Full length article

A Swedish register-based study exploring primary postpartum hemorrhage in 405 936 full term vaginal births between 2005 and 2015

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ABSTRACT

Objective: To explore diagnoses of postpartum haemorrhage following vaginal birth, in relation to socio-demographic and obstetrical data from women who gave birth at term, in Sweden, during the years 2005–2015.

Study design: A register-based cohort study was carried out, describing and comparing socio-demographic variables, obstetric variables and infant variables in 52 367 cases of diagnosed postpartum haemorrhage compared to 353 569 controls without a postpartum haemorrhage diagnosis. Postpartum haemorrhage was identified in The Swedish Medical Birth Register by ICD-10 code O72. Variables for maternal characteristics were dichotomized and used to calculate odds ratios to find possible explanatory variables for postpartum haemorrhage.

Results: Between 2005 and 2015 there was no statistically significant decrease in diagnoses of postpartum haemorrhage after vaginal birth at term. Primiparity was associated with the highest risk and women birthing their fifth or subsequent child were associated with the lowest risk of postpartum hemorrhage. Increased maternal age (> 35 years) and/or obesity (BMI > 30) were associated with higher odds of postpartum haemorrhage. The risk of postpartum hemorrhage was 55% higher when vaginal birth followed induction as compared to vaginal birth after spontaneous onset. Some of the factors known to be associated with postpartum haemorrhage were poorly documented in The Swedish Medical Birth Register.

Conclusions: Birthing women in a Swedish contemporary setting are, despite efforts to improve care, still at risk of birth being complicated by postpartum haemorrhage. Primiparity, increasing maternal age and/or obesity are found to provoke an increased risk and the reasons for these findings need to be further investigated. However, grand multi-parity did not increase the risk for postpartum hemorrhage. Codes for diagnoses require correct documentation in the birth records: only when local statistics are sound and correctly reported can intrapartum care be improved, and the incidence of postpartum haemorrhage reduced.

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Introduction

Despite decades of medical development within childbirth care, high-income countries continue to report an increase in postpartum haemorrhage (PPH) 1000 mL [1]. In high income countries, the risk of fatal outcomes associated with PPH is low. However, there is an increased risk for reproductive ill-health and psychological morbidity due to traumatic experiences associated with PPH [2]. PPH delays bonding and initiation of breastfeeding [3].

In addition, PPH prolongs hospital stay thus increasing healthcare costs [4]. According to The World Health Organization (WHO) blood loss <1000 mL does not affect healthy women [5]. Since 1997 Sweden has used ≥ 1000 mL as the cut-off point for a diagnosis of PPH in accordance with the International Classification of Disease (ICD) -10 diagnoses codes [6]. The lack of consensus on a global definition of PPH makes it difficult to compare research results between countries [1,7]. In Sweden midwives are the primary caregivers during normal labour and birth. A prophylactic injection of synthetic oxytocin is recommended for all women. Up
to two hours after the birth of the placenta, blood loss is visually assessed and only precisely measured when blood loss is considered to be excessive.

The Swedish Medical Birth Register (MBR) is a national health data register, managed and regulated by the Swedish authorities, that has collected mandatory health data since 1973 and includes data on almost all births [8]. The Nordic Obstetric Surveillance study reporting obstetric complications found that Sweden was the only Nordic country where information about PPH was not available and the necessity of uniform definitions and valid reporting to enable international comparisons was highlighted [9]. Public health care is similarly organized in the Nordic countries; maternity care is funded by taxes and there are national birth registers [10]. A study presenting the rates and causes of PPH in Sweden would thus enable future comparison between findings in these neighbouring countries. The aim, therefore, was to explore diagnoses of postpartum hemorrhage following vaginal birth, in relation to socio-demographic and obstetrical data from women who gave birth at term in Sweden.

Materials and methods

Study design

This is a cohort study based on register data retrieved from the MBR and contains information on maternal characteristics, reproductive history, obstetric diagnosis and complications during pregnancy, birth and the postpartum period [11]. PPH was identified in MBR by ICD-10 code O72.

