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## OBSTETRICS

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# Incidence, Risk factors, Maternal and Neonatal Outcomes of Second-stage Cesarean Section at Siriraj Hospital

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### ABSTRACT

**Objectives:** To determine the incidence of cesarean section (CS) during second stage of labor, to evaluate maternal and neonatal outcomes, and to determine risk factors.

**Materials and Methods:** A retrospective cohort study was conducted in 636 women with term, singleton pregnancies with cephalic presentation who delivered during January to April 2021. Data were extracted from medical records, including baseline, antenatal care data, mode of deliveries and outcomes. The incidence of 2<sup>nd</sup> stage CS was estimated. Maternal and neonatal outcomes were compared between different modes of deliveries.

**Results:** Overall CS rate was 28.5% with 22.8% occurred during 1<sup>st</sup> stage and 5.7% had CS during 2<sup>nd</sup> stage of labor. CS during 2<sup>nd</sup> stage of labor contributed to 19.9% of all CS. Instrumental vaginal delivery was performed in only 5.5%. Those with 2<sup>nd</sup> stage CS were more likely to be overweight or obese, and to have gestational weight gain above recommendation. The most common indication for CS was cephalopelvic disproportion. Neonatal birth weight and rate of macrosomia were significantly higher among those with 2<sup>nd</sup> stage CS while birth asphyxia was more common among 1<sup>st</sup> stage CS. Other maternal and neonatal outcomes were comparable.

**Conclusion:** CS during second stage of labor occurred in 5.7% of all women, contribution to 19.9% of all CS. Those with 2<sup>nd</sup> stage CS were more likely to be overweight and obese, to have excessive gestational weight gain, and to have higher neonatal birth weight and rate of macrosomia. There was no increase in serious adverse outcomes in women with 2<sup>nd</sup> stage CS.

**Keywords:** cesarean section, second stage of labor, pregnancy outcomes, risk factors.

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# อุบัติการณ์ ปัจจัยเสี่ยง และ ภาวะแทรกซ้อนของมารดาและทารก ของการผ่าตัดคลอดในระยะที่สองของการคลอดในโรงพยาบาลศิริราช

กนิษฐา ศรีภักษ์ณพล, ดิฐกานต์ บริบูรณ์หิรัญสาร

## บทคัดย่อ

**วัตถุประสงค์:** เพื่อศึกษาอุบัติการณ์ ผลการตั้งครรภ์ และประเมินปัจจัยเสี่ยงของการผ่าตัดคลอดในระยะที่สองของการคลอด

**วัสดุและวิธีการ:** ทำการศึกษาย้อนหลังโดยเก็บข้อมูลจากสตรีตั้งครรภ์ทั้งหมด 636 รายที่เป็นครรภ์เดี่ยว อายุครรภ์ครบกำหนดและทารกเป็นท่าศีรษะ ที่คลอดบุตรในช่วงเดือน มกราคม 2564 ถึง เมษายน 2564 รวบรวมข้อมูลจากเวชระเบียน ประกอบด้วย ข้อมูลทั่วไป ข้อมูลทางสูติศาสตร์และการฝากครรภ์ ข้อมูลการคลอด และภาวะแทรกซ้อนของสตรีและทารกแรกเกิด คำนวณอุบัติการณ์การผ่าตัดคลอดในระยะที่สองของการคลอด และเปรียบเทียบผลลัพธ์การคลอดของสตรีและทารกแรกเกิดในแต่ละวิธีการคลอด

