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MATERNAL-FETAL MEDICINE

The impact of maternal obesity, age, pre-eclampsia and insulin dependent diabetes on severe maternal morbidity by mode of delivery—a register-based cohort study

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Abstract
Purpose To determine the rate of severe maternal morbidity related to delivery by delivery mode and to assess if the impact of studied risk factors varies by delivery mode.
Methods A register-based study including all women having singleton delivery in Finland in 2007–2011, $n = 292{,}253$, data derived from the Finnish Medical Birth Registry and Hospital Discharge Registry. Diagnoses and interventions indicating a severe maternal complication were searched and the mode of delivery was assessed by data linkage. The impact of obesity, maternal age 35 years or more, pre-eclampsia and insulin dependent diabetes on severe maternal morbidity (all severe complications, severe infections and severe) was studied in each mode of delivery and calculated as Odds ratios.
Results The overall incidence of severe complications was 12.8/1,000 deliveries. The total complication rate was lowest in vaginal deliveries (VD) in all risk groups. Obesity increased the risk for all severe complications and severe infections in the total population, but not significantly in specific delivery modes. Age increased the risk of hemorrhage in VD. Pre-eclampsia increased the risk for hemorrhage in all deliveries except elective CS. In women with pre-eclampsia, overall morbidity was similar in VD, attempted VD and elective CS. The presence of any studied risk factor increased the risk for complications within the risk groups by the high proportion of emergency CS performed.
Conclusions An attempt of VD is the safest way to deliver even for high-risk women with the exception of women with pre-eclampsia, who had a similar risk in an attempt of VD and elective CS.

Keywords Maternal morbidity · Delivery related · Cesarean section · Vaginal delivery · Mode of delivery

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Introduction

It has been estimated that up to 60 % of maternal deaths in Europe are due to substandard care and thus avoidable [1]. Several reports have recently been published claiming that severe maternal morbidity and also mortality have increased [2–4]. The occurrence of severe complications and near-miss events is low, but they still cause maternal deaths even in high-resource countries. The first step in decreasing severe maternal morbidity is to identify the possible causes and risk factors leading to these events. Identification of high-risk patients and timely recognition of threatening situations is crucial for preventing a cascade of malicious events that may lead to a near-miss event or even to maternal death.

Maternal mortality rates are low in high-resource countries, and the rate in Finland is among the lowest in the world (4.7/100,000 live births in 2006–2010, European Perinatal Health Report 2010). Still, in spite of advancements in medical care, there has been no improvement in maternal mortality rates in Finland during last 20–30 years.

In a previous study, we showed that severe maternal morbidity related to deliveries, in fact, increased between 1997 and 2002 in Finland [3]. It has been suggested that the increase in the rate of severe morbidity in some high-resource countries is caused by the increased rate of cesarean sections (CS) or the changes in the characteristics of the obstetric population, especially increased maternal age and increased obesity [2, 5]. Changes in the management of deliveries and the management of obstetric complications may also contribute to the increasing severe morbidity [1].

We know from previous studies that the risk for maternal complications is higher in CS than in vaginal deliveries (VD), and it is especially high in emergency CS [2, 4, 6–8]. Previous studies have shown that certain maternal characteristics (obesity, increasing age) and obstetric factors (e.g. pre-eclampsia) increase the risk of severe maternal complications related to CSs [1, 8, 9]. It has been highlighted that a CS is especially harmful to women with these risks. The impact of these factors on the maternal risks is less studied related to VD. Thus, the balance between risk and benefit for different delivery modes may be different for high-risk women compared to low-risk women.

In this study, we examine if known risk factors for severe maternal complications specifically related to delivery impact differently in different modes of delivery. The aim is to contribute in making well-informed decisions when planning the deliveries of high-risk women.

Materials and methods

The data were collected by combining the data from the national Medical Birth Registry and Hospital Discharge Registry provided by the National Institute for Health and Welfare (THL) of Finland. These registers collect data on all live births and stillbirths at least 22 weeks of gestation or a fetus weighing at least 500 g, deaths and hospital inpatient discharges, including all diagnoses set during pregnancy and birth and surgical procedures performed during the hospital stay. All singleton births in 2007–2011 were included in the study.