Study population

The sample constituted 221 159 women who gave vaginal birth to 405 936 infants from gestational week ≥ 37 + 0 and onwards between 2005 and 2015. The women could have given birth several times during the observation period and each pregnancy was in this context treated as ‘one birth. Spontaneous and induced births were included, as were births by ventouse and forceps. Cesarean births (CS), multiple and premature births, stillbirths and births of infants with congenital malformations were excluded. Due to the inclusion- and exclusion criteria, it was not possible to present an exact prevalence rate for PPH in all women giving vaginal birth.

Outcome variables

The primary outcome variable was PPH ≥ 1000 mL. All ICD-10 codes in O72 were treated as one variable and dichotomized into blood loss < 1000 mL or ≥1000 mL. Data included maternal country of birth, maternal age, civil status, Body Mass Index (BMI), tobacco use during pregnancy, parity, previous CS, previous PPH, maternal hypertention and diabetes. Obstetric variables included onset of labour, artificial rupture of membranes (ARM), labour augmentation, labour dystocia, prolonged labour, epidural analgesia (EDA), pyrexia > 38.5°C, episiotomy, anal sphincter rupture, mode of birth and manual removal of placenta. Infant variables included gestational age, presentation at birth, infant gender, birth weight and head circumference.

During the study period the procedure codes for augmentation and IOL with synthetic oxytocin were revised and replaced with new codes. This resulted in difficulties retrieving complete data and hindered correlation analyses in relation to PPH and the administration of synthetic oxytocin during labour and birth.

Statistical analyses

Regression analyses were used to test the association between the dichotomised PPH variable and maternal socio-demographic characteristics and obstetrical variables. Crude and adjusted odds ratios (OR) were calculated for maternal socio-demographic characteristics (Table 2) that were potential confounders. The year of birth was entered as a continuous variable in accordance with a linear secular trend, and all other variables were entered as categorical variables. Data were analyzed using SPSS (Statistics for Windows, Version 25.0, IBM Corp., Armonk, NY, USA).

Results

A total of 52 367 (12.9%) births were considered as cases and 353 569 (87.1%) were considered as controls. In 2005, a total of 13.5% of the women included in the study suffered PPH and by 2015 this figure was 13.7%. This is not a statistically significant increase (Table 1).

A majority (70.7%) of the women gave birth between the ages of 25 and 35 years, mean 29.8 (SD ± 5.08), and mean BMI at the first antenatal visit was 24.5 (SD ± 4.5). More than 94% of the women were married or co-habiting in early pregnancy and 77.4% were born in Sweden. Previous CS was reported in 17 547 (4.3%) women. Maternal diabetes and civil status were not associated with PPH. Maternal age below 25 years, a BMI less than 18, use of tobacco during pregnancy and grand multiparity (GMP) were all associated with lower odds for a PPH diagnosis. Maternal age ≥ 35 years, BMI of ≥ 30, primiparity, previous PPH, previous CS and maternal hypertension were associated with higher odds for a PPH diagnosis. Maternal birth country outside of Sweden was also associated with increased odds for PPH (Table 2).

A comparison of obstetrical outcomes between cases and controls is shown in Table 3. Spontaneous onset of labour and birth occurring in gestational weeks 37–38 and infant birth weight ≤ 3500 g significantly decreased the likelihood for a PPH diagnosis. Breech presentation was also associated with significantly lower odds for PPH. Induction of labour (IOL), ARM, EDA, maternal pyrexia above 38.5°C, labour dystocia at any time during labour and birth, synthetic oxytocin infusion for augmentation of labour, instrumental birth, episiotomy, sphincter rupture, manual removal of placenta, occipito–posterior position of the fetal head, infant weight > 4000 g and infant head circumference > 35 cm were all associated with higher odds for a PPH diagnosis.

Crude and adjusted OR for parity and a PPH diagnosis is displayed in Table 4. Compared to the second vaginal birth, the first birth was associated with a 59% elevated risk for PPH. The association with PPH declined with the increasing number of vaginal births.

