

1 **Prevalence and risk factors of severe postpartum hemorrhage: a retrospective cohort study**

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11 **Abstract**

12 **Background:** Although maternal deaths are rare in developed regions, the morbidity associated
13 with severe postpartum hemorrhage remains a major problem. To provide new insight into severe
14 postpartum hemorrhage, we analyzed data of women giving birth in Guangzhou Medical Centre for
15 Critical Pregnant Women, which received a large quantity of critically ill obstetric patients from
16 other hospitals of Southern China.

17 **Methods:** In this study, we conducted a retrospective cohort by using the criteria of severe maternal
18 morbidities, which was defined by estimation of blood loss volume and use of blood transfusion ≥ 4
19 units, to determine the prevalence, risk factors and short-term complications of severe postpartum
20 hemorrhage.

21 **Results:** Severe postpartum hemorrhage was observed in 532 mothers (1.56%) among the total
22 population of 34 178 mothers. Placental related cause (55.83%) was the major identified cause of
23 severe postpartum hemorrhage, while uterine atony without associated retention of placental tissues
24 accounted for 38.91%. The risk factors for severe postpartum hemorrhage were maternal age < 18
25 years, previous cesarean section, history of postpartum hemorrhage, conception through in vitro
26 fertilization, pre-delivery anemia, stillbirth, prolonged labor, placenta previa, placental abruption,
27 placenta accrete spectrum and macrosomia. The prevalence rates of admission to ICU, hysterectomy,
28 acute renal failure and sepsis were significantly higher in women with severe postpartum
29 hemorrhage.

30 **Conclusion:** The results of this study suggested that severe postpartum hemorrhage could be
31 adopted as an indicator to assess the quality of obstetric care because of its severity and potential
32 lethality. Extra vigilance during the antenatal and peripartum periods is needed to identify women

33 who have risk factors and enable early intervention to prevent severe postpartum hemorrhage. It's
34 important to remember that we have to prepare for all mothers giving birth, as some get severe
35 postpartum hemorrhage without any known risk factors.

36 **Keywords:** Postpartum hemorrhage, Causes, Risk factors, Short-term complications

37 **Background**

38 Severe postpartum hemorrhage (SPPH) is the leading cause of maternal deaths and severe
39 maternal morbidities, which accounts for almost one fifth of maternal deaths worldwide, ranging
40 from 8% in developed areas to 32% in Northern Africa [1]. The incidence of postpartum
41 hemorrhage (PPH) ranges from 3% to 8% and continues to increase in recent years [2-4]. Severe
42 complications such as hemorrhagic shock, acute respiratory distress syndrome, disseminated
43 intravascular coagulation, acute renal failure, loss of fertility, pituitary necrosis (Sheehan
44 syndrome), and even maternal death may be caused by delayed recognition or an improper clinical
45 procedure.

46 The reported prevalence of SPPH varied, and was influenced by the definition, case
47 ascertainment, clinical management and characteristics of the population. There are several
48 definitions of PPH in use, and no single satisfactory definition exists. Commonly used definitions

49 of postpartum hemorrhage are based on estimations of blood loss within 24h of childbirth [5, 6].
50 The severity of PPH, however, depends not only on volume, but also on the rate of blood loss,
51 physical conditions, physiological response to bleeding and medical conditions, making women
52 more vulnerable to decompensation with bleeding around delivery [7, 8]. On the other hand, the
53 inaccuracy estimation of blood loss suggests that PPH may not be fully diagnosed.

54 Although maternal deaths are rare in developed regions, the morbidity associated with SPPH
55 remains a major problem. Therefore, SPPH is still an indicator to assess the quality of obstetric
56 care in developed areas. Although severe obstetric hemorrhage may develop unexpectedly, many
57 studies have attempted to alert doctors to severe obstetric hemorrhage by identifying specific high-
58 risk factors for PPH. These factors include previous cesarean delivery, hypertensive disorders of
59 pregnancy, fibroids, placenta previa, etc. [4, 9-11].