To select adequate diagnoses and interventions, we checked all the diagnoses given and interventions registered related to deliveries during the 5 years time and chose the ones indicating a severe complication during delivery and within 6 weeks after birth (Table 1). The diagnoses and surgical interventions recorded in the Hospital Discharge Registry were linked with the Birth Register data by using the encrypted individual national identification number of each woman. This provided a complete

Table 1 Diagnoses (ICD-10) and surgical interventions (Nordic Classification of Surgical Procedures) used as markers for severe maternal morbidity

Thromboembolic events
O87.1 DVT in puerperium (41)
O87.3 DVT in sinus durae in puerperium (9)
O88 Obstetric embolism (22)
I26.0, I26.9 Pulmonary embolism (110)
I63.6 DVT in cerebral vein, causing infarctation (16)
I80.1 DVT in v. femoralis (21)
I80.20 DVT in v.iliaca (15)
I80.29 DVT in other vein (29)
I81 DVT in vena portae (5)
I82.80 DVT in v. subclavia (5)
I82.88 DVT in other vein (32)
I82.29 DVT in vena cava (11)
Severe hemorrhage
O67.0 Hemorrhage with coagulation disorder (22)
O75.1 Obstetric shock (6)
Other severe complications
O71.0, O71.1 Uterine rupture (286)
O71.2 Uterine inversion (10)
O85 Puerperal sepsis (1887)
O74.0 Pneumonia, aspiration (9)
J80 ARDS (9)
J81 Pulmonary edema (7)
K65.0, K65.9 Peritonitis (14)
K56 Intestinal obstruction (56)
Surgical interventions for severe complications
PC7NT Embolisation of a.uterina (38)
PDT21 Embolisation of a.iliaca interna (15)
PG1PT Extensive embolisation (6)
PDC21 Ligation of a.iliaca interna (3)
PDC22 Ligation of a.iliaca externa (1)
MBB10 Tamponade of uterus (34)
LCC10 Subtotal hysterectomy (9)
LCD00 Total hysterectomy (14)
LCD96 Other hysterectomy (2)
MCW00 Hysterectomy related to a delivery (57)
MCA30 Cesarean section and subtotal hysterectomy (46)
MCA33 Cesarean section and total hysterectomy (20)
MWA00 Repair of wound dehiscence in obst. surgery (114)
MWC00 Reop. for deep infection in obstetric surgery (30)
LWA00 Repair of wound dehiscence in gyn.surgery 11 kpl
LWE00 Reop. for deep hemorrhage in gyn.surgery (28)
LWF00 Reop. for insufficiency of anastomosis or suture in gynecological surgery (15)
MWE00 Reop. for deep hemorrhage in obstetric surgery (173)
MWW96 Other reoperation in obstetric surgery (23)
JAH00 Explorative laparotomy (52)
JAH01 Explorative laparoscopy (19)

Table 1 continued

MCW96 Peripartum laparotomy (23)
Severe infection: O85, O74.0, MWC00, K65.0, K65.9 (selected cases of JAH00 and hysterectomy)
Severe hemorrhage: O67.0, O75.1, LWE00, LWF00, MWE00, JAH00 (selected cases), LCC10. LCD00, LCD96, MCW00, MCA30, MCA33, PC7NT, PDT21, PG1PT, PDC21, PDC22, MBB10

Number of cases registered in 2007–2011 related to delivery and within 42 days from delivery in parenthesis

overview of all severe complications occurring during the study years.

The following life-threatening conditions were included as severe maternal complications: thromboembolism (deep venous thrombosis, pulmonary embolism and amniotic fluid embolism), major infections (peritonitis, septic infection and re-operations because of infection), severe hemorrhage (hemorrhage requiring a hysterectomy, leading to re-operation, coagulation disorder or requiring embolization or ligation of uterine or iliac arteries or tamponade of the uterine cavity), and other events requiring surgical intervention after the delivery, uterine rupture, uterine inversion and intestinal obstruction (Table 1). The diagnoses related to thromboembolic events were included only if the woman had the diagnosis for the first time at the time of delivery and up to 42 days after the delivery, to exclude cases having occurred already during pregnancy.

