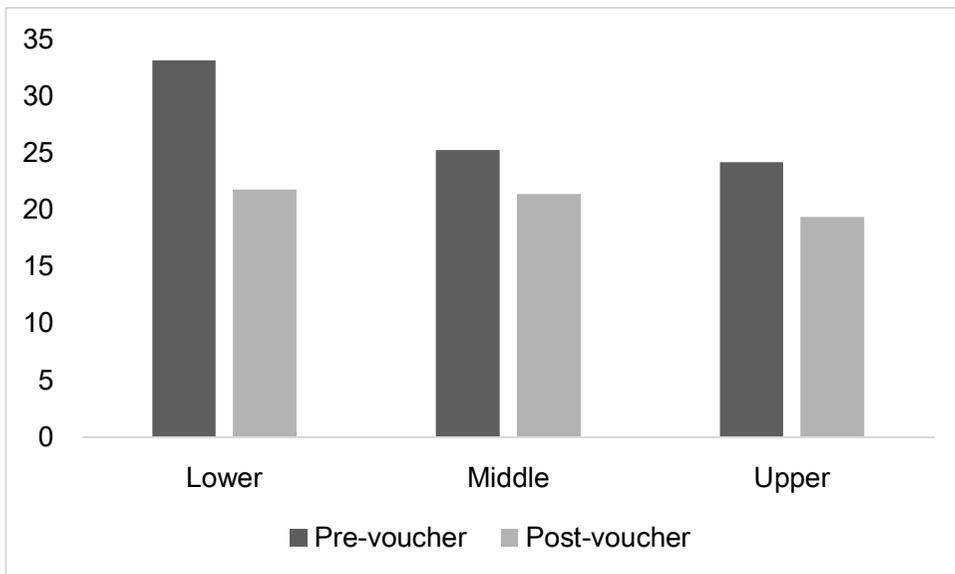
Age-adjusted proportions of preeclampsia and postpartum hemorrhage in each household income group are presented in Figure 6-2. Overall, incidence of postpartum hemorrhage increased and puerperal infection was decreased in post-voucher period.

Figure 6-1. Age-adjusted proportion (/1,000) of preeclampsia and postpartum hemorrhage in each income group before and after the introduction of voucher program

(A) Preeclampsia



(B) Postpartum hemorrhage



Model without considering the fixed effect of calendar year revealed that women in the lower and middle income groups were more likely to experience

postpartum hemorrhage compared to higher income group. Maternal age ≥ 35 years, multiple gestation, nulliparity and diabetes were associated higher risk of preeclampsia (Table 6-3). Interaction between voucher program and income level was not included in the final model because it was insignificant. When the adjusted probability for each complication, women who gave birth in post-voucher program period showed higher risk of postpartum hemorrhage and lower risk of puerperal infection.

Figure 6-2. Changes in the slope inequality indices for each complication, pre- and post-voucher period

