

Comparison of international indicators for severe maternal morbidity among South Korean women

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INTRODUCTION

•The severe maternal morbidity (SMM) could indicators replaceable maternal mortality which occurs during labor, childbirth and the postpartum period, and it can be proxy indicators of maternal mortality.

•There are several indicators of SMM, such as WHO's SMM, US-CDC's SMM, EURONET's SAMM, etc. since 2010's. Even though several severe maternal morbidity indicators exist globally, selecting indicators that can serve as an international standard remains controversial.

•In South Korea, the risk of SMM is increasing in the face of a high maternal mortality ratio (MMR) among OECD countries, which was recorded at 9.9 per 100,000 live births in 2019 and the increasing trend for high-risk pregnancies, such as advanced-age pregnancies and multiple pregnancies. However, there is limited related research, and there are few official proxy indicators of MMR.

OBJECTIVES

This study aimed to compare SMM incidence in South Korean women using four different international SMM indicators as proxy indicators of MMR. This study also aimed to ascertain the association between SMM risk and socioeconomic, clinical, and health-care provider risk factors.

MATERIALS AND METHODS

Study Design
Population-based cohort study

Study Subjects
Data were extracted from the Korean National Health Insurance Delivery Cohort for 2,113,615 cases of delivery which delivered during 2003–2018. This study defined childbirth using diagnosis and procedure codes for pregnancies with maternal age between ages 15 and 49 who had a delivery hospitalization. The study population was included for at least 280 days before childbirth through 6 weeks following childbirth between January 1, 2003, and November 19, 2018.

Measurements
Following variables were evaluated:
Outcome variable: Using the following SMM indicators: (i) the SMM algorithm, defined by the US-CDC; (ii) the new gold standard guideline for SMM, defined by the ACOG; (iii) Zwart et al's. established SMM criteria in the Netherlands; and (iv) the EURONET-severe acute maternal morbidity (EURONET-SAMM) index in eight European countries.
Covariates: Maternal age, household income, health insurance type, residential area, prenatal care using Kessner's adequate prenatal care index, delivery mode, parity, multiple births, preterm births, and maternal comorbidities using criteria according to Howell's definition, and the type of healthcare facility and its location.

All women who delivered children from 2003 to 2018 were analyzed. Pearson's chi-square tests were performed to ascertain differences in sociodemographic characteristics and their distribution between SMM cases and the study population, during labor and delivery hospitalization, based on the established codes. The frequencies and fractions of sub-indicators from each of the four SMM indicators were calculated and compared using basic statistics. Finally, the adjusted relative risk (RR) and 95% confidence intervals (CIs) were calculated using a generalized estimating equations model at a significance level of $P < 0.05$ to estimate the relationships between each SMM indicator and the demographic, obstetric, and provider factors..

RESULTS

Table 1. General characteristics of study population according to maternal age.

	US-CDC's SMM				Gold standard guideline for SMM ^a				Zwart et al.'s SMM				EURONET-SAMM							
	No		Yes		P-value	No		Yes		P-value	No		Yes		P-value	No		Yes		
	(n = 6,269,558)		(n = 151,533)			(n = 6,221,001)		(n = 200,090)			(n = 6,401,007)		(n = 20,084)			(n = 6,333,639)		(n = 87,452)		
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Maternal age (y)																				
15-19	23,179	96.4	862	3.6	<.0001	22,944	95.4	1,097	4.6	<.0001	23,983	99.8	58	0.2	<.0001	23,664	98.4	377	1.6	<.0001
20-24	313,014	97.8	6,999	2.2		310,163	96.9	9,850	3.1		319,343	99.8	670	0.2		316,158	98.8	3,855	1.2	
25-29	1,757,569	98.1	34,153	1.9		1,743,220	97.3	48,502	2.7		1,787,457	99.8	4,265	0.2		1,771,009	98.8	20,713	1.2	
30-34	2,921,132	97.8	65,872	2.2		2,899,720	97.1	87,284	2.9		2,978,744	99.7	8,260	0.3		2,948,384	98.7	38,620	1.3	
35-39	1,100,678	96.9	35,550	3.1		1,092,320	96.1	43,908	3.9		1,130,918	99.5	5,310	0.5		1,116,714	98.3	19,514	1.7	
40-44	148,938	95.1	7,703	4.9		147,636	94.3	9,005	5.8		155,204	99.1	1,437	0.9		152,476	97.3	4,165	2.7	
45+	5,048	92.8	394	7.2		4,998	91.8	444	8.2		5,358	98.5	84	1.5		5,234	96.2	208	3.8	

Table 1 shows the incidence of SMM calculated using the four SMM indicators and the distribution of the study population's general characteristics. The SMM rates during the analysis period (2003–2018) were 2.36% (n = 151,533) of a total of 6,421,091 deliveries when estimated using the US-CDC's SMM algorithm; 3.12% (n = 200,090) when estimated using the ACOG's gold standard guidelines; 0.31% (n = 20,084) when estimated using Zwart et al.'s SMM criteria; and 1.36% (n = 87,452) when estimated using the EURONET-SAMM indicators.

