

Advanced maternal age and severe maternal morbidity in South Korea: a population-based cohort study

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INTRODUCTION

- Despite the overall decline in birth rate over the last decade, the number of births by women ages 30 years and older have increased. Advanced maternal age is known to have underlying adverse maternal health outcomes. Both prevention and management of adverse health outcomes after pregnancy for the advanced maternal age group is needed.
- The severe maternal morbidity could indicators replaceable maternal mortality which occurs during labor, childbirth and the postpartum period, and it often produce high direct medical costs, extended length of stay in delivery hospitalization, and long-term rehabilitation such as postpartum readmission.
- Many studies exploring the association between maternal age and SMM have been conducted in the Westin countries; however, little information is available on the association between maternal age and severe maternal morbidity among the Northeast Asian population, such as South Korea.

OBJECTIVES

This study aimed to investigate the association between maternal age and SMM. In addition, this study aimed to determine the association between age and the risk of SMM by parity and the status of multiple births.

MATERIALS AND METHODS

Study Design

Population-based cohort study

Study Subjects

Data were extracted from the Korean National Health Insurance Service-National Delivery Cohort for 2,113,615 cases of delivery which delivered during 2013–2018. 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, 2013, and November 19, 2018.

Measurements

Following variables were evaluated:

Outcome variable: Severe maternal morbidity was defined the SMM algorithms developed by the Centers for Disease Control and Prevention and included women who had at least one of the 21 previously established ICD-10 diagnosis and procedure codes during childbirth hospitalization

Variable of interest: Maternal age at index childbirth was divided into 5-year age groups and used as a categorical variable in this study.

Covariates: Household income level, type of insurance, residential area, mode of delivery, prenatal care using Kessner's Adequacy of Prenatal Care Index 19, parity, twin birth status, maternal comorbidities using Howell's study, type of hospitals, hospital regions, and the calendar year of childbirth

We calculated the distribution of the general characteristics of the study population by maternal age at childbirth between 2013 and 2018. The association between maternal age and SMM during childbirth hospitalization was determined using a Poisson regression model with a robust error variance adjusted for all covariates, which estimated the adjusted risk ratio (RR) and 95% confidence intervals (CI). This repeated model was generated for stratified analysis of the relationship between mode of delivery, parity, or twin birth status and SMM by maternal age and evaluated for interactions.