**ผลการศึกษา:** พบอุบัติการณ์การผ่าตัดคลอดรวมทั้งหมดร้อยละ 28.5 ของสตรีตั้งครรภ์ทั้งหมด โดยเป็นการผ่าตัดคลอดในระยะที่หนึ่งของการคลอดร้อยละ 22.8 และการผ่าตัดคลอดในระยะที่สองของการคลอดร้อยละ 5.7 ซึ่งคิดเป็นร้อยละ 19.9 ของการผ่าตัดคลอดทั้งหมด พบว่ามีการใช้เครื่องมือช่วยคลอดทางช่องคลอดร้อยละ 5.5 สตรีที่ได้รับการผ่าตัดคลอดในระยะที่สองของการคลอด เป็นกลุ่มที่มีน้ำหนักเกินเกณฑ์หรือภาวะอ้วนและมีน้ำหนักตัวเพิ่มขึ้นเกินเกณฑ์สูงกว่า ข้อบ่งชี้การผ่าตัดที่พบมากที่สุดคือภาวะช่องเชิงกรานไม่ได้สัดส่วนกับขนาดของศีรษะทารก กลุ่มที่ผ่าตัดคลอดในระยะที่สองของการคลอดมีน้ำหนักทารกแรกเกิดและทารกที่มีน้ำหนักเกิน 4,000 กรัม สูงกว่าอย่างมีนัยสำคัญทางสถิติ ในขณะที่พบภาวะขาดออกซิเจนของทารกแรกเกิดสูงกว่าในกลุ่มการผ่าตัดคลอดในระยะที่หนึ่งของการคลอด ไม่พบความแตกต่างของผลการตั้งครรภ์ของสตรีและทารกแรกเกิดด้านอื่น ๆ ระหว่างการคลอดในแต่ละวิธี

**สรุป:** อุบัติการณ์การผ่าตัดคลอดในระยะที่สองของการคลอดเท่ากับร้อยละ 5.7 ของสตรีตั้งครรภ์ทั้งหมด โดยคิดเป็นร้อยละ 19.9 ของการผ่าตัดคลอดทั้งหมด ซึ่งพบเป็นกลุ่มสตรีมีน้ำหนักเกินเกณฑ์หรือภาวะอ้วนและมีน้ำหนักตัวเพิ่มขึ้นเกินเกณฑ์สูงกว่า และทารกมีน้ำหนักแรกเกิดและทารกที่มีน้ำหนักเกิน 4,000 กรัมสูงกว่า ไม่พบการเพิ่มขึ้นของผลการตั้งครรภ์ที่ไม่พึงประสงค์ชนิดร้ายแรงในการผ่าตัดคลอดในระยะที่สองของการคลอด

**คำสำคัญ:** การผ่าตัดคลอด, ระยะที่สองของการคลอด, ผลการตั้งครรภ์

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## Introduction

The World Health Organization (WHO) suggests that appropriate cesarean section (CS) rate should be between 10% and 15% at population level<sup>(1)</sup>. However, data from 150 countries during 1990 to 2014 showed that the global average of CS rate has increased by 12.4% (from 6.7% to 19.1%) with an average annual rate of increase of 4.4% and Asia has the second largest absolute increase of 15.1% (from 4.4% to 19.5%)<sup>(2)</sup>. In concordance with the increase in overall CS rate, increased tendency of CS during second stage of labor has also been observed<sup>(3-5)</sup>. Studies in the United Kingdom showed that the rate of CS during second stage of labor increased from 0.5-0.9% to 2.1-2.2%<sup>(3, 4)</sup>. A study in Singapore reported that 4.4% of pregnant women had emergency second stage CS<sup>(6)</sup>. Another study in Australia reported that 5.6% of all cesarean section cases was done at full cervical dilatation, but there was no increasing trend over the last 5 years<sup>(7)</sup>.

In association with the increasing incidence of CS during second stage of labor, increasing rates of failed operative vaginal delivery and reduced attempts at intrauterine delivery have been documented<sup>(3, 5)</sup>. A previous study reported that the most common indication for CS during second stage of labor was failure to progress without an attempt at instrumental delivery<sup>(7)</sup>. Presence of a consultant at the time of delivery has been reported to be an important determinant for CS during second stage of labor that the chance of vaginal delivery was significantly increased from 30% to 70%<sup>(8, 9)</sup>.