Discussion

The main finding was that in a cohort of vaginal births the reporting of PPH did not decrease in Sweden between the years 2005–2015. It seems reasonable, considering the time and effort
Table 2

<table>
<thead>
<tr>
<th>Blood loss &lt; 1000 mL</th>
<th>Blood loss ≥ 1000 mL</th>
<th>Crude Odds Ratio (95 % CI)</th>
<th>Adjusted** Odds Ratio (95 % CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>353,569 (100)</td>
<td>52367 (100)</td>
<td>0.79 (0.77–0.81)</td>
<td>0.70 (0.68–0.72)</td>
</tr>
</tbody>
</table>

Age groups
- < 25: 56576 (16.0)
- 25–35: 250660 (70.7)
- >35: 46933 (13.3)

Missing = 0 (0 %)

Maternal BMI
- <18: 4755 (1.4)
- 18–25: 207944 (63.4)
- 25–30: 78784 (24.0)
- >30: 33620 (11.2)

Missing = 29.290 (72.2 %)

Maternal hypertension

Married/Cohabiting
- Married/Cohabiting: 318663 (94.3)
- Single: 19280 (5.7)

Missing = 18.052 (4.4 %)

Country of birth
- Sweden: 274950 (77.8)
- Not Sweden: 77960 (22.1)

Missing = 736 (0.2 %)

Parity
- Primiparity: 148016 (41.9)
- Multiparity (2–4): 201911 (57.1)
- Grand multiparity (≥ 5): 3642 (1.0)

Missing = 0 (0 %)

Previous Caesarean Section (Yes)†
- Yes: 13462 (3.8)

Previous PPH (Yes)‡
- Yes: 15519 (7.5)

Maternal Diabetes (Yes)‡
- Yes: 1243 (0.4)

Tobacco use in pregnancy (Yes)‡
- Yes: 17614 (5.3)

* Reference = women not having not exposed to the studied variables.
** Adjusted to all variables in the table.

dedicated to research on and improvement of childbirth care, to have expected a decrease in cases of PPH. In recent years many obstetrical units in Sweden have provided in-service training for their staff in advanced life-saving obstetrics (ALSO). In 2015 and onwards (to 2022) the Swedish government has earmarked 7.5 million Euros for the improvement of childbirth care. In view of these and other measures it is an important finding that the occurrence of PPH has not improved in Sweden. Since this study was not specifically designed to explore the temporal trend in PPH and our report excludes CS, a known cause of PPH, we can only speculate as to the cause of these results. Lack of improvement in PPH statistics may be associated with an increase in interventions, for instance augmentation of labour and IOL. The prevalence of IOL in all births in Sweden increased during the same time period reported in this study from 10.8%–16.3%, which is equivalent to a 50.9 % increase [8]. The intention of IOL is to improve outcomes for the mother and infant. Despite this humanitarian stance on the part of health professionals, iatrogenic mechanisms caused by the intervention itself have been repeatedly reported in the scientific literature [12]. As early as 1978 Brinsden & Clark [13] reported that PPH was a complication that needed to be taken seriously when considering IOL. More than 40 years later PPH is still a serious complication following IOL. Women should be made fully aware of potential risks when considering an IOL, in particular when a true medical indication is lacking.

The fact that primiparity is a risk factor for PPH has been reported recurrently in earlier research and our findings reinforce this. However, reasons for this are not fully understood [14] and may be attributed to a wide range of causes. It has been found that tissue samples from the myometrium of primiparous women showed a decreased response in terms of contractility to both ergometrine and oxytocin in comparison to samples from multiparous women [15]. Both long labour and oxytocin augmentation are factors associated with PPH and it is well known that primiparous women have longer labours, which in part explains the use of synthetic oxytocin in this group. It may be argued that the increased risk of PPH in primiparous women is due to an increased risk of being subjected to a cascade of interventions during labour and birth [16]. The body produces peak levels of oxytocin when a healthy woman has the possibility to labour, give birth, meet her newborn baby skin to skin and initiate breastfeeding without disturbance or medical intervention [17]. This suggests that undisturbed labour and birth may reduce the risk of PPH in first-time mothers. In a hectic labour ward with shortage in staffing levels, midwives have limited possibilities to provide non-stressed, optimal, individualized and evidence-based care for birthing women: important factors, in particular for first time mothers.