60 To provide new insight into SPPH, we analyzed a retrospective cohort of women giving birth
61 in Guangzhou Medical Centre for Critical Pregnant Women, which received a large quantity of
62 critically ill obstetric patients from other hospitals of Southern China. In this study, we used the
63 criteria of severe maternal morbidities [12], which was defined by estimation of blood loss volume

64 and use of blood transfusion ≥ 4 units, to determine the prevalence, risk factors and short-term
65 complications of SPPH.

66 **Methods**

67 **Study population**

68 We used data on all women giving birth after 28 weeks of gestation in The Third Affiliated
69 Hospital of Guangzhou Medical University (Guangzhou Medical Centre for Critical Pregnant
70 Women) from January 2015 to August 2019 (34 178 mothers). From this population, we identified
71 532 cases of SPPH. SPPH was defined as a visually estimated blood loss exceeding 1000mL within
72 24h of childbirth, and women received either ≥ 4 units of RBCs or a multicomponent blood
73 transfusion. The deadline for eventual blood transfusion was the time of discharge. A
74 multicomponent blood transfusion was defined as blood transfusion consisting of a combination of
75 RBCs and fresh frozen plasma and/or platelet concentrates. Controls were a random sample from
76 the same source of population and period, comprising a total of 33 646 mothers.

77 Based on a review of the relevant literature and clinical plausibility, we formulated a set of 27
78 candidate risk factors on maternal characteristics and comorbidities that potentially contributed to
79 increased risk of SPPH. We restricted our analysis of potential risk factors that would likely be

80 identifiable during the antepartum period up to the time of admission for delivery and were not
81 complications developed during the delivery admission. We defined the presence of each condition
82 as having one or more corresponding codes during this period. In the study population of 34 178
83 mothers, there were 844 women excluded in the risk factor analysis because of an incomplete
84 information (Figure 1). All diagnoses were identified by the presence of a diagnostic codes from
85 the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM).
86 Surgical procedures were identified using surgical codes.

87 The explanatory variables (explained in Appendix) included demographic, pre-gestational
88 medical and obstetric-related factors. The demographic characteristics were as follows: age of
89 delivery, history of cesarean delivery, parity, body mass index (BMI) before pregnancy and history
90 of PPH. The pre-gestational medical variables were defined as medical diseases prior to pregnancy,
91 and diseases including chronic hypertension, pre-gestational diabetes mellitus (PGDM) and cardiac
92 diseases. The pregnancy-related variables were identified directly in ticked boxes, such as in vitro
93 fertilization (IVF), regular or irregular prenatal examination, singleton or twins, hypertensive
94 disorders of pregnancy, HELLP syndrome, gestational diabetes mellitus (GDM), fibroids, anemia,
95 thrombocytopenia, blood coagulation disorder, stillbirth, placenta previa, placenta abruption,

96 placenta accrete spectrum (PAS) and macrosomia. The labor-related obstetric variables included
97 induction of labor, prolonged labor, precipitate labor and mode of delivery.

98 Meanwhile, short-term postpartum complications, such as admission to ICU, hysterectomy,
99 acute renal failure, sepsis and maternal death were analyzed between the SPPH group and controls.

100 **Statistical analysis**

101 Prevalence and causes of SPPH were expressed as number (n) and percentage (% or ‰).
102 Cross-tabulations were used to show the proportions of demographic, medical and obstetric factors
103 in women with SPPH and controls. Univariate logistic analysis was done to assess candidate
104 variables as risk factors for SPPH, and the associations between potential risk factors and SPPH
105 was quantified by the OR and 95% confidence interval (CI). All explanatory variables with a
106 significance level of $P < 0.05$ in univariate analysis were included in multivariate logistic analysis
107 using a fully stepwise selection algorithm. In consideration of previous reports and clinical
108 plausibility, we especially included twins, thrombocytopenia, blood coagulation disorder,
109 precipitate labor and macrosomia in multivariate analysis, despite $P \geq 0.05$ in univariate analysis.
110 Finally, cross-tabulation and odds ratios were used to calculate differences in the frequency of severe

111 postpartum complications between mothers with SPPH and controls. The data were analyzed with
112 SPSS version 24. Statistical significance was judged as $P < 0.05$.