Table 2. The incidence of severe maternal morbidity using the four indicators

	US-CDC's		Gold standard			Zwart et al.'s		EURONET	
	SMM		guideline for SMM			SMM		-SAMM	
	(n = 151,533)		(n = 200,090)			(n = 20,084)		(n = 87,452)	
	N	%	N	%		N	%	N	%
Acute myocardial infarction	645	0.4			ICU admission	10,188	50.7		
Aneurysm	66	0			Uterine rupture	637	3.2		
Acute renal failure	2310	1.5			Eclampsia/HELLP syndrome	5406	26.9		
Adult respiratory distress syndrome	610	0.4			Major obstetric hemorrhage (≥4 units of blood ce	6837	34.0		
Amniotic fluid embolism	233	0.2			lls; embolization or hysterectomy for MOH)				
Cardiac arrest/ ventricular fibrillation	293	0.2			Miscellaneous (opinion of the treating obstetrician) *	-	-		
Conversion of cardiac rhythm	744	0.5			Eclampsia			7302	8.4
Disseminated intravascular coagulation	15,131	10			Septicemia during pregnancy or labor			15,672	17.9
Eclampsia	4912	3.2			Hysterectomy in the context of pregnancy			7251	8.3
Heart failure/arrest during procedure or surgery	5	0			Hysterectomy associated with obstetric hemorrhage			5839	6.7
Puerperal cerebrovascular disorders	1330	0.9			Red blood cell transfusion associated with OH			63,213	72.3
Pulmonary edema/ acute heart failure	5283	3.5			*Excluded in the indicators				
Severe anesthesia complications	140	0.1			Abbreviations: EURONET-SAMM, European Network on Severe Acute				
Sepsis	12,016	7.9			Maternal Morbidity; GSG, gold standard guidelines (American College of				
Shock	7798	5.2			Obstetricians and Gynecologists) for SMM; HELLP, hemolysis, elevated				
Sickle cell anemia with crisis	5	0			liver enzymes and low platelet syndrome; ICU, intensive care unit; MOH,				
Air and thrombotic embolism	1821	1.2			major obstetric hemorrhage; OH, obstetric hemorrhage; SMM, severe				
Blood product transfusion	117,076	77.3			maternal morbidity; US-CDC, United States Centers for Disease Control				
Hysterectomy	7251	4.8			and Prevention				
Temporary tracheostomy	84	0.1							
Ventilation	3233	2.1							
US-CDC's SMM			151,533	75.7					
Prolonged postpartum length of stay*			-	-					
Maternal intensive care unit admission			10,188	5.1					
Administration of blood products (≥4 units)			636	0.3					
30 days readmission			50,265	25.1					

Table 3. The relationship between risk factors and the four indicators of severe maternal morbidity

	US-CDC's SMM			Gold standard guideline for SMM			Zwart's SMM			EURONET -SAMM		
	RR	95% CI		RR	95% CI		RR	95% CI		RR	95% CI	
Individual factors												
Maternal age (y)												
15-19	1.35	1.25	1.45	1.27	1.19	1.36	0.85	0.64	1.13	1.05	0.95	1.17
20-24	1.09	1.06	1.12	1.09	1.06	1.11	0.88	0.81	0.95	0.98	0.95	1.02
25-29	1.00			1.00			1.00			1.00		
30-34	1.10	1.08	1.11	1.05	1.04	1.07	1.17	1.12	1.21	1.14	1.12	1.16
35-39	1.34	1.32	1.36	1.24	1.23	1.26	1.76	1.69	1.84	1.47	1.44	1.50
40-44	1.67	1.63	1.71	1.52	1.49	1.56	2.72	2.55	2.90	2.04	1.97	2.11
≥45	1.85	1.67	2.04	1.70	1.54	1.87	3.19	2.56	3.97	2.49	2.17	2.86
Type of insurance												
Self-employed	1.14	1.13	1.16	1.12	1.11	1.13	1.21	1.17	1.25	1.14	1.12	1.15
Employees	1.00			1.00			1.00			1.00		
Medical aid	1.80	1.71	1.89	1.70	1.63	1.78	1.58	1.37	1.81	1.57	1.46	1.68
Obstetric factors												
Mode of delivery												
Vaginal delivery	1.00			1.00			1.00			1.00		
Instrument delivery	1.53	1.51	1.56	1.38	1.36	1.40	1.37	1.30	1.43	1.49	1.46	1.52
Cesarean section	2.28	2.25	2.32	1.84	1.82	1.86	2.51	2.41	2.61	1.41	1.39	1.44
Preterm birth												
No	1.00			1.00			1.00			1.00		
Yes	1.39	1.36	1.42	1.36	1.34	1.39	1.61	1.53	1.70	1.53	1.49	1.58
Parity												
0	1.25	1.24	1.27	1.27	1.26	1.28	1.15	1.12	1.19	1.39	1.37	1.41
1+	1.00			1.00			1.00			1.00		
Multiple birth												
No	1.00			1.00			1.00			1.00		
Yes	1.64	1.60	1.67	1.59	1.56	1.62	1.37	1.29	1.46	1.37	1.32	1.42
Prenatal care												
Adequate	1.00			1.00			1.00			1.00		
Intermediate	1.13	1.12	1.15	1.05	1.04	1.06	1.10	1.06	1.14	0.97	0.95	0.99
Inadequate	1.39	1.33	1.45	1.26	1.21	1.31	1.38	1.23	1.54	1.10	1.03	1.17
Maternal comorbidities												
0	1.00			1.00			1.00			1.00		
≥1	1.51	1.50	1.53	1.42	1.41	1.43	2.32	2.25	2.39	1.33	1.31	1.35

CONCLUSIONS

This study confirmed that the risk of SMM was associated with maternal low socioeconomic status, and adequate prenatal care could be an independent factor in preventing SMM in various international SMM indicators, which was the highlights predictable factors for SMM. Future studies are needed to further determine the risk of or preventable factors more concerning using various international SMM indicators. Furthermore, it is needed to explore specific causes on the risk of sub-indicators of SMM.