The incidence of severe complications was assessed separately for VD (including spontaneous VD, instrumental VD and vaginal breech delivery), elective CS and emergency CS. CS was defined as elective or emergency CS by the obstetrician in charge. Usually a CS is defined as an emergency procedure if the membranes have broken, labor has started or the obstetric situation requires the CS to be performed within 12 h from the decision, but most often within 30 min from the decision. We also studied the incidence of severe complications in attempted VD including VD and emergency CS. The following risk factors for maternal complications were included: maternal obesity (body mass index (BMI) 30 or more, using the pre-pregnancy weight or the weight at the first visit at the maternity clinic), advanced age (35 years or more), pre-eclampsia (PE) (O14 in ICD-10) and insulin dependent diabetes mellitus (IDM) (O24.0 in ICD-10).

The incidence of severe complications was reported as the number of severe complications in 1,000 deliveries. The impact of the studied risk factors on the risk of all severe maternal complications, severe infections and severe hemorrhage was assessed and presented as Odds ratios (OR). The crude and adjusted ORs and confidence intervals (CI) for the risk of maternal morbidity were calculated for each risk group by mode of delivery (all deliveries, VDs, attempted VDs, elective CS and emergency CS) with a logistic regression analysis. The ORs were adjusted for maternal BMI, maternal age, PE, IDM, smoking and parity.

The study was approved by the Ethics Committee of the Hospital District of Southwest Finland. The National Institute for Health and Wellfare (THL) of Finland granted permission to use national register data (Dnro THL/1321/5.5.00/2010 and DnroTHL/1027/5.05.00/2013).

Results

There were 292,253 singleton deliveries in Finland in 2007–2011. The CS rate among these was 15.8 % during the study period. The proportion of emergency CS was 61.0 % of all CSs. The proportion of emergency CS varied markedly by risk group. The overall frequency of emergency CS was 9.7 %, but 15.6 % among women with BMI of 30 or more, 12.7 % among women aged 35 years or more, 53.1 % among women with PE and 41.2 % among women with IDM.

The average age at delivery was 30.1 years, and 53 048 women (18.2 %) delivered at an age of 35 years or more. There were 33,464 women with a BMI of more than 30, and 10,770 women with a BMI of more than 35, constituting 11.5 % and 3.7 % of all delivering women, respectively. PE was recorded in 0.8 % and type I diabetes mellitus (IDM) in 0.6 % of the study population.

The total incidence of severe maternal complications related to delivery was 12.8 in 1,000 singleton deliveries. The total complication rate was lowest in VD (10.2/1,000 deliveries) and highest in emergency CS (31.6/1,000 deliveries). In the total obstetric population, the incidence of severe hemorrhage was 1.4/1,000 deliveries and of severe infection was 8.1/1,000 deliveries (Table 2). The total complication rate was higher in all studied risk groups than in women without these risks, but the OR for the risk varied by risk group and delivery mode (Table 2).

Women with a BMI of 30 or more had an increased risk of severe birth related complications compared to women with a lower BMI. They had an increased risk for severe infections, but not for severe hemorrhage. The risk for infection increased least and non-significantly in VD and most in emergency CS (Table 2).

Women aged 35 years or more had a higher risk of severe hemorrhage than younger women, but a lower risk of severe infection. An increase in hemorrhage was seen among women having VD, but not in CS. A lower risk for severe infection compared to younger women was seen in all delivery modes (Table 2).

Pre-eclampsia increased the risk of all complications and specially the risk for severe hemorrhage. The increased

Table 2 Incidence of severe maternal complications, severe hemorrhage and severe infections/1,000 deliveries among all singleton deliveries and in specific risk groups in 2007–2011 ($n = 292,253$)

