



Changes in the Cesarean Section Rate in Korea (1982–2012) and a Review of the Associated Factors

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Although Cesarean section (CS) itself has contributed to the reduction in maternal and perinatal mortality, an undue rise in the CS rate (CSR) has been issued in Korea as well as globally. The CSR in Korea increased over the past two decades, but has remained at approximately 36% since 2006. Contributing factors associated with the CSR in Korea were an improvement in socio-economic status, a higher maternal age, a rise in multiple pregnancies, and maternal obesity. We found that countries with a no-fault compensation system maintained a lower CSR compared to that in countries with civil action, indicating the close relationship between the CSR and the medico-legal system within a country. The Korean government has implemented strategies including an incentive system relating to the CSR or encouraging vaginal birth after Cesarean to decrease CSR, but such strategies have proved ineffective. To optimize the CSR in Korea, efforts on lowering the maternal childbearing age or reducing maternal obesity are needed at individual level. And from a national view point, reforming health care system, which could encourage the experienced obstetricians to be trained properly and be relieved from legal pressure with deliveries is necessary.

Keywords: Cesarean Section Rate; Korea; Statistics; Trends

INTRODUCTION

The Cesarean section rate (CSR) is percentage of the number of Cesarean section (CS) deliveries among the total number of deliveries. In 1985, the World Health Organization (WHO) stated that the countries with some of the lowest perinatal mortality rates have a low CSR—less than 10% (1)—and then cautioned that the rising CSR would be reduced to an acceptable level (2, 3). Despite the WHO's recommendation, global data shows a rise in the CSR over the past 30 yr due to a rise in primiparas, higher maternal age, universal use of electronic fetal heart rate monitoring, increased CSs of breech presentation, and increased CS on maternal request (4).

The Korean Health Insurance Review and Assessment Service (KHIRA) has published a “Cesarean delivery evaluation report” every year since 2001 and published through its website, representing the official Korean data, and supplied this information to the Organisation for Economic Co-operation and Development (OECD). It is an annual report targeting all medical institutions involved with deliveries for the purpose of providing informations about selecting the most appropriate medical service for consumers, preventing childbirth-related complications, improving national health, and, ultimately, reducing the CSR.

KHIRA evaluates and ranks medical institutions according to a 9-grade system of classification. Medical institutions graded two places from the bottom receive financial penalties. This policy was initially successful but later had a negligible effect on reducing the CSR. As a result, the CSR has stabilized but remains at a high level in Korea (5).

At present, there is no representative study describing the current status of the CSR in Korea. We evaluated the CSR during recent decades by comparing data from Korea with those from OECD countries and analyzed contributing factors associated with the CSR in Korea. We also provide basic reference about the CSR, investigate the activities to reduce the Korean CSR, and try to find ways of reducing the CSR.

DATA COLLECTION

We gathered our data from reports published by a national agency in Korea from 1982 to 2012. Data prior to 2000 were obtained from “Cesarean delivery survey in Korea (2000)” (6) published by the Korean National Health Insurance System (KNHIS) and from the “National survey on fertility and family health and welfare in Korea (2003)” (7), published by the Korea Institute for Health and Social Affairs (KIHS). Data from 2001 to 2012 were obtained

from “Cesarean delivery evaluation report” (KHIRA, 2013) (8) and “Social indicators in Korea” by Statistics Korea (2012) (9).

The data from KNHIS and KIHSA before 2000 were based only on the local survey, not the national survey. However, the survey conducted by KHIRA since 2001 has been worthy of note as a national complete enumeration survey. We used annual data regarding the total number of live births, multiple births,

Table 1. The total number of live births, multiple births, and multiple birth deliveries in Korea (1982-2012)

Year	Total No. of live births	Total No. of multiple births	Multiple birth rate*	Total No. of multiple birth deliveries
1982	848,312	-	-	-
1985	655,489	-	-	-
1988	633,092	-	-	-
1990	649,738	-	-	-
1991	709,275	7,066	10.0	-
1992	730,678	8,258	11.3	-
1993	715,826	8,108	11.3	-
1994	721,185	8,183	11.3	-
1995	715,020	9,422	13.2	-
1996	691,226	9,376	13.6	-
1997	668,344	9,057	13.6	-
1998	634,790	9,605	15.1	-
1999	614,233	9,606	15.6	-
2000	634,501	10,692	16.9	5,146
2001	554,895	9,966	18.0	4,808
2002	492,111	9,658	19.6	4,691
2003	490,543	9,808	20.0	4,632
2004	472,761	9,880	20.9	4,679
2005	435,031	9,459	21.7	4,651
2006	448,153	10,767	24.0	4,693
2007	493,189	13,456	27.3	6,597
2008	465,892	12,790	27.5	6,289
2009	444,849	12,062	27.1	5,709
2010	470,171	12,841	27.3	6,170
2011	471,265	13,852	29.4	6,571
2012	484,550	15,621	32.2	7,575

Birth statistics by Statistics Korea (9). *Multiple birth rate/1,000 live births.

Table 2. Comparison of the mean maternal age by true birth order in England (and Wales) and Korea (2002-2013)

Year	All births		True birth order							
			First		Second		Third		Fourth	
	England	Korea	England	Korea	England	Korea	England	Korea	England	Korea
2013	-	31.8	-	30.7	-	32.6	-	34.4	-	34.4
2012	29.8	31.6	30.7	30.5	32.0	32.4	32.7	34.2	33.4	34.2
2011	29.7	31.4	30.6	30.3	32.1	32.2	32.8	34.1	33.4	34.1
2010	29.6	31.3	30.5	30.1	32.0	32.0	32.7	34.0	33.4	34.0
2009	29.5	31.0	30.4	29.9	32.0	31.8	32.6	33.9	33.4	33.9
2008	29.5	30.8	30.3	29.6	31.9	31.7	32.6	33.8	33.4	33.8
2007	29.5	30.6	30.3	29.4	31.9	31.5	32.6	33.6	33.4	33.6
2006	29.5	30.4	30.2	29.3	31.8	31.3	32.6	33.5	33.2	33.5
2005	29.5	30.2	30.1	29.1	31.7	31.0	32.5	33.3	33.3	33.3
2004	29.4	30.0	30.0	28.8	31.6	30.8	32.5	33.1	33.2	33.1
2003	29.4	29.7	29.9	28.6	31.5	30.4	32.5	32.9	33.1	32.9
2002	29.3	29.5	29.7	28.3	31.4	30.2	32.3	32.7	33.1	32.7

Statistics Korea, Korean Statistical Information Service (10), and Office for National Statistics (births in England and Wales) (13).

multiple birth deliveries, and multiple birth rates as published by the Korean Statistical Information Service of Statistics Korea (10). All of the data sources defined the CSR as percentage of the number of CS deliveries among the total number of deliveries. We analyzed the annual data on total number of live births, multiple births, multiple birth deliveries, total deliveries, vaginal deliveries, and CS deliveries. We investigated annual changes in the CSR and the CSR in primiparas, the CSR by maternal age, medical institutions, and districts.