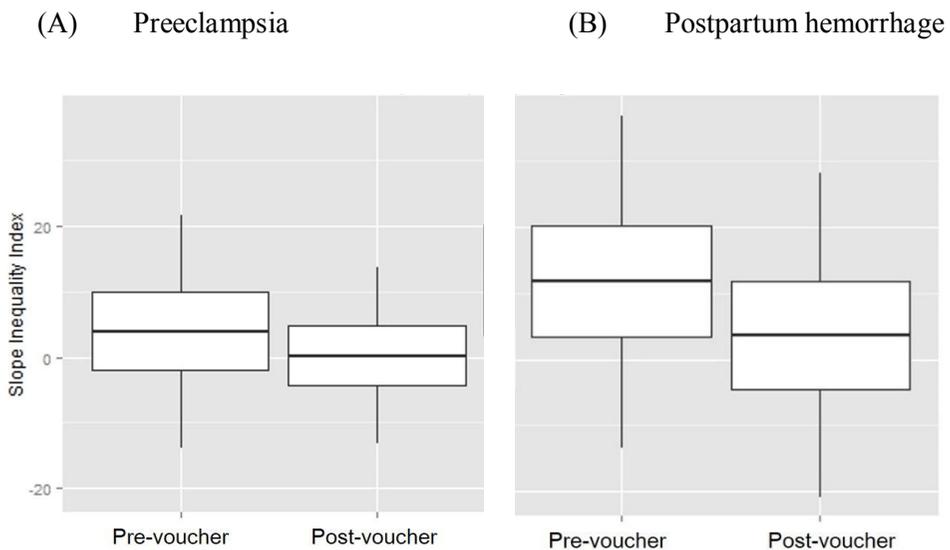
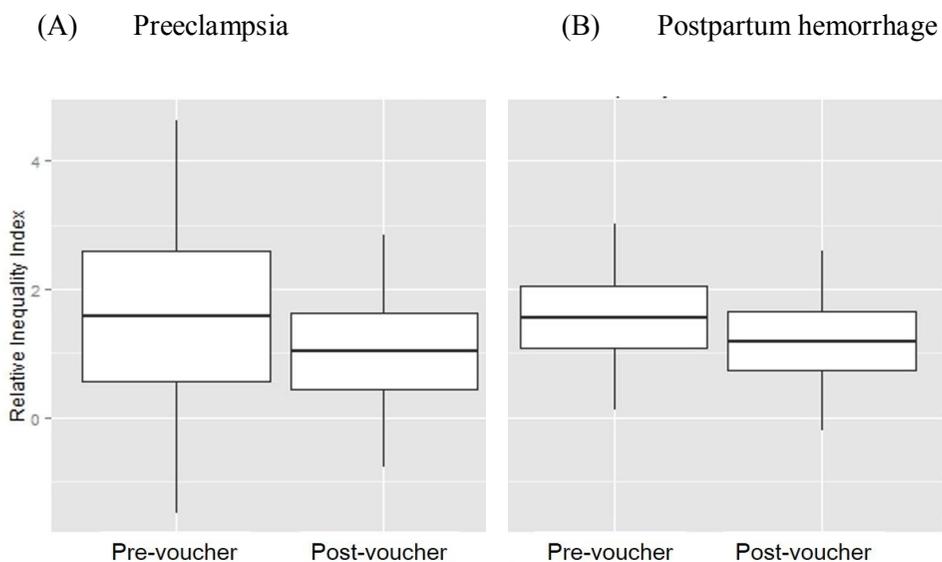


Figure 6-3. Changes in relative inequality indices for each complication, pre- and post-voucher scheme period



In the multivariable logistic regression model without the effect of calendar year, significant decreased risks of preeclampsia and postpartum hemorrhage after the introduction of voucher program were observed. For both complications, women in lower household income group showed higher risk compared to those in higher income group. Mothers who were paid workers at the time of pregnancy had lower risk of postpartum hemorrhage requiring blood transfusion.

Table 6-3. Relationship between the introduction of voucher scheme and preeclampsia and postpartum hemorrhage *without* controlling for effect of calendar year, the Korean National Health Insurance cohort data from 2002 to 2013

	Preeclampsia OR [95% CI]	P value	Postpartum hemorrhage OR [95% CI]	P value
<i>Age group</i>				
Age 15-19 vs 25-29	0.99 [0.24, 4.00]	0.984	2.87 [1.72, 4.80]	0.004
Age 20-24 vs 25-29	0.86 [0.56, 1.33]	0.501	1.07 [0.84, 1.36]	0.001
Age 30-34 vs 25-29	1.09 [0.89, 1.33]	0.406	1.18 [1.05, 1.34]	<.001
Age 35-39 vs 25-29	1.52 [1.17, 1.97]	0.002	1.55 [1.32, 1.82]	0.917
Age 40-44 vs 25-29	2.07 [1.31, 3.29]	0.002	2.34 [1.77, 3.08]	0.001
Being a paid worker	1.02 [0.83, 1.25]	0.867	0.88 [0.78, 1.00]	0.049
<i>Income groups</i>				
Lower vs Higher	1.25 [1.00, 1.57]	0.047	1.25 [1.09, 1.43]	0.017
Middle vs Higher	1.07 [0.88, 1.31]	0.517	1.17 [1.04, 1.32]	0.360
Nulliparity	0.85 [0.70, 1.03]	0.089	0.83 [0.74, 0.93]	0.001
Multiple gestation	6.25 [4.49, 8.70]	<.001	3.93 [3.06, 5.05]	<.001
Diabetes	3.97 [2.79, 5.65]	<.001	2.16 [1.63, 2.86]	<.001
Voucher scheme	0.76 [0.62, 0.93]	0.007	0.79 [0.71, 0.89]	<.001