	All modes of delivery ($n = 291,886$)		VD ($n = 245,600$)		Attempted VD ($n = 273,839$)		Elective CS ($n = 18,047$)		Emergency CS ($n = 28,239$)	
	Incidence	OR (95 % CI)	Incidence	OR (95 % CI)	Incidence	OR (95 % CI)	Incidence	OR (95 % CI)	Incidence	OR (95 % CI)
All severe maternal complications, incidence/1,000 deliveries and the impact of each risk factor (OR)										
All women ($n = 292,253$)	12.8		10.2		12.4		18.0		31.6	
BMI ≥30 (11.5 %)	15.8	**OR 1.3 (1.2–1.4) $p < 0.0001$**	11.3	OR 1.1 (0.99–1.3)	15.1	**OR 1.2 (1.1–1.4) $p < 0.0001$**	22.6	OR 1.3 (0.98–1.7)	35.9	OR 1.1 (0.9–1.3)
Age ≥35v (18.2 %)	13.1	OR 1.0 (0.9–1.1)	9.4	**OR 0.9 (0.8–1.0) $p = 0.0499$**	12.4	OR 1.0 (0.9–1.1)	19.0	OR 1.0 (0.8–1.3)	33.3	OR 0.9 (0.8–1.1)
Pre-eclampsia (0.8 %)	23.3	**OR 1.8 (1.4–2.4) $p < 0.0001$**	15.5	OR 1.6 (0.97–2.7)	23.8	**OR 2.0 (1.5–2.6) $p < 0.0001$**	19.9	OR 1.1 (0.4–2.6)	31.1	OR 1.1 (0.8–1–5)
IDM (0.6 %)	15.7	OR 1.2 (0.8–1.7)	6.8	OR 0.7 (0.3–1.6)	15.1	OR 1.2 (0.8–1.9)	17.2	OR 0.8 (0.4–1.7)	27.1	OR 0.8 (0.5–1.4)
Severe infections, incidence/1,000 deliveries and the impact of each risk factor (OR)										
All women	8.1		7.8		8.1		7.0		11.0	
BMI ≥30	9.4	**OR 1.2 (1.1–1.4) $p = 0.001$**	8.7	OR 1.1 (0.99–1.3)	9.5	**OR 1.2 (1.1–1.4) $p = 0.003$**	9.2	OR 1.4 (0.9–2.1)	13.9	**OR 1.4 (1.03–1.8) $p = 0.029$**
Age ≥35v	6.6	**OR 0.8 (0.7–0.9) $p < 0.0001$**	6.4	**OR 0.8 (0.7–0.9) $p = 0.0005$**	6.6	**OR 0.8 (0.7–0.9) $p = 0.0001$**	6.6	OR 0.8 (0.6–1.3)	7.7	**OR 0.7 (0.5–0.95) $p = 0.021$**
Pre-eclampsia	6.8	OR 0.8 (0.5–1.3)	9.3	OR 1.2 (0.6–2.4)	6.8	OR 0.8 (0.5–1.4)	6.6	OR 0.5 (0.1–3.6)	4.6	OR 0.4 (0.2–1.002) $p = 0.0506$
IDM	7.3	OR 0.8 (0.5–1.5)	4.1	OR 0.5 (0.2–1.6)	8.0	OR 1.0 (0.5–1.8)	5.7	OR 0.5 (0.1–2.1)	13.5	OR 1.3 (0.6–2.7)
Severe hemorrhage, incidence/1,000 deliveries and the impact of each risk factor (OR)										
All women	1.4		0.6		1.2		4.6		5.9	
BMI ≥30	1.7	OR 1.2 (0.9–1.6)	0.6	OR 0.9 (0.6–1.6)	1.4	OR 1.2 (0.9–1.6)	4.3	OR 0.9 (0.5–1.6)	5.9	OR 0.9 (0.6–1.4)
Age ≥35v	1.9	**OR 1.5 (1.2–1.9) $p = 0.0005$**	0.9	**OR 1.7 (1.1–2.5) $p = 0.008$**	1.5	**OR 1.5 (1.1–2.0) $p = 0.003$**	5.0	OR 1.1 (0.7–1.8)	6.1	OR 0.9 (0.6–1.4)
Pre-eclampsia	9.3	**OR 6.9 (4.4–10.7) $p < 0.0001$**	5.2	**OR 9.5 (3.8–23.3) $p < 0.0001$**	10.2	**OR 8.6 (5.5–13.5) $p < 0.0001$**	3.3	OR 0.9 (0.2–6.7)	14.6	**OR 2.9 (1.7–4.9) $p < 0.0001$**
IDM	1.7	OR 0.8 (0.5–1.5)	0	NA	1.6	OR 1.0 (0.2–4.0)	1.9	OR 0.5 (0.1–3.3)	3.9	OR 0.6 (0.2–2.4)