In the present study it was also shown that grand multiparity (GMP) was not associated with an elevated risk for PPH compared to the second birth. This finding is in line with previously reported studies [18–20]. However, in textbooks and guidelines for midwives and obstetricians there remain a prevailing pre-conception that GMP is associated with an elevated risk for PPH. This preconception, probably based on the Irish obstetrician Beth Solomons expression “the dangerous multipara” coined in the mid-1930: [21], promotes a more aggressive approach to the third stage of labour, which may result in excessive, unnecessary or inappropriate use of obstetric interventions. Solomons based his assumption about GMP and PPH on potential physiological changes (thinning) of the uterine wall as a risk factor for PPH. In view of present results, it may be proposed that GMP in conjunction with a healthy pregnancy and without previous adverse obstetric outcomes, is not directly associated with an elevated risk for PPH, which is a finding worthy of note.

Both increased maternal BMI at antenatal booking and increasing maternal age (>35 years) increased the risk for PPH...
in the present study. Blomberg et al. [22] reported that PPH was attributable to atomic bleeding which increased linearly as BMI increased, a result also described in a recent meta-analysis [14]. It is suggested that obesity can cause ineffective uterine contractions. However, an in vitro study concluded that human uterine contractility is unaffected by increasing BMI [23]. It has been discussed whether a general negative attitude towards obese women by health professionals directly influences clinical decision-making and subsequent care [24]. Obese women are commonly viewed as problematic and decisions to proceed to interventions are made much earlier compared to non-obese women, thus impeding obese women from optimizing their chances for normal birth [24].

Although we have shown that both maternal age more than 35 years and primiparity are risk factors for PPH, it remains unclear why this is so in a country with adequate care during pregnancy, birth and the postpartum period. In a meta-analysis it was shown that the risk for PPH is minimal in mothers aged 35 years or older, due to good general health and effective healthcare systems [14]. Others suggest that advanced maternal age serves merely as a

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**Table 3**


<table>
<thead>
<tr>
<th>Blood loss ≥ 1000 mL</th>
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<tr>
<td><strong>n (%)</strong></td>
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</tr>
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<td>52367 (100)</td>
<td>353569 (100)</td>
</tr>
</tbody>
</table>

- **Spontaneous start (Yes)**: 309313 (87.5)
- **Artificial rupture of membranes (Yes)**: 26989 (7.6)
- **Epidural Analgesia (Yes)**: 110949 (31.4)
- **Fever > 38.5° (Yes)**: 1566 (0.4)
- **ICD-10 codes for labour dystocia (Yes)**: 3060 (0.9)

- **Primary inadequate contractions (O62.0)**: 5673 (1.6)
- **Secondary uterine inertia (O62.1)**: 20072 (5.7)
- **Prolonged first stage of labour (O63.0)**: 177 (0.1)
- **Prolonged second stage of labour (O63.1)**: 3737 (0.9)
- **Augmentation/induction with synthetic oxytocin (Yes)**: 13862 (3.9)

### Birth mode vaginal

- **Spontaneous birth**: 324586 (91.8)
- **V/E Forceps**: 28983 (8.2)
- **Missing = 0 (%)**: 7992 (15.3)
- **Missing = 0 (%)**: 0.0

### Epiotomy (Yes)

- 21772 (6.2)

### Anal sphincter rupture third and fourth degree (Yes)

- 10486 (3.0)

### Manual removal of placenta (Yes)

- 2944 (0.8)

### Gestational age

- 37–38 full weeks: 55629 (15.7)
- 39 to 42 weeks of gestation and beyond: 297940 (84.3)