Cesarean section during second stage of labor has been associated with increased maternal and neonatal mortality and morbidity<sup>(4-6, 10-13)</sup>. Related complications include extension of uterine incision, maternal hemorrhage, intraoperative trauma to bladder or bowel, blood transfusion need, increase length of hospital stay, neonatal trauma, neonatal intensive care unit (NICU) admission, and perinatal asphyxia<sup>(13-15)</sup>.

At Siriraj Hospital, there is also an increasing trend of CS over the past many years and overall CS

rate is currently as high as 40-50%. However, there is still limited information on CS that was performed during the second stage of labor. In addition, the operation could also result in more serious complications than those performed during the first stage of labor. Therefore, the primary objective of this study was to determine the incidence of CS during the second stage of labor. In addition, possible risk factors as well as maternal and neonatal outcomes were evaluated. The information would provide additional information on CS rate and could lead to better decision-making process and care of pregnant women in the future.

## Materials and Methods

A retrospective cohort study was conducted at the Department of Obstetrics and Gynecology, Faculty of Medicine Siriraj Hospital after approval of Siriraj Institutional Review Board (SIRB). Sample size was estimated from approximate incidence of CS during second stage of labor of 13% of all CS. At 95% significance level and 5% allowable error and estimated 35% CS rate from a pilot study, at least 550 delivering women were required. As data were collected from all women during January to April 2021, a total of 636 women were included.

Singleton, term with cephalic presentation women in spontaneous or induced labor were included in this study. Women who were indicated for CS (e.g., previous CS, placenta previa, etc.) were excluded. Medical records of 636 pregnant women who delivered during January to April 2021 who met inclusion and exclusion criteria were retrieved and data were extracted. The second stage of labor was defined as the stage of labor that cervical dilatation reaches 10 cm.

Routine antenatal care according to institutional guideline was provided either by attending residents or staff. Universal gestational diabetes mellitus (GDM) screening was offered to all pregnant women using 50-gram glucose challenge test and 100-gram oral glucose tolerance test. Any antenatal complications were managed as appropriate according to specific

management guidelines. Intrapartum care was managed by attending residents under staff supervision. Progress of labor monitoring and interventions during labor, including artificial rupture of the membranes, use of oxytocin and analgesics, and decision of CS were performed according to institutional guideline, customized to each woman. Intrapartum ultrasonography was not routinely performed.

Data collection included baseline characteristics, antenatal care data, complications during pregnancy, labor characteristics, intrapartum care, mode of delivery, indication for cesarean section, operative data, and maternal and neonatal outcomes. Regarding indication for CS, cephalopelvic disproportion (CPD) was diagnosed according to institutional guideline, i.e., when there was abnormal labor progression (including protracted cervical dilatation, arrest of cervical dilatation, prolonged deceleration phase or prolonged second stage) with adequate uterine contraction for at least 2 hours. Pre-pregnancy body mass index (BMI) was calculated from pre-pregnancy weight in kg divided by squared height in meter. According to the Institute of Medicine, BMI were classified into underweight ( $< 18.5 \text{ kg/m}^2$ ), normal ( $18.5\text{-}24.9 \text{ kg/m}^2$ ), overweight ( $25\text{-}29.9 \text{ kg/m}^2$ ), and obesity ( $\geq 30 \text{ kg/m}^2$ ) and corresponding recommended gestational weight gain were 12.5-18 kg, 11.5-16 kg, 7-11.5 kg, and 5-9 kg, respectively<sup>(16)</sup>.

Data on perinatal outcomes included intraoperative complications, postpartum hemorrhage, uterine atony, neonatal birth weight birth asphyxia (Apgar score  $< 7$ ), and neonatal intensive care unit (NICU) admission. Incidence of CS during second stage of labor was estimated. Various characteristics were compared between different modes of delivery to determine associated factors. In addition, maternal and neonatal outcomes were also evaluated and compared between different modes of delivery.

Descriptive statistics were used to describe various variables as appropriate, including mean, standard deviation, number, and percentage. Chi square test and analysis of variance (ANOVA) with Tukey post hoc test were used for comparison of characteristics between different modes of delivery. A p value of  $< 0.05$  was considered statistically significant.