Incidences reported in all deliveries and separately in vaginal deliveries, attempted vaginal deliveries, elective cesarean sections and emergency cesarean sections. Impact of specific risk factors calculated as Odds Ratios with 95 % confidence intervals, women in risk groups compared to women without the specific risk, adjusted for maternal BMI, age, pre-eclampsia, IDM, smoking and parity

Table 3 Risk for severe complications in elective CS compared to VD and in elective CS compared to attempted VD for all women and women with BMI ≥30, age ≥35 years, pre-eclampsia and IDM

		Crude OR	95 % confidence interval	Adjusted OR	95 % confidence interval
Elective CS compared to VD					
All deliveries	All complications	1.8	1.6–2.0	**1.8**	**1.6–2.0**
					***p* < 0.001**
	Infections	0.9	0.8–1.1	0.9	0.8–1.1
					$p = 0.414$
	Hemorrhage	7.4	5.6–9.6	**6.6**	**5.0–8.8**
					***p* < 0.0001**
BMI ≥30	All complications	2.0	1.6–2.7	**2.1**	**1.6–2.7**
					***p* < 0.0001**
	Infections	1.1	0.7–1.6	1.2	0.8–1.7
					$p = 0.458$
	Hemorrhage	6.9	3.3–14.3	**6.7**	**3.2–14.2**
					***p* < 0.0001**
Age ≥35 years	All complications	2.0	1.6–2.6	**2.0**	**1.6–2.5**
					***p* < 0.0001**
	Infections	1.0	0.7–1.5	1.0	0.7–1.4
					$p = 0.839$
	Hemorrhage	5.7	3.5–9.4	**5.5**	**3.2–9.2**
					***p* < 0.0001**
Pre-eclampsia	All complications	1.3	0.5–3.4	1.2	0.4–3.4
					$p = 0.733$
	Infections	0.7	0.2–3.3	0.4	0.1–3.3
					$p = 0.402$
	Hemorrhage	0.6	0.1–5.5	0.7	0.1–5.9
					$p = 0.724$
IDM	All complications	2.6	0.9–7.7	**2.2**	**1.6–2.9**
					***p* < 0.0001**
	Infections	1.4	0.3–7.0	1.5	0.99–2.2
					$p = 0.058$
	Hemorrhage	NA		NA	
Elective CS compared to attempted VD					
All deliveries	All complications	1.5	1.3–1.6	**1.4**	**1.2–1.6**
					***p* < 0.0001**
	Infections	0.9	0.7–1.0	0.9	0.7–1.1
					$p = 0.171$
	Hemorrhage	3.9	3.1–5.0	**3.4**	**2.6–4.4**
					***p* < 0.0001**
BMI ≥30	All complications	1.5	1.2–2.0	**1.5**	**1.2–1.9**
					***p* = 0.002**
	Infections	1.0	0.7–1.4	1.1	0.7–1.6
					$p = 0.796$
	Hemorrhage	3.3	1.6–5.5	**2.8**	**1.5-5.3**
					***p* = 0.001**

Table 3 continued

		Crude OR	95 % confidence interval	Adjusted OR	95 % confidence interval
Age ≥35 years	All complications	1.5	1.2–1.9	**1.5**	**1.2–1.8**
					***p* = 0.001**
	Infections	1.0	0.7–1.4	0.9	0.6–1.4
					$p = 0.718$
	Hemorrhage	3.3	2.1–5.1	**3.1**	**2.0–4.94**
					***p* < 0.0001**
Pre-eclampsia	All complications	0.8	0.4–2.0	0.7	0.3–1.7
					$p = 0.419$
	Infections	1.0	0.2–4.3	0.6	0.1–4.2
					$p = 0.568$
	Hemorrhage	0.3	0.04–2.4	0.3	0.04–2.1
					$p = 0.210$
IDM	All complications	1.1	0.5–2.5	**1.5**	**1.2–2.0**
					***p* = 0.003**
	Infections	0.7	0.2–2.6	1.3	0.9–2.0
					$p = 0.156$
	Hemorrhage	1.2	0.1–13.3	1.7	0.8–3.6
					$p = 0.202$

The ORs with confidence intervals calculated by adjusting for maternal BMI, age, pre-eclampsia, insulin dependent DM, smoking and parity

risk is seen in VDs and emergency CSs, but not in elective CS. The risk for severe infection was similar or lower for women with PE than in women without PE (Table 2).