We checked the CSR of OECD countries (34 member countries in January 2014) using OECD health data from 1990 to 2012 (11). The CSR from OECD countries were calculated from CS surgical procedures per 100 live births (OECD-CS-SPR), unlike Korean reports. We also compared the mean values of the annual CSR of OECD countries with those of Korea.

BIRTHS, DELIVERIES, AND THE CSR IN KOREA

Total number of live births, multiple births, multiple birth deliveries, and multiple birth rates in Korea (1982-2012)

Table 1 shows the total number of live births, multiple births, and multiple birth deliveries in Korea from 1982 to 2012. Remarkably, the total number of live births decreased from 848,312 in 1982 to 484,550 in 2012. However, the total number of multiple births increased from 7,066 in 1991 to 15,621 in 2012; as a result, multiple birth rates (the number of multiple births per 1,000 live births) increased from 10.0 in 1991 to 32.2 in 2012—more than a three-fold rise.

The trend in childbearing age in Korea

According to data from Statistics Korea, the mean childbearing age in Korea rose steadily from 29.5 in 2002 to 31.8 in 2013, as shown in Table 2. The percentage of pregnant women aged over 35 yr increased rapidly from 8.3% in 2003 to 20.2%—one in five mothers—in 2013. This ratio for maternal age is the highest in

the world and represents a very serious problem in Korea, which is yet to be resolved (10).

Fig. 1 shows the mean childbearing age at the birth of the first child in OECD countries in 2009. The mean childbearing age is 29.9 yr in Korea, which ranks fourth from the highest, 27.8 for OECD countries, and 25.0 in the United States. The United Kingdom ranks first with a mean age of 30.0 (12).

Table 2 compares the mean maternal age by true birth order in England and Korea. England shows negligible change—from a mean of 29.3 in 2002 to 29.8 in 2012—whereas Korea shows noticeable change—from a mean of 29.5 in 2002 to 31.6 in 2012 and 31.8 in 2013 (10, 13).

Fig. 2 demonstrates the maternal age at birth in the United States, England, and Korea (10, 14, 15). The percentage of women aged 30–34 yr is 25.6% for the United States and 29.3% for England, but Korea shows a very high percentage at 49.4%. Korea also shows the highest percentage (16.3%) of women aged 35–39 yr among three countries and higher mean maternal age (31.6 yr) than the United States (25.8 yr) and England (29.8 yr).

Changes in the total number of deliveries, vaginal deliveries, CS deliveries, CSR, and CSR in primiparas in Korea (1982-2012)

The number of maternity units including all tertiary and general hospitals, private clinics, midwifery clinics, and public health centers decreased largely from 1,119 in 2006 to 739 in 2012, while the number of total deliveries increased slightly from 460,347 in 2001 to 472,747 in 2012, as shown in Table 3 (6-9). The number of vaginal deliveries showed a very small rise from 273,732 in 2001 to 298,406 in 2012. On the contrary, CS deliveries showed a slight reduction for the same period—from 186,615 to 174,341. The CSR increased from 4.4% in 1982 to 43% in 1999 and then gradually decreased to 36% in 2006. Since 2006, the CSR has remained virtually unchanged. The CSR in primiparas decreased from

36.1% in 2005 to 34.9% in 2006 and then slightly increased to 37.5% in 2012. Vaginal birth after Cesarean (VBAC) is the proportion of mothers who delivered vaginally after CS deliveries. VBAC increased from 2.9% in 2001 to 4.6% in 2006 and then decreased to 3.5% in 2012.

Analysis of the CSR by maternal age and type/location of maternity units in Korea (2011-2012)

Table 4 shows changes in the CSR with maternal age and type/location of maternity units in Korea (2011-2012). In 2011, the percentage of deliveries by maternal age range was as follows: 0.6% in women aged ≤ 19 yr, 4.7% in women aged 20-24 yr, 25.1% in women aged 25-29 yr, 49.1% in women aged 30-34 yr, 17.8% in women aged 35-39 yr, 2.7% in women aged 40-44 yr, and 2.7% in women aged ≥ 45 yr. The number of deliveries for women aged over 35 yr was 20.6%. The CSR by maternal age range was as follows: 17.4% in women aged ≤ 19 yr, 25.4% in women aged 20-24

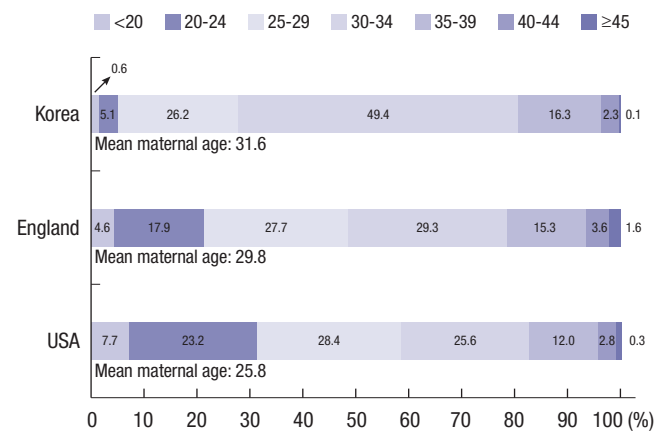


Fig. 2. Maternal age at birth in the USA, England, and Korea in 2012 (10, 14, 15). The mean maternal age was higher in Korea (31.6 yr) compared to that in the USA (25.8 yr) and England (29.8 yr) in 2012.