## Results

During the study period, there were 636 deliveries that met the inclusion criteria and were included in the analysis. Baseline characteristics of the women are shown in Table 1. The mean age was 29.4 years, mean pre-pregnancy BMI was  $22.5 \text{ kg/m}^2$ , 53.3% were nulliparous, and 22.8% were overweight or obese. Mean gestational weight gain was 13.8 kg and 34.7% gained weight above recommendation. GDM and preeclampsia were diagnosed in 13.8% and 11.3% respectively.

**Table 1.** Baseline characteristics of pregnant women

Characteristics	n (%)
Mean age $\pm$ SD (years)	29.4 $\pm$ 5.9
Mean BMI $\pm$ SD ( $\text{kg/m}^2$ )	22.5 $\pm$ 4.9
GA at first ANC $\pm$ SD (weeks)	11.4 $\pm$ 5.9
Mean gestational weight gain $\pm$ SD (kg)	13.8 $\pm$ 5.8
Nulliparous	339 (53.3)
BMI category	
Underweight	126 (19.8)
Normal	365 (57.4)
Overweight	97 (15.3)

Characteristics	n (%)
Obese	48 (7.5)
Gestational weight gain	
Below recommendation	176 (27.7)
Within recommendation	239 (37.6)
Above recommendation	221 (34.7)
GDM	88 (13.8)
Preeclampsia	72 (11.3)

SD: standard deviation, BMI: body mass index, GA: gestational age, ANC: antenatal care, GDM: gestational diabetes mellitus

Table 2 summarizes labor and delivery characteristics. Mean gestational age (GA) at delivery was 38.6 weeks of gestation. The majority (90.1%) of the women were in spontaneous labor 41.4% had cervical dilatation of  $\geq 5$  cm at admission. Artificial rupture of membranes, oxytocin infusion, and analgesic use were 53.8%, 54.4%, and 43.4%, respectively. Of the women included, 63 had induced labor (9.9%). Artificial rupture of membranes, oxytocin infusion, and analgesic use were 54%, 76.2%, and

45.2%, respectively. CS was performed in 181 women (28.5%) and CPD was the most common indication in 54.7%. CS during the second stage of labor occurred in 36 cases (5.7%). Of all CS, 80.1% occurred in 1<sup>st</sup> stage and 19.9% in 2<sup>nd</sup> stage of labor. In those with vaginal delivery, median duration of second stage of labor was 18 minutes and 35 (5.5%) were diagnosed with prolonged second stage and delivered by instrumental vaginal delivery (all were by vacuum extraction).

**Table 2.** Labor and delivery characteristics of the pregnant women (n = 636).

Characteristics	n (%)
Mean GA at delivery $\pm$ SD (weeks)	38.6 $\pm$ 1.1
Spontaneous of labor (n = 573)	
Cervical dilatation $\geq 5$ cm on admission	237 (41.4)
Artificial rupture of membranes	308 (53.8)
Oxytocin infusion	312 (54.4)
Analgesic use	249 (43.4)
Induction of labor (n = 63)	
Artificial rupture of membranes	34 (54)
Oxytocin infusion	48 (76.2)
Analgesic use	28 (45.2)
Delivery mode	
Vaginal delivery	420 (66)
Instrumental vaginal delivery <sup>b</sup>	35 (5.5)
Cesarean section	181 (28.5)
Second stage duration (n = 420)	
Median duration (min) (IQR)	18 (11, 35)
Prolonged second stage	35 (5.5)
Indication for CS (n = 181)	
CPD	99 (54.7)
Non-reassuring fetal heart rate	42 (23.2)
Others <sup>b</sup>	40 (22.1)
Stage of labor at CS (n = 181)	
1 <sup>st</sup> stage of labor	145 (80.1)
2 <sup>nd</sup> stage of labor	36 (19.9)

<sup>a</sup> All are vacuum extraction. <sup>b</sup> Includes prolonged rupture of membranes, failed induction, fetal macrosomia.