When the calendar years are included in the multivariable model, the risk of preeclampsia in 2013 is lower than in 2002. For postpartum hemorrhage, the risk of postpartum hemorrhage is reduced compared to 2002 since the year of 2011. Since there were no significant interactions between calendar year and income group, and between income group and voucher these terms were not included in the final model.

Table 6-4. Relationship between the introduction of voucher scheme and preeclampsia and postpartum hemorrhage *with* controlling for effect of calendar year, the Korean National Health Insurance cohort data from 2002 to 2013

	Preeclampsia		Postpartum hemorrhage	
	OR [95% CI]	P value	OR [95% CI]	P value
<i>Pre-voucher period</i>				
2003 vs 2002	0.86 [0.61,1.21]	0.584	0.79 [0.65,0.96]	0.145
2004 vs 2002	0.95 [0.67,1.34]	0.215	0.73 [0.60,0.90]	0.665
2005 vs 2002	0.84 [0.58,1.22]	0.750	0.81 [0.65,1.00]	0.103
2006 vs 2002	0.67 [0.44,1.02]	0.254	0.71 [0.56,0.89]	0.992
2007 vs 2002	1.07 [0.74,1.54]	0.024	0.88 [0.71,1.09]	0.006
2008 vs 2002	1.02 [0.70,1.50]	0.075	0.62 [0.48,0.79]	0.155
<i>Post-voucher period</i>				
2009 vs 2002	0.70 [0.45,1.09]	0.420	0.76 [0.60,0.97]	0.455

2010 vs 2002	0.85 [0.56,1.29]	0.711	0.67 [0.52,0.86]	0.573
2011 vs 2002	0.66 [0.43,1.02]	0.234	0.56 [0.44,0.73]	0.025
2012 vs 2002	0.78 [0.51,1.18]	0.842	0.55 [0.42,0.71]	0.013
2013 vs 2002	0.47 [0.28,0.78]	0.009	0.56 [0.43,0.74]	0.034
<i>Age group</i>				
15-19 vs 25-29	0.98 [0.24,3.96]	0.730	2.88 [1.72,4.81]	0.005
20-24 vs 25-29	0.87 [0.56,1.33]	0.131	1.07 [0.84,1.35]	<.001
30-34 vs 25-29	1.1 [0.9,1.34]	0.534	1.21 [1.07,1.37]	<.001
35-39 vs 25-29	1.53 [1.17,1.99]	0.127	1.61 [1.37,1.9]	0.707
40-44 vs 25-29	2.09 [1.32,3.33]	0.013	2.47 [1.87,3.26]	0.000
Being a paid worker	1.02 [0.84,1.26]	0.821	0.9 [0.79,1.02]	0.089
<i>Income groups</i>				
Lower vs Higher	1.25 [1,1.56]	0.051	1.24 [1.08,1.42]	0.020
Middle vs Higher	1.07 [0.88,1.31]	0.607	1.17 [1.03,1.31]	0.372
Nulliparity	0.86 [0.7,1.06]	0.146	0.88 [0.78,0.99]	0.040
Multiple gestation	6.26 [4.5,8.72]	<.001	3.96 [3.08,5.09]	<.001
Diabetes	4 [2.81,5.7]	<.001	2.2 [1.66,2.91]	<.001

6-4. Discussion

This study explored the effect of the voucher program for antenatal care and birth services on the occurrence of preeclampsia and postpartum hemorrhage. There are

three major findings in this study: First, there was a significant disparity in preeclampsia and postpartum hemorrhage across the income gradient in the study period. Second, the decreased risk of preeclampsia and postpartum hemorrhage could be associated with the introduction of universal voucher program. And lastly, significant reduction of postpartum hemorrhage was observed since 2011 after controlling of related factors. To the best of our knowledge, this is the first report assessing the effect of universal voucher program on the risk of major obstetric complications.