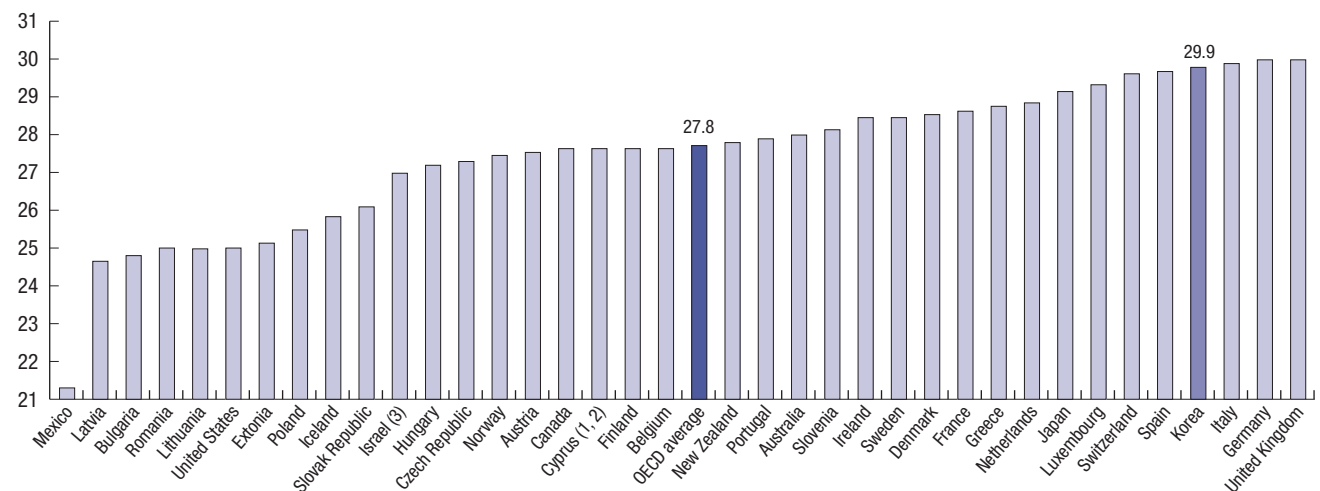


Fig. 1. Mean age of the women at the birth of the first child in 2009 (12). (Modified using the OECD report by updating the Korean data). The mean age was higher in Korea (29.9 yr) compared to that in OECD countries (27.8 yr) in 2009.

Table 3. Cesarean section rate in Korea (1982-2012)

Year	No. of medical care facilities	No. of total deliveries (A)	No. of vaginal deliveries	No. of Cesarean section deliveries (B)	Cesarean section rate (B/A) (%)	Cesarean section rate in primipara	VBAC (%)
1982	-	-	-	-	4.4*	-	-
1985	-	-	-	-	6.0 [†]	-	-
1988	-	-	-	-	11.9*	-	-
1990	-	-	-	-	13.1 [†]	-	-
1991	-	-	-	-	17.3*	-	-
1994	-	-	-	-	31.5*	-	-
1995	-	-	-	-	21.3 [†]	-	-
1997	-	-	-	-	35.9*	-	-
1999	-	-	-	-	43.0 [†]	-	-
2000	-	-	-	-	37.7 [†]	-	-
2001	-	460,347	273,732	186,615	40.5	-	2.9
2002	-	461,928	280,233	181,695	39.3	-	2.9
2003	-	471,486	291,257	180,229	38.2	-	3.1
2004	-	459,985	286,443	173,542	37.7	-	3.7
2005	-	425,181	267,230	157,951	37.1	36.1	4.3
2006	1,119	437,096	279,667	157,429	36.0	34.9	4.6
2007	1,027	479,965	305,675	174,290	36.3	35.6	4.2
2008	954	454,526	289,672	164,850	36.3	35.7	4.2
2009	860	433,716	277,422	156,294	36.0	35.8	3.7
2010	808	459,516	293,944	165,572	36.0	36.1	3.8
2011	777	461,426	293,653	167,773	36.4	36.5	3.7
2012	739	472,747	298,406	174,341	36.9	37.5	3.5

Cesarean delivery survey in Korea (2000) by Korea National Health Insurance Service (6). Cesarean section rate is the number of Cesarean section deliveries among the total number of deliveries, expressed as a percentage. *The 2003 national survey on fertility and, family health and welfare in Korea by the Korea Institute for Health and Social Affairs (7); [†]Cesarean delivery evaluation report in Korea (2013) by the Korea Health Insurance Review and Assessment Service (8), and social indicators in Korea (2013) by Statistics Korea (9). VBAC, vaginal birth after cesarean.

yr, 31.1% in women aged 25–29 yr, 35.7% in women aged 30–34 yr, 45.5% in women aged 35–39 yr, 59.0% in women aged 40–44 yr, and 62.6% in women aged ≥ 45 yr. The CSR increased with maternal age. The CSR for women aged over 35 yr was 47.8%. For the same period, the CSR by maternal age in the United States was as follows: 22.4% in women aged ≤ 19 yr, 28.0% in women aged 20–24 yr, 31.5% in women aged 25–29 yr, 35.7% in women aged 30–34 yr, 45.5% in women aged 35–39 yr, 49.2% in women aged ≥ 40 yr (14). Again, the CSR increased with maternal age (14). The CSR for both countries was similar for women aged 24–34 yr, but in Korea, the CSR was higher in women aged over 35 yr (10). In 2012, the percentage of deliveries by type of maternity units was as follows: tertiary hospitals 5.8%, general hospitals 9.4%, and hospitals 43.3%, private clinics 41.3%, midwifery clinics 0.3%, and public health centers 0.0%. The highest proportion of deliveries occurred in hospitals and private clinics. The CSR by maternity units was as follows: tertiary hospitals 50.8%, general hospitals 44.1%, hospitals 34.7%, and private clinics 35.9%. The highest CSR occurred in tertiary hospitals, where CS deliveries comprised about half of all deliveries. The CSR by maternity units for primiparas was as follows: tertiary hospitals 48.6%, general hospitals 43.3%, hospitals 35.2%, and private clinics 37.2%.

In terms of geographical location of maternity units, in 2012 the three highest CSR occurred in Chungcheongnam-do (41.7%), Ulsan (39.5%), Daejeon (39.2%), and while the three lowest CSR

occurred in Gwangju (28.6%), Jeollanam-do (33.8%), and Gyeongsangbuk-do (35.1%). The CSR is higher than 34% for all regions of Korea except Gwangju.