GA: gestational age, SD: standard deviation, CPD: cephalopelvic disproportion, CS: cesarean section, IQR: interquartile range

Table 3 shows a comparison of various characteristics between different modes of delivery. BMI was significantly higher in those with all CS ( $p < 0.001$ ), while gestational weight gain was comparable between groups. Those with CS were significantly more likely to be nulliparous and overweight

or obese. Those with 2<sup>nd</sup> stage CS were more likely to be overweight or obese, and to have gestational weight gain above recommendation compared to those with 1<sup>st</sup> stage CS and vaginal delivery. GDM was also significantly more common among those with CS but rates of preeclampsia were comparable.

**Table 3.** Comparison of various characteristics between different modes of delivery.

Characteristics	Vaginal n = 455	1 <sup>st</sup> stage CS n = 145	2 <sup>nd</sup> stage CS n = 36	p value
Mean age $\pm$ SD (years)	29.0 $\pm$ 5.9	30.1 $\pm$ 6.1	31.4 $\pm$ 4.7	0.018
Mean BMI $\pm$ SD (kg/m <sup>2</sup> )	22.0 $\pm$ 4.6	23.6 $\pm$ 5.4 <sup>a</sup>	24.2 $\pm$ 5 <sup>a</sup>	< 0.001
Mean GA at delivery $\pm$ SD (weeks)	38.1 $\pm$ 1.0	38.8 $\pm$ 1.1 <sup>b</sup>	38.8 $\pm$ 1.1	0.026
Mean gestational weight gain $\pm$ SD (kg)	13.8 $\pm$ 5.8	13.6 $\pm$ 5.9	15 $\pm$ 6.1	0.409
	n (%)	n (%)	n (%)	
Nulliparous	203 (44.6)	114 (78.6)	22 (61.1)	< 0.001
BMI category				0.002
Underweight	99 (21.8)	22 (15.1)	5 (13.9)	
Normal	270 (59.3)	81 (56)	14 (38.9)	
Overweight	59 (12.9)	27 (18.6)	11 (30.5)	
Obese	27 (6)	15 (10.3)	6 (16.7)	
Gestational weight gain				0.012
Below recommendation	133 (29.2)	39 (26.9)	4 (11.1)	
Within recommendation	178 (39.1)	50 (34.5)	11 (30.6)	
Above recommendation	144 (31.7)	56 (38.6)	21 (58.3)	
GDM	44 (9.7)	37 (25.5)	7 (19.4)	< 0.001
Preeclampsia	46 (10.1)	18 (12.4)	8 (22.2)	0.078

<sup>a</sup> significantly different from vaginal delivery ( $p = 0.001$  and  $0.019$  for 1<sup>st</sup> and 2<sup>nd</sup> stage CS)

<sup>b</sup>: Significantly different from vaginal delivery ( $p = 0.037$ )

CS: cesarean section, SD: standard deviation, BMI: body mass index, GA: gestational age, GDM: gestational diabetes mellitus

A comparison of labor and delivery characteristics are shown in Table 4. Those with CS were more likely to occur in women with induction of labor. Among those with spontaneous labor, cervical dilatation  $\geq 5$  cm on admission was significantly less common in those with CS. Artificial rupture of membranes were more common in CS both in those with spontaneous labor and induction of labor. In terms of indications for CS, CPD was significantly more likely in those with 2<sup>nd</sup> stage compared to 1<sup>st</sup>

stage CS (88.9% vs 46.2%,  $p < 0.001$ ).

Comparisons of maternal and neonatal outcomes are shown in Table 5. Those with 2<sup>nd</sup> stage CS had significantly higher birth weight than those with vaginal delivery. Rate of macrosomia was highest among those with 2<sup>nd</sup> stage CS with a significant linear trend. Birth asphyxia was significantly more common among those with 1<sup>st</sup> stage CS. Other outcomes were comparable between the 3 groups.