The presence of IDM did not increase any of the studied complications significantly in specific delivery modes. When elective CS was compared to VD or attempted VD among women with IDM, the risk for complications was significantly higher in elective CS, the adjusted OR for severe complications being 2.2 (1.6–2.9) and 1.5 (1.2–2.0), respectively (Table 3).

When comparing the risks related to elective CS to VD, the adjusted OR varies by risk group from 1.8 to 2.2 for all severe complications, and from 3.8 to 6.6 for severe hemorrhage, except for women with PE who have similar risk in all delivery modes. When comparing the risks related to elective CS to attempted VD, the adjusted OR varies by risk group from 1.4 to 1.5 for all complications and from 1.7 to 3.4 for hemorrhage, except for women with PE, who have, again, similar risks in all delivery modes.

Deep venous thrombosis (DVT) occurred in 131 deliveries (0.45/1,000 deliveries), more often after CS (0.8/1,000 deliveries in elective CS and 1.0/1,000 in emergency CS) than in VD (0.4/1,000 deliveries) ($p < 0.0001$). DVT was especially frequent after crash-emergency CS, 2/1,000 deliveries. DVT occurred also significantly more often in all studied risk groups than in women without these risks. The OR of DVT was 3.9 (95 % CI 1.4–10.5) for women with PE compared to women without PE, and 1.5 fold for women with IDM compared to women without IDM (OR 1.3, 95 % CI 0.2–9.0). DVT increased by increasing BMI from 0.3/1,000 deliveries in women with a BMI below 20–0.9/1,000 in women with a BMI of 35 or more ($p = 0.0217$). The frequency of DVT increased also by age, from 0.4/1,000 in women aged less than 35 years to 1.3 in women aged 40 years or more.

Discussion

The incidence of severe delivery related complications was higher in CSs than in VD and the total complication risk was higher in all risk groups than in women without these risks, but the impact of the risk factors varied by risk factor and by delivery mode. The risk was actually even lower for some risk patients compared to patients not having the risk factor. To our knowledge, the safety of different delivery modes for high risk patients has not been studied as comprehensively before.

The incidence of severe complications was also higher in elective CS when compared to attempted VD. This finding is in line with our previous study published in 2008 and with several other studies [4, 6, 7, 10].

One of the strengths of this study is the high degree of coverage of the used Finnish registers. All deliveries in Finland take place in public hospitals, and data on maternal health, obstetric history, events during the delivery and data on the newborn are comprehensively recorded in the Birth Register. A cohort including all singleton births

during 5-year time constitutes an adequately sized population for subgroup analyses.

On the other hand, a register-based study lacks detailed individual data on several factors that may confound the results. We adjusted the ORs for maternal complications for maternal BMI, maternal age, PE, IDM, smoking and parity. There may be more factors affecting the results. Use of antimicrobial- and antithrombotic-prophylaxis varies in Finnish delivery units[8], and this may have impact on the results, but this information is not available in the registers and could not be taken into account.

The total incidence of severe delivery related complications was somewhat higher, 12.8/1,000 deliveries, than in studies by Zwart et al. or Waterstone et al., 6.4/1,000 and 7.4/1,000, respectively [1, 9]. The differences are probably rather due to different definitions of severe morbidity and variation in the data collection methods than to true medical reasons. In all these studies, CS was related to a two to fourfold risk of a severe delivery related maternal complication compared to VD.

The most marked difference in the occurrence of severe complications between these studies is the difference in the incidence of sepsis. Sepsis was the most common severe complication in our study (6.5/1,000, Table 1), while it was less common, 0.2/1,000 in the Dutch study and 0.4/1,000 in the British study [1, 9]. In the study by Waterstone, only severe sepsis with signs of organ failure, hypoperfusion or hypotension was included, while we included all patients with septic fever and bacteremia (positive blood cultures). Lack of a uniform definition of sepsis makes comparisons between different studies unreliable [11].