113 **Results**

114 SPPH was observed in 532 mothers (1.56%) among the total population of 34 178 mothers.
115 The causes of SPPH are showed in Figure 2. Placental related cause (55.83%) was the primary
116 identified cause of SPPH, while uterine atony without associated retention of placental tissues
117 accounted for 38.91%. Trauma and coagulopathy could be identified for 2.82% and 1.13% of the
118 SPPH cases, respectively.

119 **Risk factors of SPPH**

120 The study population comprised a total of 506 cases of SPPH and 32 828 controls without
121 SPPH. The distribution of potential risk factors was presented in Table 1. In the univariate analysis,
122 SPPH was more likely among mothers with the following characteristics: ≥ 35 y, multipara, history
123 of PPH, previous cesarean delivery, conception through IVF, irregular prenatal examination, GDM,
124 anemia, stillbirth, prolonged labor, cesarean section, placental previa, placental abruption and PAS.

Table 1 Clinical profile of women with SPPH versus controls

SPPH(n=506)	Controls (n=32 828)	OR	95%CI	<i>P</i>
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Maternal age (y)

<18	1 (0.20%)	20 (0.06%)	3.99	0.53-29.84	0.177
18-34.9	318 (62.85%)	25389 (77.34%)	Ref.		
35-39.9	149 (29.45%)	5883 (17.92%)	2.02	1.66-2.46	<0.001
≥40	38 (7.51%)	1536 (4.68%)	1.98	1.41-2.78	<0.001

Parity

0	138 (27.27%)	17913 (54.57%)	Ref.		
1-2	355 (70.16%)	14698 (44.77%)	3.14	2.57-3.82	<0.001
≥3	13 (2.57%)	217 (0.66%)	7.78	4.34-13.95	<0.001

Previous cesarean delivery

302 (59.68%)	6323 (19.26%)	6.21	5.19-7.43	<0.001
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BMI (kg/m²)

<18.5	41 (8.10%)	3239 (9.87%)	0.83	0.60-1.14	0.250
18.5-24.9	354 (69.96%)	23107 (70.39%)	Ref.		
25-29.9	91 (17.98%)	5531 (16.85%)	1.07	0.85-1.36	0.547
≥30	20 (3.95%)	951 (2.90%)	1.37	0.87-2.16	0.172

History of PPH

20 (3.95%)	161 (0.49%)	8.35	5.20-13.40	<0.001
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Chronic hypertension	0 (0.00%)	79 (0.24%)	0.00	0.00	0.977
PGDM	0 (0.00%)	248 (0.76%)	0.00	0.00	0.995
Cardiac disease	8 (1.58%)	354 (1.08%)	1.47	0.73-2.99	0.282
IVF	84 (16.60%)	4283 (13.05%)	1.33	1.05-1.68	0.019
Irregular prenatal examination	282 (55.73%)	15524 (47.29%)	1.40	1.18-1.68	<0.001
Twins	34 (6.72%)	2186 (6.66%)	1.01	0.71-1.43	0.957
Hypertensive disorders of pregnancy					
Gestational hypertension	15 (2.96%)	706 (2.15%)	1.40	0.83-2.36	0.203
Preeclampsia	26 (5.14%)	1422 (4.33%)	1.21	0.81-1.80	0.356
Eclampsia	0 (0.00%)	18 (0.05%)	0.00	0.00	0.999
HELLP syndrome	2 (0.40%)	68 (0.21%)	1.91	0.47-7.82	0.367
GDM	105 (20.75%)	5369 (16.35%)	1.34	1.08-1.66	0.008
Fibroids	5 (0.99%)	172 (0.52%)	1.90	0.78-4.63	0.161
Anemia	158 (31.23%)	2954 (9.00%)	4.59	3.79-5.56	<0.001
Thrombocytopenia	6 (1.13%)	317 (0.97%)	1.23	0.55-2.77	0.617
Blood coagulation disorder	2 (0.40%)	43 (0.13%)	3.03	0.73-12.52	0.127