Several studies reported the disparities in maternal morbidities across socioeconomic gradient in the setting of universal health coverage. In the study of Juarez et al, the difference in the adverse perinatal outcome was measured with the odds ratio of experience of adverse outcomes according to different maternal educational level (Juarez, Revuelta-Eugercios et al. 2014). An attributable fraction of stillbirth risk was significant in the research of the effect of maternal country of origin (Luque-Fernandez, Lone et al. 2012).

The preferential effect of universal supporting system toward persons in higher socioeconomic class was not observed in this study. Because the socioeconomic deprivation is related with preeclampsia, the impact of voucher could have been more profound in lower income group (Haelterman, Qvist et al. 2003, Aabidha, Cherian et al. 2015). Considering the poor compliance for care is also one of the risk factor of preeclampsia (Turner 2010), in addition to chronic maternal deprivation, better economic access to care could have further reduced risk

of preeclampsia in the lower income group (Barton and Sibai 2008, Aabidha, Cherian et al. 2015).

With introduction of voucher program, immediate indicators such as antenatal care utilization and facility-based delivery rate were found to be improved. A study in Bangladesh reported that the effect to voucher on outcomes including utilization rate of maternal health services were found to be positive (Ahmed and Khan 2011). In addition, Kenya's reproductive voucher program improved performance of facility-based delivery in the subsequent pregnancy in economically deprived women (Amendah, Mutua et al. 2013). This improved health care utilization could lead to reduction of maternal morbidities and mortality. The findings of our study suggests the beneficial effect of universal voucher program even in the setting of universal health coverage and adequate antenatal care utilization (OECD library 2012).

There are several limitations in this study. First, we could not consider the disease severity in the model. Because we used specific procedure code for each condition, the limitation of insurance claim data regarding validity would have been minimized. On the other hand, only severe conditions which required the specific procedures were included in the disease cases. Second, we could not measure the antenatal care utilization which is a major mediator to the development of obstetric complications. Because there was no standard criteria for hospital admission, considerable number of preeclampsia or postpartum hemorrhage cases could have

been admitted without visiting outpatient clinic. Therefore, measuring of antenatal care utilization was not feasible in this study.

In conclusion, the universal voucher program for antenatal care and birth services in Korea might have contribute to decrease of preeclampsia and postpartum hemorrhage even in the setting of universal health coverage. More evidences regarding the impact of the universal voucher program on maternal health would facilitate development of more effective policies for improving maternal health.

CHAPTER 7. OVERALL DISCUSSION AND CONCLUSION

7-1. Different temporal trend of incidences of maternal complication according to household income

This study was to address the temporal trend of incidence and disparity of maternal complications in Korea for the last decade. With the trend analysis, the change after introduction of the universal voucher program (*Goeun-mom* card) was evaluated using statistical model. It is the first study exploring the health impact of *Goeun-mom* card using the NHI cohort database.

The first study was on the annual predicted incidence of the two most common maternal complications. Among the two complications, the annual incidences of postpartum hemorrhage showed decreasing trend. Although preeclampsia did not show significant unidirectional change, generally decreasing pattern was observed in the lower household income group. Considering most of maternal health indicators are presented without considering socioeconomic status, income-stratified numbers would reveal the trend more sensitively.

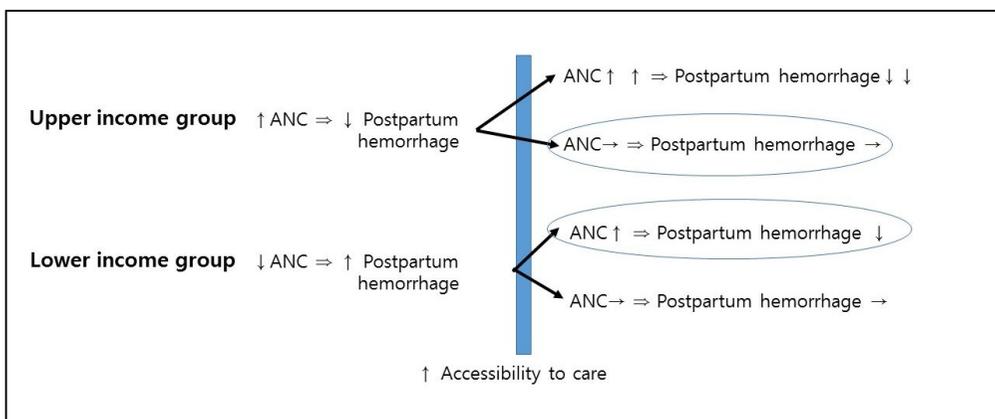
7-2. Income-based disparities in the incidence of maternal complication