COMPARISON OF THE OECD-CESAREAN SECTION SURGICAL PROCEDURES IN OECD COUNTRIES (1990–2011) AND IN KOREA (2001–2011), AND ITS RELATIONSHIP WITH THE MEDICO-LEGAL SYSTEM

OECD-CS SPR in Korea (2001–2011)

The CSR in OECD countries is calculated by CS surgical procedure as per 100 live births (OECD-CS SPR). For Korea, the OECD-CS SPR was 33.6 in 2001, 36.9 in 2002, 36.7 in 2003 and 2004, 36.3 in 2005, 35.1 in 2006, 35.4 in 2007 and 2008, 35.1 in 2009, and 35.2 in 2010 and 34.6 in 2011 (Table 5) (11).

OECD-CS SPR in OECD countries (1990–2011)

Table 5 shows the trend of OECD-CS SPR in OECD countries from 1990 to 2011. In 2011, the mean OECD-CS SPR was 26.9. According to the most recent data, the five countries ranked highest for OECD-CS SPR were Mexico (49.0), Turkey (46.2), Chile (37.7), Italy (37.7), and Portugal (34.8), while Korea (34.6) was ranked sixth. Northern European countries such as Iceland (14.7), Netherland (15.6), Finland (16.2), Sweden (16.2), and

Table 4. Cesarean section rate by maternal age, type, and district of the medical care facilities in Korea (2011, 2012)

Parameters	Delivery	Vaginal delivery	Cesarean section delivery	Cesarean section rate (%)	Cesarean section rate in primipara (%)
Total No. (%) in 2012	472,747 (100.0)	298,406 (43.1)	174,341 (36.9)	36.9	37.5
By maternal age group (yr) (2011)					
≤19	0.6	0.7	0.3	17.4	-
20-24	4.7	5.5	3.3	25.4	-
25-29	25.1	27.1	21.4	31.1	-
30-34	49.1	49.6	48.2	35.7	-
35-39	17.8	15.3	22.3	45.5	-
40-44	2.7	1.7	4.3	59.0	-
≥45	0.1	0.1	0.1	62.6	-
By type of maternal care facilities (2012) (n=739)					
Tertiary hospital (n=43)	5.8	4.6	7.8	50.2	48.6
General hospital (n=97)	9.4	8.3	11.2	44.1	43.3
Hospital (n=140)	43.3	44.8	40.8	34.7	35.2
Clinics (n=445)	41.3	42.0	40.2	35.9	37.2
Midwifery clinics (n=13)	0.3	0.4	-	-	-
Health center (n=1)	0.0	0.0	-	-	-
By district of medical care facilities (2011, 2012)					
Seoul	20.0*	20.3*	19.5*	36.1 [†]	36.6 [†]
Busan	7.2	7.2	7.3	38.1	38.9
Daegu	5.7	5.5	6.1	38.9	39.5
Incheon	4.9	4.9	4.9	36.6	37.1
Gwangju	4.3	4.8	3.4	28.6	27.7
Daejeon	3.9	3.9	4.0	39.2	40.4
Ulsan	2.4	2.2	2.7	39.5	39.2
Gyeonggi	25.1	24.9	25.4	36.9	37.7
Gangwon	2.5	2.5	2.7	39.0	39.0
Chungbuk	2.9	2.8	3.1	39.0	39.1
Chungnam	3.4	3.3	3.6	41.7	43.6
Jeonbuk	3.6	3.6	3.7	37.5	38.4
Jeonnam	2.6	2.7	2.4	33.8	34.7
Gyeongbuk	4.1	4.1	4.0	35.1	35.8
Gyeongnam	6.0	6.1	5.8	36.5	38.0
Jeju	1.2	1.2	1.3	38.7	37.5

Values are presented as percentage unless otherwise indicated. Cesarean delivery evaluation report in Korea (2013) by the Korea Health Insurance Review and Assessment Service (8) and social indicators in Korea (2012) by Statistics Korea (9). Cesarean section rate is the number of Cesarean section deliveries among the total number of deliveries, expressed as a percentage. *The first, second, and third columns indicate 2011 data; [†]The fourth and fifth columns indicate 2012 data.

Norway (16.5) ranked low for OECD-CS SPR (11).

Comparison of the OECD-CS SPR in Korea and the mean OECD-CS SPR by yr (2001-2011)

Fig. 3 compares the OECD-CS SPR of Korea with the mean OECD-CS SPR from 2001 to 2011. In Korea, the OECD-CS SPR was 33.6 in 2001, rose to 35.4 in 2007 and 2008, and decreased slightly to 34.6 in 2011. The mean OECD-CS SPR rose from 20.2 in 2001 to 26.9 in 2011. However, the mean OECD-CS SPR in Korea was higher every year than the mean overall OECD-CS SPR (11).

The relationship between the OECD-CS SPR and the medico-legal system

To understand the relationship between the CSR and the medico-legal system, we analyzed the correlation between the responsibility of doctors and the CSR within the medico-legal system, focusing on six OECD countries and Korea (Fig. 4) (11, 16, 17). The OECD-CS SPR in Sweden has remained stable at < 20 (12.1 in 1998 and 16.2 in 2011)—partially owing to the no-fault

compensation system for legal damages. Meanwhile, the OECD-CS SPR of the United States and Australia and Korea—with civil litigation system by fault liability—is increasing gradually: 32.8 and 32.2, respectively, in 2011.

POLICIES AND PERSPECTIVES FOR CS DELIVERY IN KOREA

Principal findings of this study

The main results of this study are summarized as follows. 1) The number of live births in Korea has decreased markedly—by 43%—over a recent 30-yr period, and the number of medical facilities involved with deliveries has decreased by 34% over a recent 6-yr period. 2) The CSR of Korea has increased over recent decades like other developed countries, but has decreased since 2000. Subsequently, the CSR has remained at around 36–37% since 2006, although it has increased in primiparas. 3) Multiple pregnancies and maternal age—high-risk factors for a rise in CSR—have increased steadily in Korea. In particular, the mean

Table 5. Cesarean section surgical procedures per 100 live births in OECD countries (1990-2011)