RESULTS

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

	Maternal age							
	No.(%)							
	15-19 (n=6,409)	20-24 (n=86,215)	25-29 (n=406,587)	30-34 (n=1,016,141)	35-39 (n=520,305)	40-44 (n=75,480)	45+ (n=2,478)	Total (n=2,113,615)
Severe maternal morbidity								
No	6,191 (96.6)	84,473 (98.0)	399,728 (98.3)	998,209 (98.2)	508,680 (97.8)	73,029 (96.8)	2,346 (94.7)	2,072,656 (98.1)
Yes	218 (3.4)	1,742 (2.0)	6,859 (1.7)	17,932 (1.8)	11,625 (2.2)	2,451 (3.3)	132 (5.3)	40,959 (1.9)
Household income level								
Q1	2,726 (42.5)	26,069 (30.2)	92,634 (22.8)	181,164 (17.8)	95,393 (18.3)	15,075 (20.0)	576 (23.2)	413,637 (19.6)
Q2	1,564 (24.4)	28,108 (32.6)	124,201 (30.6)	228,924 (22.5)	96,389 (18.5)	14,835 (19.7)	539 (21.8)	494,560 (23.4)
Q3	1,349 (21.1)	21,304 (24.7)	132,104 (32.5)	396,097 (39.0)	187,117 (36.0)	22,317 (29.6)	642 (25.9)	760,930 (36.0)
Q4	770 (12.0)	10,734 (12.5)	57,648 (14.2)	209,956 (20.7)	141,406 (27.2)	23,253 (30.8)	721 (29.1)	444,488 (21.0)
Type of insurance								
1	2,573 (40.2)	31,137 (36.1)	90,813 (22.3)	177,792 (17.5)	111,552 (21.4)	23,365 (31.0)	973 (39.3)	438,205 (20.7)
2	2,788 (43.5)	52,563 (61.0)	313,457 (77.1)	835,506 (82.2)	406,238 (78.1)	51,065 (67.7)	1,430 (57.7)	1,663,047 (78.7)
3	1,048 (16.4)	2,515 (2.9)	2,317 (0.6)	2,843 (0.3)	2,515 (0.5)	1,050 (1.4)	75 (3.0)	12,363 (0.6)
Residential area								
Seoul	686 (10.7)	9,235 (10.7)	61,914 (15.2)	207,109 (20.4)	111,940 (21.5)	16,116 (21.4)	467 (18.9)	407,467 (19.3)
Other metropolitan	1,587 (24.8)	21,330 (24.7)	102,731 (25.3)	262,599 (25.8)	135,475 (26.0)	19,243 (25.5)	613 (24.7)	543,578 (25.7)
Small city	3,441 (53.7)	46,658 (54.1)	213,719 (52.6)	496,011 (48.8)	248,582 (47.8)	36,114 (47.9)	1,229 (49.6)	1,045,754 (49.5)
Rural	695 (10.8)	8,992 (10.4)	28,223 (6.9)	50,422 (5.0)	24,308 (4.7)	4,007 (5.3)	169 (6.8)	116,816 (5.5)
Mode of delivery								
Spontaneous vaginal delivery	2,345 (36.6)	28,270 (32.8)	123,260 (30.3)	309,422 (30.5)	142,353 (27.4)	15,628 (20.7)	377 (15.2)	621,655 (29.4)
Instrumental delivery	2,483 (38.7)	32,110 (37.2)	145,154 (35.7)	322,568 (31.7)	140,567 (27.0)	16,103 (21.3)	401 (16.2)	659,386 (31.2)
Cesarean section delivery	1,581 (24.7)	25,835 (30.0)	138,173 (34.0)	384,151 (37.8)	237,385 (45.6)	43,749 (58.0)	1,700 (68.6)	832,574 (39.4)
Adequacy of prenatal care								
Adequate	4,400 (68.7)	78,437 (91.0)	393,190 (96.7)	993,314 (97.8)	505,307 (97.1)	71,885 (95.2)	2,240 (90.4)	2,048,773 (96.9)
Intermediate	1,803 (28.1)	6,906 (8.0)	11,836 (2.9)	21,030 (2.1)	13,850 (2.7)	3,263 (4.3)	218 (8.8)	58,906 (2.8)
Inadequate	206 (3.2)	872 (1.0)	1,561 (0.4)	1,797 (0.2)	1,148 (0.2)	332 (0.4)	20 (0.8)	5,936 (0.3)
Parity								
1	5,896 (92.0)	64,663 (75.0)	282,708 (69.5)	543,149 (53.5)	185,741 (35.7)	24,442 (32.4)	734 (29.6)	1,107,333 (52.4)
2+	513 (8.0)	21,552 (25.0)	123,879 (30.5)	472,992 (46.6)	334,564 (64.3)	51,038 (67.6)	1,744 (70.4)	1,006,282 (47.6)
Status of multiple birth								
Singleton	6,381 (99.6)	85,760 (99.5)	403,495 (99.2)	1,003,165 (98.7)	510,891 (98.2)	74,384 (98.6)	2,451 (98.9)	2,086,527 (98.7)
Multiple	28 (0.4)	455 (0.5)	3,092 (0.8)	12,976 (1.3)	9,414 (1.8)	1,096 (1.5)	27 (1.1)	27,088 (1.3)
Maternal comorbidity								
0	3,862 (60.3)	48,834 (56.6)	218,633 (53.8)	416,105 (41.0)	191,510 (36.8)	25,251 (33.5)	795 (32.1)	904,990 (42.8)
1+	2,547 (39.7)	37,381 (43.4)	187,954 (46.2)	600,036 (59.1)	328,795 (63.2)	50,229 (66.6)	1,683 (67.9)	1,208,625 (57.2)
Type of hospital (No. of beds)								
500+	294 (4.6)	2,029 (2.4)	12,608 (3.1)	46,119 (4.5)	32,857 (6.3)	6,985 (9.3)	377 (15.2)	101,269 (4.8)
100-499	617 (9.6)	4,896 (5.7)	22,240 (5.5)	67,274 (6.6)	45,781 (8.8)	9,424 (12.5)	403 (16.3)	150,635 (7.1)
30-99	2,616 (40.8)	39,386 (45.7)	200,893 (49.4)	512,092 (50.4)	254,096 (48.8)	33,698 (44.6)	985 (39.8)	1,043,766 (49.4)
< 30	2,882 (45.0)	39,904 (46.3)	170,846 (42.0)	390,656 (38.5)	187,571 (36.1)	25,373 (33.6)	713 (28.8)	817,945 (38.7)
Hospital region								
Seoul	724 (11.3)	9,559 (11.1)	63,153 (15.5)	211,657 (20.8)	119,366 (22.9)	18,096 (24.0)	559 (22.6)	423,114 (20.0)
Other metropolitan	1,984 (31.0)	24,656 (28.6)	117,562 (28.9)	294,779 (29.0)	149,374 (28.7)	21,221 (28.1)	707 (28.5)	610,283 (28.9)
Small city	3,635 (56.7)	50,966 (59.1)	223,964 (55.1)	506,620 (49.9)	249,954 (48.0)	35,824 (47.5)	1,190 (48.0)	1,072,153 (50.7)
Rural	66 (1.0)	1,034 (1.2)	1,908 (0.5)	3,085 (0.3)	1,611 (0.3)	339 (0.5)	22 (0.9)	8,065 (0.4)