The second study demonstrates the first result of longitudinal study on the income-based disparity in maternal common morbidities-preeclampsia, postpartum hemorrhage and puerperal infection. The key messages of this study are that the incidence of maternal morbidities such as preeclampsia could show differential trend according to income gradient. The mechanism of this possible independent impact of low income on higher risk of preeclampsia and postpartum hemorrhage is not clear (Murray, Lopez et al. 1998, Maharaj 2007). Low household income could mean relatively low educational status and unhealthy behavior of women, living more stressful environments with limited access to decent housing or utilities, increased maternal infection and unwanted pregnancy which is linked with low commitment to prenatal care (Raisanen, Kramer et al. 2014). A study in Australia indicated that women belong to the lowest socioeconomic group generally report an experience of poorer care during pregnancy, while having a higher risk of hospital admission or transfer during labor and delivery, in addition to being less likely to have had any antenatal care, or postnatal visit (Yelland, Sutherland et al. 2012). Considering the negative impact of relatively lower level of household income on the incidence preeclampsia and postpartum hemorrhage in Korea, relative economic inequality may have an effect on maternal health even with the NHI system.

7-3. Different temporal trend of incidences and disparities of preeclampsia

The study in chapter 6 was to explore the impact of the universal voucher program on the individual risk of preeclampsia and postpartum hemorrhage. When the effect of calendar year was controlled, births during post-voucher program showed generally lower risk of preeclampsia and postpartum hemorrhage supporting the possible protective health effect of this voucher program. The significant change in the occurrence of postpartum hemorrhage among the lower and higher income groups could be explained by the potential diagnostic pathway (Figure 7-1). For preeclampsia, increased utilization does not prevent development or reporting of the disease. However, significant changes in the occurrence of preeclampsia in all income groups were not observed in this study. Increased access and utilization might have led prevention of postpartum hemorrhage.

Figure 7-1. Possible pathways in the change of diagnostic flow for postpartum hemorrhage



Considering the incremental value of the voucher, the absence of corresponding effect may suggest that the presence of voucher itself could promote maternal health. Although the value of universal voucher increased more than twice (from 200,000 KRW to 500,000 KRW) during the post-voucher period, there was no significant calendar year effect on the occurrence of preeclampsia after year of 2008. In fact, after the introduction of voucher program, the cost for antenatal care and services which are not covered by NHI increased in response (Ministry of Health & Welfare 2015). Therefore, the increasing value of the voucher could have not reduced the out-of-pocket cost of antenatal care. If the out-of-pocket cost became available, this issue could be further investigated.

The reason of significant reduction of preeclampsia risk since 2011 is not clear. Because of certain unfavorable condition for childbirth in general such as national economic recession, smaller group of women might have given births then, selecting less deprived group as pregnant women.

As the first study of health impact of voucher program for antenatal care, the findings of this study is still valuable. It would provide an evidence that the universal voucher program for antenatal care and birth services could reduce maternal adverse outcomes even in the setting of the universal health coverage.

7-4. Implications for maternal health-related policy and future researches

This study demonstrated that the NHI database could be used for monitoring of temporal trend of maternal health condition. Health officials and policymakers would require timely information about the maternal health status in order to assist in the planning and prioritization of health policies. Even with the readily available NHI information database, systems for translating the information to evidence-based healthcare policies are extremely limited (Kim 2013). Although there is regular survey and nationwide statistics for maternal mortality, the data on maternal complications has not been easily available. However, the NHI cohort database may provide timely data of maternal health status as shown in this study.