Countries	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Australia	17.5	17.9	18.2	18.8	19.2	19.3	19.3	20.1	20.9	21.7	23.1	25.1	26.8	28.2	28.2	30.0	30.6	30.6	30.8	31.2	32.2	32.2*
Austria	-	-	-	-	-	-	-	13.9	14.6	15.9	16.8	18.0	19.8	20.7	22.8	23.8	25.1	26.5	27.1	28.2	28.3	28.3
Belgium	10.5	11.6	12.0	12.9	12.9	13.5	13.7	13.8	14.4	15.9	16.3	16.3	17.4	17.6	17.8	19.3	19.8	19.4	19.5	19.3	19.9	19.9*
Canada	18.4	17.9	17.5	17.5	17.5	17.5	17.9	18.4	18.8	19.6	20.9	22.2	23.4	24.8	25.3	26.2	26.2	26.6	26.4	26.2	26.1	26.1*
Chile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37.7	37.7*
Czech Republic	7.6	8.4	8.8	9.1	10.1	10.1	11.6	11.8	12.6	12.3	12.9	13.3	14.1	15.3	16.0	17.1	18.3	19.6	20.5	21.2	22.5	23.3
Denmark	12.4	12.3	12.2	12.5	12.5	12.5	10.9	11.4	11.9	12.2	12.9	13.6	16.0	15.3	16.5	17.3	17.4	17.7	16.6	20.5	21.2	21.2*
Estonia	-	-	-	-	-	-	-	-	-	-	14.6	15.5	15.0	16.4	17.2	18.9	19.0	20.0	20.0	20.7	20.3	19.8
Finland	13.6	14.3	14.5	14.6	15.4	15.6	15.7	15.6	15.4	15.8	15.8	16.5	16.4	16.2	16.3	16.2	16.1	16.2	16.4	15.9	16.1	16.2
France	-	-	-	-	-	-	-	15.6	16.3	16.8	17.2	17.8	18.5	18.6	18.6	19.1	19.4	19.9	19.8	20.0	20.2	20.2
Germany	15.7	15.2	15.9	16.6	17.1	17.2	17.6	18.1	19.1	19.8	20.9	22.0	23.7	24.8	26.0	26.7	27.8	28.5	29.4	30.3	31.4	31.1
Greece	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27.1	28.2	28.2	28.8	30.5	31.8	32.8	33.4
Iceland	11.8	11.4	13.4	13.0	13.8	14.1	15.2	16.3	15.9	17.3	17.7	16.8	17.4	17.9	16.4	15.6	17.2	16.9	16.1	15.8	-	14.7
Ireland	10.5	11.6	12.0	12.9	-	13.4	14.5	15.3	17.5	19.8	20.7	21.2	21.8	23.4	23.6	24.3	23.8	26.5	25.6	26.5	26.6	26.6*
Israel	-	-	-	-	-	-	-	-	12.9	13.9	14.7	16.1	16.8	16.7	17.6	18.6	18.6	18.8	19.5	19.2	19.3	19.8
Italy	20.8	22.6	23.2	24.1	24.8	26.1	26.9	26.9	30.7	32.4	33.3	34.9	36.2	37.3	38.4	39.1	39.5	39.2	38.6	38.8	38.5	37.7
Japan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Korea	-	-	-	-	-	-	-	-	-	-	-	33.6	36.9	36.7	36.7	36.3	35.1	35.4	35.4	35.1	35.2	34.6
Luxembourg	16.5	17.0	17.4	-	16.8	16.4	16.4	16.9	18.1	21.0	21.9	24.3	25.6	26.1	24.0	24.1	24.4	25.7	26.8	26.3	25.7	27.6
Mexico	-	-	-	-	24.2	25.3	25.4	27.7	27.4	27.9	28.2	30.4	33.2	34.7	37.0	38.2	39.5	40.7	43.9	42.0	44.8	49.0
Netherlands	7.4	7.7	8.0	8.4	9.2	9.7	10.1	10.4	11.1	11.3	11.9	13.6	13.5	13.5	13.6	13.6	13.8	13.9	14.3	14.8	15.6	15.6*
New Zealand	12.1	13.0	12.5	13.8	14.4	15.1	15.7	16.5	18.2	18.4	20.2	21.2	22.2	22.2	22.5	23.0	24.4	23.2	23.3	24.1	23.8	24.3
Norway	12.8	12.5	12.6	12.5	12.6	12.7	12.7	12.9	13.7	13.5	13.7	15.6	16.1	15.6	15.2	15.9	15.9	17.2	17.1	16.5	-	16.5†
Poland	-	-	-	-	13.8	15.2	15.6	16.1	-	-	-	-	-	15.7	16.4	18.5	19.2	19.0	19.3	22.8	26.1	29.9
Portugal	-	-	-	19.8	21.2	21.6	22.0	23.4	23.9	24.6	23.9	25.4	25.7	26.6	27.0	27.8	31.0	31.2	32.7	33.0	-	34.8
Slovak Republic	8.7	9.1	9.9	10.6	11.2	11.5	12.2	13.0	13.3	13.9	14.7	16.6	17.8	18.5	19.2	20.7	21.9	23.5	24.7	27.0	26.1	26.1*
Slovenia	8.6	8.9	9.2	9.6	9.4	9.2	10.0	10.2	10.3	10.1	11.0	12.5	13.7	14.4	14.2	15.4	16.4	16.8	17.0	17.7	19.0	19.4
Spain	14.2	15.0	16.2	17.3	17.8	18.8	19.3	19.6	20.3	20.9	21.4	22.2	23.2	23.6	24.2	25.0	25.9	25.3	24.7	25.0	25.0	24.9
Sweden	-	-	-	-	-	-	-	-	12.1	14.2	14.5	15.6	16.1	16.5	16.7	16.9	17.2	17.2	16.7	16.9	16.4	16.2
Switzerland	18.6	17.7	-	-	-	-	-	-	-	-	-	-	24.2	25.1	27.5	28.5	30.2	32.0	32.5	32.4	32.8	33.0
Turkey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.4	38.0	41.4	43.7	45.7	46.2
United Kingdom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.0	21.1	21.6	23.2	23.7	23.8	24.1
United States	22.7	22.6	22.3	21.8	21.2	20.8	20.7	20.8	21.2	22.0	22.9	24.4	26.1	27.5	29.1	30.3	31.1	31.8	32.3	32.9	32.8	32.8
Mean	13.7	14.0	14.2	15.6	15.8	16.0	16.4	16.7	17.1	18.0	18.5	20.2	21.4	21.8	22.5	23.2	24.1	24.8	25.2	25.8	26.2	26.2

Organization for Economic Co-operation and Development (OECD) health data by OECD (11). *2010; †2009.