### Infant sex

- **Female**: 172415 (48.8)
- **Male**: 181154 (51.2)

### Fetal position

- **Cephalic OA**: 335586 (96.2)
- **Cephalic OP**: 12602 (3.6)
- **Breech**: 637 (0.2)

### Infant birthweight

- **< 3500 g**: 151891 (43.0)
- **3500–4000 g**: 13541 (38.3)
- **4001–4500 g**: 54590 (15.4)
- **≥ 4500 g**: 11453 (3.2)

### Head circumference

- **< 35**: 220664 (63.4)
- **≥ 35**: 127697 (36.6)

### Parity and total number of births (%)

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- **First birth, 174 851 (43.1)**: 148 016 (81.9)
- **Second birth, 155 524 (38.3)**: 137 824 (87.2)
- **Third birth, 52 915 (13.0)**: 47 378 (88.3)
- **Fourth birth, 13 915 (3.4)**: 12 481 (88.5)
- **Fifth or more births, 8 731 (2.2)**: 7 870 (89.1)

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1. Reference = women not having not exposed to the studied variables.

2. Adjusted to maternal characteristics.

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**Table 4**

PPH in relation to parity in 405 936 full term vaginal births.

<table>
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<tr>
<th>Parity and total number of births (%)</th>
<th>Blood loss &lt; 1000 mL</th>
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1. Adjusted for maternal age, previous PPH, VBAC, prolonged labour, augmentation during labour and birth and manual removal of placenta.

2. GMP defined here as five or more births, in accordance with the International Federation of Gynecology and Obstetrics (FIGO).
surrogate factor [25] and that iatrogenesis could be the answer to why age and parity appear as risk factors. It is necessary that we discard the lack of trust in women’s ability to birth and the medical environment that we provide for birthing women, if we wish to reduce the risk for PPH.

**Strengths and limitations**

The present study is based on data collected from the MBR, which has high coverage and validity: this is a major strength of the register [6]. However, some of the factors associated with PPH were poorly documented in MBR. For instance, the diagnosis code for atomic uterus was only attributed to 44.5% of the causes behind PPH, a figure that normally is cited as being about 70% [8]. It is possible however, that this reflects alert and proper management of a potential PPH, reducing the incidence of an atomic uterus diagnosis in this Swedish context. Notwithstanding this supposition, a recent study on practical PPH team training did not detect any improvements concerning estimated blood loss, Hb levels or red blood cell transfusions despite improved clinical management of blood loss after birth [26]. Labour dystocia and the use of synthetic oxytocin are confounding variables, which were both found to be poorly documented and this may have affected the results. The absence of registered blood loss in millilitres in the MBR made it impossible to report exact blood loss measurements such as the number of women with a blood loss of 500 ml or more, which is often acknowledged as PPH in research studies and guidelines globally.

An important methodological limitation is that in large data sets, such as the present one, small differences in outcomes may become statistically significant without clinical relevance. The timespan from 2005 to 2015 was chosen for convenience and because it made possible detection of differences in PPH outcomes in relation to national recommendations for augmentation of labour and birth, which were implemented in 2011. However, due to the poor documentation of administration of synthetic oxytocin in the data set, the reporting of this was limited. Further research will be necessary to enable development and testing of logistic regression models that can predict risks for PPH.

**Conclusions**

In conclusion, this register-based cohort study showed that the rate of PPH in vaginal births did not decrease in Sweden during the years 2005–2015. The causes behind these findings are complex and not fully understood. Considering the governmental efforts to improve childbirth care a new epidemiological study on PPH including all births is warranted just as an in-depth understanding of why maternal age over 35 years and obesity are still associated with an increased risk and the reasons for this need to be further investigated. Of importance was the finding that grand multiparity was not associated with higher odds for a PPH diagnosis. Codes for diagnoses require correct documentation in the birth records: only when local statistics are sound and correctly reported can intrapartum care be improved and the incidence of PPH reduced.

**Declaration of Competing Interest**

The authors report no declarations of interest.

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**References**