The findings of this study revealed a possible health impact of the voucher program for antenatal care and birth services. The '*Goeun-mom card*' was initially aimed to promote fertility rate rather than to improve maternal health. Because there is no evidence of fertility promotion after implementation of the voucher, this program could be regarded as a failure. However, with more evidences of maternal health promotion, the voucher scheme might be revised to promote maternal health.

It often would be valuable for researchers and policy practitioners to know of change points in a trend or points of inflection in a growth curve (Prince and Maisto 2013). For trend test of incidence and disparities, APC or AAPC calculated by Joinpoint program was applied in this study. This technique is known to be useful in detecting abrupt changes and describing shifting time trends (Shaffer and Mather 2008). Because there was no joinpoint in the secular trend of preeclampsia and postpartum hemorrhage, the effect of any calendar year or voucher program was not evident (chapter 3 and 4). Compared to the joinpoint regression models,

generalized linear regression models including the effect of calendar year would be more sensitive to detect a change because it considers the fixed effect of covariates and random effect of calendar year. For the null result from joinpoint regression analysis, this approach could be helpful.

There is still a considerable burden of maternal complications in Korea. And this burden of mothers is expected to rise with more old mothers. Continuous monitoring and evaluation of policies for maternal health using the NHI database, we could develop more effective approaches for equitable maternal health.

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국문 초록

서론

건강의 불형평에 대해 이루어진 기존의 많은 연구 중에는 사회경제적 수준에 따른 주산기 결과의 격차를 보고한 것들이 있다. 국내에서는 소득 자료와 출산 결과를 함께 할 수 있는 자료가 많지 않아 소득 격차에 따른 모성 건강 결과의 차이에 대해서는 보고된 것이 없다. 지금까지는 대규모의 산모 코호트 자료가 없었기 때문에 국내에서 산모들의 사회경제적 수준에 따른 건강 결과의 불형평을 연구하는 데에 대표성에 한계가 있었으나 작년부터 건강보험공단에서 일반에 제공하고 있는 표본 코호트 자료로는 이러한 연구가 가능하다. 최근 한국에서는 십수 년간의 저출산 추세로 인해 출산 장려와 모성 건강 증진을 목표로 하여 임신출산진료비 바우처 프로그램을 비롯한 다양한 출산 진료비 지원 정책들이 시행되어 왔는데 이러한 정책들이 모성 건강에 미친 영향에 대해서는 별로 연구된 바가 없다.

2008년 12월부터 시작된 임신출산 진료비

지원제도(임신출산진료비 바우처 제도, ‘고운맘카드’)는 전국의 모든 임산부들이 소득 수준에 관계 없이 본인부담금의 일부를 전자 바우처로 결제할 수 있도록 한 제도이다. 정책 의도는 출산 의욕을 고취하고 건강한 태아의 분만과 산모의 건강관리를 보조한다는 것인데 제도 도입

이후 뚜렷한 성과 평가 없이 1-2년 간격으로 지원 금액이 지속적으로 증가하여 2012년부터는 단태아 임신 1례당 50만원을 지원하고 있다. 그러나 의료 접근성에 영향을 미칠 수 있는 제도임에도 불구하고 바우처 제도가 모체 건강에 미치는 영향에 대해서는 연구된 바가 없다. 이에 따라 모성 합병증 전반에 관한 자료를 마련하여 모성 건강의 불평등 추세와 바우처 이후의 변화를 보고자 본 연구를 계획하였고 그 세부 목적은 다음과 같다.

첫째, 2002년부터 2013년까지의 건강보험공단 코호트 자료에서의 산모 합병증의 시간에 따른 추이를 분석한다.

둘째, 코호트 자료에서 임신중독증, 산후 출혈의 시간에 따른 절대불평등지수와 상대불평등지수의 변화 추세를 분석한다.

셋째, 임신출산진료비 바우처 프로그램(고운맘카드)의 시행 전후로 코호트 자료에 나타난 임신중독증과 산후출혈의 발생위험도에 차이가 있는지 또한 소득 수준에 따라 그 영향이 다른지를 분석한다.