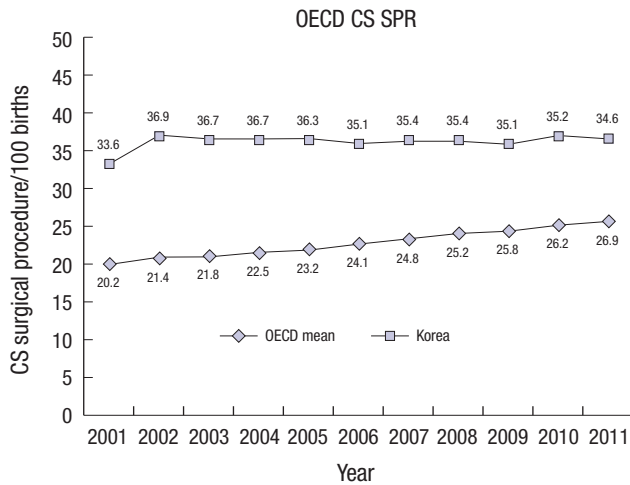


Fig. 3. Comparison of the rate of OECD Cesarean section surgical procedures per 100 live births (OECD-CS SPR) in Korea with the mean OECD-CS SPR in OECD countries from 2001 to 2011 (11). The OECD-CS SPR in Korea was higher than the mean OECD-CS SPR in OECD countries.

maternal age was 31.6 yr in 2012—significantly above the maternal age of 25.8 yr in the United States and 29.8 yr in England for the same year. 4) The CSR of northern European countries exempted from responsibility with no-fault compensation system for birth injury remained low. Meanwhile, the CSR of the United States and Australia with civil litigation system by fault liability has gradually risen.

The rise in the CSR in Korea and other countries

The WHO defined the optimal CSR as 10%-15% in 1985, and reported that, at a CSR higher than 15%, the risk to maternal and neonatal health exceeded the benefit (1). However, about 15 yr on, the actual CSR was higher than 15% in more than half of countries (69/137) that took part in the survey for the World Health Report in 2010 (18). Furthermore, the CSR over the last 10-yr period has risen. By 2011, the CSR had risen to 32.9 in the United States and to 24.1 in England (11). This was almost two or three times higher than the optimal CSR recommended by the WHO in 1985. The optimal recommended CSR varies among countries, so the ideal CSR has not yet been agreed upon (19, 20).

The CSR in Korea increased from 4.4% in 1982, rose steeply to 43.0% in 1999, and since then has showed a slight decline. Again, it has remained at around 36%-37%. A similar pattern of increasing CSR is observable in almost all developed countries. In the United States, the CSR was only 5% in 1970 but increased dramatically to 21% in 1995 and to 32.8% in 2011 (21, 22). In England, under progressive healthcare services, it increased from 9% in 1980 to 25.5% in 2012 (15).

The positive contribution of CS: childbirth safety

In developing countries with a high mortality rate, there is a posi-

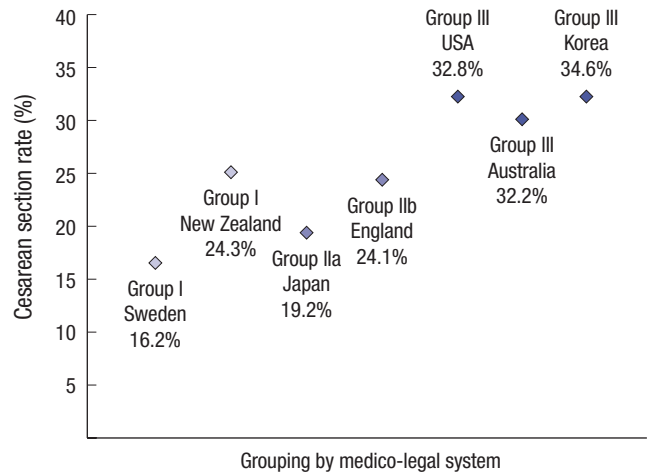


Fig. 4. The Cesarean section rate in 2011 according to legal pressure (11, 16, 17). The following systems were considered: no-fault compensation system in Sweden, government sponsored no-fault compensation system and unitary compensation system in New Zealand, fault liability system in Japan, mistake lawsuit system in England, and civil litigation system in the USA, Australia, and Korea (Grouping by system: Group I, Sweden and New Zealand; Group IIa, Japan; Group IIb, England; Group III, USA, Australia, and Korea).

tive connection between the adaptive rise in the CSR and decrease in maternal and perinatal mortality (20). In 1982, the CSR in Korea was only 4.4%. And the perinatal mortality rate was high as 21.3%, but then decreased to 6.0% in 1996. Therefore, the rise in the CSR from the 1980s to the mid-1990s in Korea is thought to have contributed to an improvement in maternal and child health (23-28). When Korea joined the OECD membership in 1996, as a result of continuous economic growth, the CSR in Korea was 35.9%, and rose markedly to 43.0% in 1999. The trend toward a rise in CSR was found commonly among most OECD countries as well as in Korea.

The rise in the CSR in Korea and associated factors

The socio-economic status in Korea rose in the 1980s and 1990s, leading to a rise in the educational level in females. There was a five-fold increase in the national income per head, from 2,355 USD in 1985 to 11,292 USD in 2000. In 1985, 60% of Korean females aged 15-44 yr were educated to a level below middle school and about 6.4% of females progressed to university. Since then, the female educational level has risen, and more than 30% of females progressed to university level education in 2000 (9, 29, 30). According to the study by Lee et al. (31), the rise in the CSR in the 1980s seemed to correlate with the female educational level, so the higher the education level, the higher the CSR. The CSR in university graduates was 2.61 times higher than that in those educated to a level below middle school. In other words, we can assume that the sudden rise in the CSR from the 1980s to the early 1990s was influenced by economic determinants such as a rise in national income, an improvement in female socio-economic status, and an accessibility of medical facilities. How-

ever, the correlation between the female educational level and the CSR changed over time; in 1994, there was no significant difference between the two variables. The CSR in well-educated females was lower than that in those educated to a level below middle school (odds ratio, 0.44; 0.24-0.79, $P = 0.011$) (31). Namely, neither the rise in female educational level nor the improvement in health care indicators alone could explain the cause of the rise in the CSR in Korea in the 1990s. Additionally, the study in China showed that the rise in the CSR between 1993 and 2008 was more influenced by the medical service system than by the socio-economic and income status of each individual (32).