**Table 4.** Comparison of labor and delivery characteristics between different modes of delivery.

Characteristics	Vaginal n = 455 n (%)	1 <sup>st</sup> stage CS n = 145 n (%)	2 <sup>nd</sup> stage CS n = 36 n (%)	p value
Onset of labor				< 0.001
Spontaneous	423 (93)	118 (81.4)	32 (88.9)	
Induction	32 (7)	27 (18.6)	4 (11.1)	
Spontaneous of labor (n = 573)				
Artificial rupture of membranes	253 (59.8)	39 (33.1)	16 (50)	< 0.001
Cervical dilatation ≥ 5 cm on admission	202 (47.8)	25 (21.2)	10 (31.3)	< 0.001
Oxytocin use	246 (54.2)	88 (62.4)	23 (63.9)	0.15
Analgesic use	197 (43.3)	60 (42.9)	18 (50)	0.723
Induction of labor (n = 63)				
Artificial rupture of membranes	23 (71.9)	8 (29.6)	3 (75)	0.004
Oxytocin use	27 (84.4)	17 (63)	4 (100)	0.081
Analgesic use	17 (53.1)	8 (30.8)	3 (75)	0.109
Indication for CS (N=181)				< 0.001
CPD	-	67 (46.2)	32 (88.9)	
Non-reassuring fetal heart rate	-	38 (26.2)	4 (11.1)	
Others	-	40 (27.6)	0 (0)	

CS: cesarean section, CPD: cephalopelvic disproportion

**Table 5.** Comparison maternal and neonatal outcomes between different mode of delivery.

Outcomes	Vaginal n = 455 n (%)	1 <sup>st</sup> stage CS n = 145 n (%)	2 <sup>nd</sup> stage CS n = 36 n (%)	p value
Mean birth weight ± SD (g)	3051.2 ± 361.5	3131.7 ± 438.4	3244.2 ± 403.3a	0.003
Extension of uterine incision				< 0.001
Postpartum hemorrhage	423 (93)	118 (81.4)	32 (88.9)	
Uterine atony	32 (7)	27 (18.6)	4 (11.1)	
Birth weight for GA				
AGA	253 (59.8)	39 (33.1)	16 (50)	< 0.001
SGA	202 (47.8)	25 (21.2)	10 (31.3)	< 0.001
LGA	246 (54.2)	88 (62.4)	23 (63.9)	0.15
Macrosomia	197 (43.3)	60 (42.9)	18 (50)	0.723
Birth asphyxia				
NICU admission	23 (71.9)	8 (29.6)	3 (75)	0.004

<sup>a</sup> Significant difference compared to vaginal delivery (p = 0.01)<sup>b</sup> Significant linear trend (p = 0.003)

CS: cesarean section, SD: standard deviation, GA: gestational age, AGA: average for gestational age, SGA: small for gestational age, LGA: large for gestational age, NICU: neonatal intensive care unit

## Discussion

In this study, the overall CS rate was 28.5%. CS during second stage of labor occurred in 5.7% of all women, which contributed to 19.9% of all CS. The rate was higher compared with previous reports of 1.8-2.65% of all women<sup>(7, 10, 12, 13)</sup> and 4.8-5.6% of all CS<sup>(7, 10)</sup>. This might partly be due to differences in population characteristics and intrapartum care process between settings. Another important factor might be from the differences in the attempts of instrumental delivery.

A study in the United Kingdom observed a significant increasing trend of second-stage CS over a 30-year period that the rate increased from 0.5% in 1976 to 2.1% in 2006<sup>(4)</sup>. Similarly, a study in Ireland also reported that the rate of second-stage CS increased from 0.9% in 2006 to 1.8% in 2008<sup>(10)</sup>. More recent study also reported that the rate significantly increased by over a third in the ten-year period from 0.8% to 1.24%<sup>(11)</sup>. However, there was no observed trend over the 5 years from the other study in Australia<sup>(7)</sup>.