연구 방법

본 연구는 국민건강보험공단의 표본 코호트 데이터베이스 자료를 사용하였다. 이 자료는 개인정보유출을 막기 위해 익명화된 자료를 구축한 것으로 그 대표성이 보고된 바 있는 자료이다. 가구 소득 수준에

따라 세 그룹으로 나누어 매해의 주요 산모 합병증 - 임신중독증, 산후 출혈 발생률을 연령군의 분율을 보정하여 구한다. 2002년부터 2013년까지의 발생률이 시간에 따라 어떠한 경향을 보이는지를 Joinpoint 프로그램을 통해 분석한다. 이를 통해 구한 발생률 자료로 절대불평등지수(Slope inequality index)와 상대불평등지수(Relative inequality index)를 HD*Calc 프로그램을 이용하여 구하고 2002년부터 2013년까지의 추세를 분석한다. 앞의 두 연구를 통해 불평등이 나타난 모성 합병증에 대해서 임신출산진료비 바우처 실시 시기인 2009년 이후로 임신중독증의 발생 위험에 차이가 있는지를 다변수일반화선형모형을 통해 분석한다.

결과

- (1) 2002년부터 2013년까지 산후 출혈은 지속적으로 유의한 감소 추세를 보였다. 임신중독증의 발생률은 유의한 추세를 보이지 않았다. 소득수준에 따라 발생률은 나누어 보았을 때 산후 출혈은 저소득, 고소득군에서 감소 추세를 보였고 임신중독증은 모든 소득군에서 일관된 추세를 보이지 않았다.
- (2) 임신중독증과 산후 출혈 모두에서 저소득군이 발생 위험 요인으로 나타났다. 임신중독증과 산후 출혈의 연도별 연령보정 발생률에 있어서 절대불평등지수와 상대불평등지수는 모두 유

의한 변화를 보이지 않았다.

- (3) 산모의 연령과 위험요인을 보정하고 각 년도의 효과를 고려할 경우 바우처를 도입한 이후인 산후 출혈은 2011년부터, 임신중독증은 2013년부터 산후출혈과 임신중독증의 위험도가 감소하였다.

결론

2002 년을 제외하고는 임신중독증, 산후 출혈의 연도별 발생률에 있어서 절대불평등지수와 상대불평등지수로 본 가구 소득에 따른 불평등 지수는 시간에 따라 유의한 변화가 없었다. 또한 임신출산진료비 바우처 프로그램 도입 시기와 관계 없이 산후 출혈은 저소득군과 고소득군에서 모두 발생률이 지속적으로 감소하였다. 본 연구는 모성 합병증의 가구 소득에 기반한 불평등에 대한 기초 연구로서 임신출산진료비 바우처 프로그램의 건강 영향에 대한 근거자료를 제공하여 향후 모성 건강 증진을 위한 정책 평가의 사례로 이용될 수 있을 것이다.

주요어: 발생률, 불평등, 불형평, 임신중독증, 산후 출혈, 국민건강보험

표본 코호트 자료

학번: 2013-31221

Appendix 1. Procedure codes for delivery mode and determination of nulliparity and multiple gestation

Codes	Procedures (in Korean)	Nulliparity	Multiple gestation
R3136300	유도분만[촉진분만포함](경산)-제 1 태아	0	0
R3146300	겸자 또는 흡입분만(경산)-제 1 태아	0	0
R4356300	정상분만(경산)-제 1 태아	0	0
R4362300	둔위분만(경산)	0	0
R4380300	제왕절개술 기왕력이 있는 질식분만	0	0
R4508	제왕절개술및자궁적출술(1 태아임신의경우)-부분절제(경산)	0	0
R4510	제왕절개술및자궁적출술(1 태아임신의경우)-전절제(경산)	0	0
R4514	제왕절개만출술(1 태아임신의경우)-반복	0	0
R4518	제왕절개만출술(1 태아임신의경우)-초회(경산)	0	0
R3131300	유도분만[촉진분만포함](초산)-제 1 태아	1	0
R3141300	겸자 또는 흡입분만(초산)-제 1 태아	1	0
R4351300	정상분만(초산)-제 1 태아	1	0
R4361300	둔위분만(초산)	1	0
R4507	제왕절개술및자궁적출술(1 태아임신의경우)-부분절제(초산)	1	0
R4509	제왕절개술및자궁적출술(1 태아임신의경우)-전절제(초산)	1	0
R4517	제왕절개만출술(1 태아임신의경우)-	1	0