Our study showed that, in Korea, maternal age is increasing steadily and that the mean childbearing age in 2012 was 31.6 yr. Maternal age in this population was markedly higher than that in the United States (25.8 yr) and in England (29.8 yr) for the same year. Furthermore, the ratio of mothers aged 30-34 yr was 49.4%. This rate was very high compared with that in the United States (25.6%) and England (29.3%). Many earlier studies from across the world have linked older maternal age with the rise in the CSR (33).

Older maternal age is one cause of the rising CSR because of the increased likelihood of the development of chronic diseases (e.g., diabetes, hypertension) before pregnancy and diseases during pregnancy (e.g., gestational diabetes, gestational hypertension, placenta previa, and abruptio placentae), which increase antepartum and intrapartum complications (34). An epidemiological study of childbirth in Australia showed that, between 1984 and 2003, the likelihood ratio of an emergency or scheduled CSR was 2.7 and 5.4 respectively, in mothers aged over 40 yr (35). Furthermore, according to a recent study in England, the percentage of mothers aged over 40 yr rose by 80% between 2006 and 2011 and the CSR in mothers aged 40 yr rose from 34.6% to 53.7% over the same period (36). Our study showed that the percentage of mothers aged over 40 yr in Korea more than doubled between 2002 (5.5%) and 2012 (11.4%)—over a period of 10 yr (10). This indicates that the rise in the CSR was related to the rise in older mothers in Korea.

Twin pregnancies have increased by about 50% in Korea, and the rise in the birth of twins appears to have influenced the rise in the CSR. The frequency of metabolic syndromes has also risen recently in Korea (37). It would be associated with maternal obesity and influence gestational diabetes, and gestational hypertension, leading, in turn, to a rise in the CSR and severe complications such as pulmonary embolism. A pre-gestational body mass index of over 25.0 kg/m² increases the likelihood of the CSR and small-for-gestational-age infants (38).

The primary CSR is the percentage of Cesarean births to women who have not had a previous CS delivery in a given year. Primary CS delivery has been shown to be one of the causes of repeat CS delivery. A rise in primary CSR leads to a rise in the CSR, so lowering the primary CSR contributes to a reduction in the CSR. In the United States, a decrease in the CSR from 1985 to 1996 was

influenced by the reduction in primary CSR, as well as by the rise in VBAC (39). However, the primary CSR in the United States increased from 14.6% in 1996 to 23.1% in 2010, and the CSR also increased to 32.8% (40). The CSR of primiparas in Korea has been rising: 34.9% in 2006 and 37.5% in 2012. It seems likely that the primary CSR in Korea will show a similar pattern, because primary CS delivery has mainly occurred in primiparas.

The main causes of primary CS in Korea are cephalopelvic disproportion, fetal malpresentation, and fetal distress (6). The reasons for the rise in the primary CSR are a rise in failed labor, a reduction in operative vaginal delivery, a rise in a diagnosis of fetal distress by the use of fetal electronic monitoring, and preference for CS in cases of breech or multiple deliveries. Compared with other races, in Asian women, the primary CSR for failure to progress is quite high because they have a relatively small pelvic cavity (41). Furthermore, maternal aging is a major problem in Korea, as mentioned previously. The percentage of pregnant women aged over 35 yr increased from 8.4% in 2001 to 21.6% in 2012, so the rise in primary CSR was likely due to increased failed labor in older pregnant women. This inevitable phenomenon of maternal aging was believed to be a result of the rise in female social activity.

Moreover, as woman's right to choose the mode of delivery needs to be respected, CS on maternal request without indication is one of causes of the rise in the primary CSR. Studies showed that 7%-8% of CS deliveries in England and the United States had done on maternal request, and a survey in Korea reported that 6%-7% of CS deliveries was taken on maternal request without indication (42-44). Doctors are having difficulty in declining CS delivery by maternal request. One European study explored the attitudes of obstetricians. More than 75% of German and English doctors accepted CS delivery by maternal request, as did even 22% of doctors in the Netherland where the CSR were lowest. Associated factors were fear of litigation, country of practice, and working in a university-affiliated hospital (45).

Even though no nationwide survey has been conducted on CS on maternal request in Korea, it seems to be difficult for clinicians to insist on vaginal delivery on medical grounds rather than accept a maternal request for CS delivery. Moreover, medico-legal system in Korea would make the clinicians accept a maternal request for CS without hesitation if obstetricians kept being blamed for attempting vaginal delivery in place of performing CS in litigation.

HAS THE STRATEGY OF THE KOREAN GOVERNMENT TO REDUCE THE CSR BEEN PROVEN EFFECTIVE?

Introduction of an incentive system linked to the CSR

The Korean government and KHIRA have started an annual evaluation of the CSR among all medical facilities involved with deliveries in an effort to reduce CS without indication intended

initiated by medical staff and optimize the CSR. Public release of an evaluation report on Cesarean delivery was initiated through the KHIRA website in 2005. The national medical insurance institute then introduced a “Pay for Performance” policy in 2007. It ranked hospitals according to their CSR, granted financial incentives or penalties, and tried to induce an eventual reduction in the CSR. However, the repeated release of information on the CSR coupled with financial incentives failed to reduce the CSR, which was revealed to have remained the same in Korea between 2006 and 2012 (5). Recently, the government announced that the policy of granted financial incentives or penalties according to CSR will be discontinued. This infers that the high CSR in Korea is not linked to the financial interests of doctors. In fact, there was no statistical correlation between increased CSR and doctors’ income in a survey of private clinics in the metropolitan area of Korea in 2000, when the CSR was very high (46). Furthermore, the financial benefit to doctors from CS is negligible because the medical charge for CS is very low in Korea. Likewise, a similar situation exists in Taiwan whereby a financial incentive policy failed to reduce the CSR (47). A report from the United States demonstrated that doctors’ income had very little effect on increasing the CSR; furthermore, financial incentives failed to reduce the CSR (48, 49).