Table 2. Relative risk for the relationship between maternal age and SMM adjusted for all covariates

SMM			RR	(95% CI)	
	RR	(95% CI)			
Maternal age (years)					
15-19	1.32	(1.15 - 1.51)	Maternal comorbidity		
20-24	1.12	(1.07 - 1.18)			
25-29	1.00				
30-34	1.03	(1.00 - 1.06)			
35-39	1.24	(1.21 - 1.28)			
40-44	1.57	(1.50 - 1.64)			
45+	2.07	(1.75 - 2.44)	500+	4.33	(4.20 - 4.47)
Household income level			100-499	2.44	(2.36 - 2.51)
Q1	1.09	(1.06 - 1.12)	30-99	1.00	
Q2	1.10	(1.07 - 1.13)	< 30	1.04	(1.02 - 1.07)
Q3	1.06	(1.04 - 1.09)	Hospital region		
Q4	1.00		Seoul	1.00	
Type of insurance			Other metropolitan	1.23	(1.18 - 1.29)
1	1.11	(1.08 - 1.13)	Small city	1.10	(1.06 - 1.14)
2	1.00		Rural	1.18	(1.01 - 1.38)
3	2.09	(1.92 - 2.28)	Year		
Residential area			2013	1.00	
Seoul	1.00		2014	0.96	(0.93 - 0.99)
Other metropolitan	1.09	(1.04 - 1.15)	2015	1.02	(0.99 - 1.05)
Small city	1.18	(1.14 - 1.22)	2016	1.00	(0.97 - 1.04)
Rural	1.20	(1.14 - 1.27)	2017	0.95	(0.92 - 0.98)
Mode of delivery			2018	0.97	(0.94 - 1.00)
Spontaneous vaginal delivery	1.00		Adjusted for household income level, type of insurance, residential area, mode of delivery, adequacy of prenatal care, parity, status of multiple birth, maternal comorbidity, type of hospital, hospital region, and year.		
Instrumental delivery	1.61	(1.57 - 1.66)			
Cesarean section delivery	1.56	(1.52 - 1.60)			
Adequacy of prenatal care					
Adequate	1.00				
Intermediate	1.45	(1.38 - 1.52)			
Inadequate	1.54	(1.33 - 1.78)			
Parity					
1	1.34	(1.31 - 1.36)			
2+	1.00				
Status of multiple birth					
Singleton	2.04	(1.95 - 2.13)			
Multiple	1.00				

Table 3. The relationship between maternal age and severe maternal morbidity, stratified by parity, and status of multiple birth adjusted for all covariates.

	Severe maternal morbidity							
	15-19		20-24		25-29		30-34	
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)
Parity								
1	1.44	(1.24 - 1.66)	1.12	(1.06 - 1.19)	1.00		1.08	(1.04 - 1.11)
2+	1.76	(1.14 - 2.73)	1.22	(1.09 - 1.36)	1.00		1.25	(1.21 - 1.30)
Status of multiple birth								
Singleton	1.32	(1.15 - 1.52)	1.12	(1.06 - 1.18)	1.00		1.48	(1.38 - 1.59)
Multiple	1.15	(0.47 - 2.81)	1.26	(0.90 - 1.75)	1.00		1.47	(1.04 - 2.06)

CONCLUSIONS

The risk of SMM by maternal age exhibits a J-shape whereby younger and older women have the highest rates of SMM, with maternal group ages 40 years and older having the highest. Furthermore, women who aged 40 years and older had a particularly high risk of SMM in nulliparous and multiparous women, as well as singleton births. To improve maternal health outcomes, policymakers need more specific efforts to identify and manage risk factors for SMM in these vulnerable age groups.