초회(초산)			
R313830 0	유도분만[촉진분만포함](경산)- 다태아분만시 제 2 태아부터[1 인당]	0	1
R314830 0	겸자 또는 흡입분만(경산)-다태아분만시 제 2 태아부터[1 인당]	0	1
R435830 0	정상분만(경산)-다태아분만시 제 2 태아부터[1 인당]	0	1
R4516	제왕절개만출술(다태아임신의경우)-반복	0	1
R4520	제왕절개만출술(다태아임신의경우)- 초회(경산)	0	1
R5002	제왕절개술및자궁적출술- 다태아임신의경우(경산)	0	1
R313330 0	유도분만[촉진분만포함](초산)- 다태아분만시 제 2 태아부터[1 인당]	1	1
R314330 0	겸자 또는 흡입분만(초산)-다태아분만시 제 2 태아부터[1 인당]	1	1
R435330 0	정상분만(초산)-다태아분만시 제 2 태아부터[1 인당]	1	1
R4519	제왕절개만출술(다태아임신의경우)- 초회(초산)	1	1
R5001	제왕절개술및자궁적출술- 다태아임신의경우(초산)	1	1

Appendix 2. Dianosis-related Group (DRG) code for cesarean delivery cases (in Korean)

질병군분류번호	명칭
O01600	제왕절개분만(단태아), 심각하거나 중증 혹은 중등도의 합병증이나 동반상병 미동반
O01601	제왕절개분만(단태아), 중등도의 합병증이나 동반상병 동반
O01602	제왕절개분만(단태아), 중증의 합병증이나 동반상병 동반
O01603	제왕절개분만(단태아), 심각한 합병증이나 동반상병 동반
O01700	제왕절개분만(다태아), 심각하거나 중증 혹은 중등도의 합병증이나 동반상병 미동반
O01701	제왕절개분만(다태아), 중증 혹은 중등도의 합병증이나 동반상병 동반
O01702	제왕절개분만(다태아), 심각한 합병증이나 동반상병 동반

Appendix 3. Treatment codes for MgSO₄ to determine the presence of preeclampsia (in Korean)

(A) From 2002 to 2009

Formulation	Product identification number	Ingredient code/ Ingredient/ Manufacture
Injection	187601BIJ	magnesium sulfate 10g
Injection	187601BIJ	A27854431 미네탑주사액 50%20ml 구주제약
Injection	187601BIJ	A02750981 대한황산마그네슘주사액 50% 대한약품공업
Injection	187601BIJ	A04900631 제일제약황산마그네슘주사액 50% 제일제약
Injection	187601BIJ	A29551611 마시주사 50% 휴온스
Injection	187601BIJ	A12802261 대원마구내신주사액 50% 대원제약
Injection	187602BIJ	magnesium sulfate 2g
Injection	187602BIJ	A27854421 미네탑주사액 10%20ml 구주제약
Injection	187602BIJ	A02750971 대한황산마그네슘주사액 10% 대한약품공업
Injection	187602BIJ	A04900641 제일제약황산마그네슘주사액 10% 제일제약
Injection	187602BIJ	A29551601 마시주사 10% 휴온스
Injection	187602BIJ	A12800101 대원마구내신주사액 10% 대원제약

(B) From 2010 to 2013

Product identification number	Ingredient	Manufacture	Ingredient code
645101090	대한황산마그네슘주사액 10%	대한약품공업(주)	187602BIJ

645101100	대한황산마그네슘주사액 50%	대한약품공업(주)	187601BIJ
650500730	제일제약황산마그네슘주사액 10%	(주)제일제약	187602BIJ
650500740	제일제약황산마그네슘주사액 50%	(주)제일제약	187601BIJ
669803160	미네탑주사액 50%20 밀리리터 (황산마그네슘)	구주제약(주)	187601BIJ
669803170	미네탑주사액 10%20 밀리리터 (황산마그네슘)	구주제약(주)	187602BIJ
671801530	마구내신주사액 (황산마그네슘수화물)	대원제약(주)	187602BIJ
671801540	마구내신주사액 50% (황산마그네슘수화물)	대원제약(주)	187601BIJ