Encouraging vaginal birth after Cesarean (VBAC)

Repeated CS is the major cause of a high CSR. There are two ways of reducing it: 1) by conducting VBAC in pregnant women with a previous CS delivery, and 2) by reducing the primary CSR. A high CSR is a global trend in developed countries. In the United States, the CSR rose rapidly until the early 1980s. The American College of Obstetricians and Gynecologists (ACOG) conducted an extensive campaign for VBAC and recommended VBAC to all pregnant women with a previous CS delivery and no specific contraindications (50). As a result, the VBAC rate increased significantly from 5% in 1985 to 28.3% in 1996, with a concomitant reduction in the CSR of around 20% (51). However, complications such as uterine rupture, neonatal death, and brain injury also increased, which led to increased medical, social, and lawsuit costs. Obstetricians then avoided VBAC, and the percentage of VBAC decreased to 8.3% in 2007 (52, 53). ACOG stated that VBAC should be performed after individual risks and benefits must be fully evaluated because failed VBAC could result in increased maternal and perinatal morbidity compared to elective cesarean section and that VBAC should be conducted in centers where immediate emergency CS can be performed (54). In Korea, despite the experts’ concerns about VBAC (55), KHIRA included VBAC as a major monitoring index for the evaluation of CS delivery to encourage obstetricians to advocate VBAC. However, the percentage of VBAC did not increase significantly; it was 2.9% in 2001, 4.6% in 2006, and reduced to 3.5% in 2012. These percentages are very low compared with the 20%-55% in OECD

countries (39); VBAC had no effect on lowering the CSR in Korea. Obstetricians avoid VBAC as they fear medico-legal issues in cases of severe complications and the poor cost-effectiveness in terms of general equipment and personnel expenses (56, 57). Both VBAC and planned CS have advantages and disadvantages, and further studies are required to establish appropriate indications and safety (58). Therefore, governmental support, such as a medico-social insurance system and financial support to maintain equipment and man power, should precede the wide spread promotion of VBAC because the safety and effectiveness of VBAC is not totally evident.

Diagnosis-related groups may increase the primary CSR in Korea

Diagnosis-related groups (DRG) for some surgical procedures have been enforced in all medical facilities in Korea since 2013; that is, CS is also included for prospective payment system based on DRG and the medical charge cannot be changed. For example, hospitals cannot charge additional costs to a national medical insurance organization for unexpected CS after failure to induce labor. The labor induction failure rate rises to 49% in pregnant women with 41 weeks or more of gestation and have a low Bishop score, and is even higher in pregnant women aged over 35 yr (59, 60). Therefore, under the DRG system of Korea, there is continued concern about the high primary CSR and low rate of labor induction. Because the induction of labor carries a higher risk of CS than spontaneous labor, discretion should be exercised for when carrying out nonmedically indicated induction of labor to reduce the primary CSR, especially for the convenience of pregnant women and doctors (60-64).

The no-fault compensation system may contribute to the decrease in the primary CSR in Korea

We analyzed the CSR of OECD countries and found that in countries where a no-fault compensation system was established for medico-legal issues, the CSR remains at a low level—around 20% or less—especially in northern European countries. In contrast, in those countries with a fault liability system, such as the United States and Australia, the CSR is higher than 30%. In Korea, because a fault liability system is applied in medico-legal cases, it is assumed that any further reduction in the CSR might not be possible. Conversely, the decrease in CSR can be expected to follow a no-fault compensation system like in Sweden. In reality, one Australian study revealed that the CSR in New Zealand—where the government sponsored a no-fault compensation system—was 24.7% in 2007; however, in Australia with a fault liability system it was 32.3% under the same treatment protocol. They suggested that if the Australian government would adopt a no-fault system, CSR would decrease by 7% due to decreased defensive treatment and this eventually further improve the maternity service for the next generation (65).

The birth environment in Korea

Korea had the lowest birth rate out of the OECD countries (1.19 per 1,000 live births) in 2008; however, it has risen slightly to 1.23 in 2012 but still remains lower than the mean rate of the OECD countries (10). Besides the low birth rate, the number of medical facilities involved with deliveries decreased and the sharply reduction in obstetricians became one of the most pressing social issues in Korea. Vaginal delivery in nulliparous woman is more time consuming than CS, and at the same time requires a skilled clinicians who can do exact and rapid clinical decision-making and are ready to perform operative vaginal delivery if necessary under possibility of medical litigations. It is hardly to say that the CSR in Korea would be decreased by reducing primary CSR at poor medical environment presently (66). Fortunately, unlike other OECD countries where the CSR is continuously increasing, the CSR remains constant in Korea, and it is assumed that this results from an improved perception of CS among pregnant women and a relatively stable medical service (31).

SUMMARY AND CONCLUSION

The CSR has risen steadily over the last three decades in developed countries because of reduced operational risks owing to advances in medical techniques. Maternal and perinatal mortality is high in resource-limited countries, and it has been proved—both medically and epidemiologically—that CS can contribute to a reduction in maternal and perinatal mortality (67, 68). On the other hand, as CS can increase maternal complications such as hemorrhage, infection, pulmonary embolism, and amniotic embolism compared with vaginal delivery (65), it should be conducted with caution from the doctors' viewpoint as well as from that of the pregnant women.

The CSR in Korea had been constantly increasing, then gradually decreased since 2000, and has remained at 36%-37% since 2006. Factors that lead to a rise in CSR are increased maternal age, multiple pregnancies, and maternal obesity. In particular, Korea has become an aging society in which the mean age of pregnant women was 31.6 yr in 2012, contrasting with 25.8 and 29.8 yr in the United States and England, respectively. It is inferred that this older maternal age leads to a further rise in the CSR.

The Korean government introduced a "Pay for Performance" policy from 2007, but this failed to reduce the CSR, which has remained constant since 2006. Furthermore, the widespread promotion of VBAC does not seem to have been successful because its safety and effectiveness is not established and Korean mothers tend to have an only child as the Statistics Korea announced that the birth rate was 1.19 in 2013 (70).

There is no doubt that reducing the primary CSR is the most important way of decreasing the CSR (21, 71). Compared with the primary CSR of the United States or England, that in Korea has increased in parallel with the sharp rise in maternal age. De-

spite this, from July 2013, the government has enforced a DRG system even in tertiary centers that are responsible for high-risk deliveries and deliveries in older mothers. This is very likely to increase the primary CSR. Additionally, a recent government policy relating to fault liability has increased the tendency of obstetricians to avoid deliveries (72). These trends could lead to a lack of experienced obstetricians who can cope with high-risk deliveries. Lastly, this study demonstrated that the CSR is closely linked with the compensation system for medico-legal problems.

In conclusion, to reduce the CSR, social efforts such as a perceptual change regarding CS, lowering the maternal age, and maintaining health and proper weight are essential. Moreover, governmental efforts to encourage experienced obstetricians to exercise discretion in their decision to perform CS and to reduce the legal implications regarding delivery should be assured.

DISCLOSURE

The authors have no conflicts of interest to disclose.

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