The impact of maternal obesity on obstetric complications has been studied extensively. In addition to an increased risk of pregnancy complications, there are also more problems related to the deliveries of obese women. An attempt of VD is resulting in emergency CS more often among obese women than women of normal weight [12, 16]. The rate of complications increases linearly with the BMI [17].

In this study, obesity increased the rate of severe infections in the groups of all deliveries and emergency CS, but not significantly in the group of elective CS. In previous studies, infections have been more common in obese women even related to elective CS, despite prophylactic antibiotics [12, 13]. An increased risk of endometritis and wound infections and a twofold increased risk of sepsis have been reported [8, 12, 13, 18].

Several studies show, that obese women have a higher risk of obstetric hemorrhage than women with normal weight [12, 15, 16]. These studies have included all hemorrhages exceeding 1,000–1,500 ml, whereas in our study only hemorrhages that required hysterectomy or re-operation were included. In this study obesity did not increase the occurrence of severe hemorrhage. Also a Dutch study documented that obesity increased severe acute maternal morbidity in a dose dependent manner, but there was no association with major obstetric hemorrhage [19]. Many studies do not separate the different modes of delivery, but Fyfe et al. did study postpartum hemorrhage in obese women related to CS and VD and reported that the risk for postpartum hemorrhage increased 1.7-fold in CS and 2.1-fold in VD [15]. It is well known that the risk of DVT is increased in obese women in all stages of pregnancy and postpartum and this was also the case in the present study [13].

Many studies have showed higher prevalence of pregnancy related problems, worse perinatal outcomes and increased risk for cesarean sections, both elective and non-elective, among women with increasing age compared to younger women. A higher risk of thromboembolic events related to obesity and advanced maternal age related to CS have also been reported [20]. The impact of age on delivery related complications has been less studied. Kuklina et al. studied severe maternal complications related to delivery and observed a pattern of increasing rates of each complication with increasing maternal age [2]. A Belgian study reports a higher maternal mortality rate for women aged over 35 and 40 compared to younger women. The maternal deaths are usually preceded by occurrence of a severe maternal complication eventually leading to death [21].

Pre-eclampsia is a severe obstetric problem with sequels both for the neonate and the mother. It is one of the leading causes of maternal death worldwide, even in some high-resource countries [3]. Maternal death due to PE is extremely rare in Finland, but PE is a frequent cause of severe maternal morbidity and as seen in this study, PE increases significantly the risk of severe delivery-related hemorrhage. This was also shown in a Norwegian population-study, where women with PE had 2.1 times more postpartum hemorrhage exceeding 1,500 ml compared to women with no PE, and the increase concerned as well CS as VD [22].

The excessive risk for both neonatal and maternal complications and an increased risk for a CS among women with IDM have been reported in many studies. The impact of IDM on complications directly related to delivery is much less studied. Acosta et al. studied the incidence of sepsis and severe sepsis in a birth cohort of 1,622,474 in California, and reported that IDM was a risk factor for septic infection to progress into severe sepsis [14]. In a USA study on IDM women having CS after labor or rupture of membranes, the postoperative infection rate after antimicrobial prophylaxis was similar to that of non-diabetic women [23]. In the present study, women with IDM had a similar rate of any type of severe complications as did non-diabetic women (Table 2).

The more the emergency CSs are performed, the higher is the complication rate among women attempting VD. The

emergency CS rate was extremely high among women with PE and IDM (53.1 and 41.2 %, respectively). Women with PE had less severe complications in elective CS than in attempted VD, though the difference was not significant. In the most severe forms of PE the decision to deliver is made promptly, and the CS is often categorized as an emergency procedure. Although the CS is performed without the woman being in labor, complications of these women end up in the group of emergency CS and attempted VD, and this may distort the results. To define the safest delivery mode for these patients it needs further investigation.

To decrease severe maternal complications, not only elective CS should be decreased, but also the criteria to proceed from an attempted VD to an emergency CS should be scrutinized. We should contemplate, if the high rate of CS in these risk groups could be safely decreased with a change in management policies.

Conclusion

The impact of the studied obstetric risk factors on the occurrence of life-threatening maternal complications vary by delivery mode and by risk group. In all groups, except women with pre-eclampsia, VD is the safest way to deliver and should be attempted whenever possible.

Conflict of interest We declare that we have no conflict of interest.

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