Previous studies reported that approximately 40% of women had CS during second stage of labor without a trial of instrumental delivery<sup>(7, 10)</sup>. However, in this study, all the women underwent second stage CS did not have instrumental delivery attempts and the majority were diagnosed with cephalopelvic disproportion. This might be from lack of competency in performing the operation due to inadequate training and experience as a decline in instrumental deliveries is observed over the past decade in our institution. The results also showed that instrumental deliveries occurred in only 5.5% of all women in this study. However, the use of instrumental delivery might not always be successful and might not reduce the rate of CS during second stage of labor as a previous study. The proportion of second stage CS because of failed instrumental delivery also increased from 59.1% in 1976 to 71.0% in 2006<sup>(4)</sup>. Whether the use of instrumental deliveries will decrease the rate of second stage CS could not be determined from this study and needs to be explored in future studies.

The results of this study showed that women with second stage CS were more likely to be overweight or obese and to have excessive gestational weight gain than those with vaginal delivery and CS during first stage of labor. Nulliparity was common among those with CS at any stage and more common in women delivered by CS during second stage of labor<sup>(7, 10, 11, 13)</sup>. Overweight and obesity as well as excessive gestational weight gain have been consistently reported to increase the risk of CS<sup>(17)</sup>. Both conditions could lead to abnormal labor progression, difficult delivery and increase the risk of CS. On the other hand, risk of CS was lowered among obese women who gained weight below the recommendation, without increased adverse neonatal outcomes<sup>(17, 18)</sup>. Therefore, appropriate weight gain during pregnancy could help reduce CS rate, both overall and during second stage of labor.

In terms of adverse maternal and neonatal outcomes, no serious complication was observed in this study. This was similar to a previous study in Singapore<sup>(6)</sup>. However, other previous studies reported increased adverse outcomes among those with CS during second stage of labor, including postpartum hemorrhage, need for blood transfusion, NICU admission<sup>(4, 10, 13)</sup>. Macrosomia was more common among those with second stage CS which was consistent with higher diagnosis of cephalopelvic disproportion. These women could have normal labor progression until they reached second stage of labor. On the other hand, birth asphyxia was more common in those with first stage CS. This could be related to the higher rate of non-reassuring fetal heart rate in this group. A previous study reported higher rate of macrosomia in second stage CS<sup>(15)</sup> and others reported increased in low cord blood arterial pH value and neonatal birth asphyxia<sup>(4, 13)</sup>. Moreover, some studies reported intraoperative complications, such as uterine trauma and uterine incision extension<sup>(6, 13)</sup>, such complications were not observed in this study. Some studies also reported that maternal and neonatal morbidities were comparable between those with second stage CS and instrumental



deliveries<sup>(11, 19)</sup>.

The limitations of this study included the retrospective nature of data that some information was missing. There was relatively small number of women delivered by CS during second stage of labor which could result in less valid and reliable comparisons of some variables between groups. Generalization of the results are also limited due to the study was conducted in a single tertiary care center. However, the strengths of this study might include that this was probably among a few studies in Thailand concerning CS rate during second stage of labor in relatively low risk pregnant women. In addition, diagnosis and decision to perform a CS were verified by consultation staff and based on intrapartum management guideline.

The results of this study could help in more understanding of the rate of second stage CS and related outcomes. Associated risk factors that were identified could help caring physicians raise their awareness or better forecast of the condition that might lead to better and timely decision to minimize risk of adverse outcomes.

Further evaluation of second stage CS is still needed in various aspects and in different contexts of care, including incidence, risk factors, and related adverse maternal and neonatal outcomes. Larger prospective studies could provide more details regarding these interesting aspects. The results would be helpful in raising awareness of care providers and planning better intrapartum care.

## Conclusion

In conclusion, the overall CS rate was 28.5%. CS during second stage of labor occurred in 5.7% of all women, which contributed to 19.9% of all CS. Most common indication was cephalopelvic disproportion. Those with second stage CS were more likely to be overweight and obese and to have excessive gestational weight gain. There were no significant serious adverse outcomes in women with second stage CS.

## Potential conflicts of interest

The authors declare no conflicts of interest.

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