Stillbirth	7 (1.38%)	132 (0.40%)	3.48	1.62-7.47	0.001
Induction of labor	22 (4.35%)	3045 (9.28%)	0.45	0.29-0.68	<0.001
Prolonged labor	18 (3.56%)	583 (1.78%)	2.04	1.27-3.29	0.003
Precipitate labor	1 (0.20%)	219 (0.67%)	0.30	0.04-2.11	0.223
Mode of delivery					
Vaginal delivery	370 (73.12%)	27780 (84.62%)	Ref.		
Cesarean section	136 (26.88%)	5408 (16.47%)	2.02	1.66-2.47	<0.001
Placenta previa	311 (61.46%)	1392 (4.24%)	36.02	29.88-43.42	<0.001
Placental abruption	11 (2.17%)	337 (1.03%)	2.14	1.17-3.93	0.014
PAS	283 (55.93%)	1076 (3.28%)	37.45	31.10-45.09	<0.001
Macrosomia	41 (8.10%)	2553 (7.78%)	1.05	0.76-1.44	0.79

126 Risk factors independently associated with SPPH were showed in Table 2. The risk of SPPH

127 increased significantly as age<18y (adjusted ratio (aOR)=11.52). The risk of mothers who had

128 history of PPH and previous cesarean section elevated, and the aOR was 4.94 and 2.57, respectively.

129 Placental factors were associated with SPPH significantly; placental previa had the highest adjusted

130 odds ratio of SPPH (9.75), followed by PAS (8.00) and placental abruption (3.85). Other obstetric

131 risk factors were prolonged labor (aOR=5.24), stillbirth (aOR=2.61), anemia (aOR=2.37),
 132 macrosomia (aOR=2.30), and IVF (aOR=1.78). Besides, cesarean section was a protective factor in
 133 this study, which had an aOR of 0.58.

134 **Table 2** Multivariable logistic model for SPPH

Independent risk factors	Adjusted OR	95% CI	<i>P</i>
Maternal age<18y	11.52	1.51-87.62	0.018
Previous cesarean section	2.57	1.90-3.47	<0.001
History of PPH	4.94	2.63-9.29	<0.001
IVF	1.78	1.31-2.43	<0.001
Anemia	2.37	1.88-3.00	<0.001
Stillbirth	2.61	1.02-6.69	0.045
Prolonged labor	5.24	3.10-8.86	<0.001
Cesarean section	0.58	0.46-0.74	<0.001
Placenta previa	9.75	7.45-12.75	<0.001
Placental abruption	3.85	1.91-7.76	<0.001
PAS	8.00	6.20-10.33	<0.001

Macrosomia	2.30	1.38-3.83	0.001
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135 **Maternal morbidity of SPPH**

136 The prevalence rates of admission to ICU, hysterectomy, acute renal failure and sepsis were
137 significantly higher in women with SPPH (Table 3). SPPH increased the prevalence of admission
138 to ICU and hysterectomy by 8.97 and 180.37 times, respectively. Meanwhile, the risk of acute renal
139 failure and sepsis elevated by 31.74 and 6.53 times in SPPH group. During the period of the present
140 study, only one woman with SPPH developed to death (1.9‰), and eight women in controls (0.2‰).
141 Severe postpartum hemorrhage accounted for 11.11% of maternal deaths, and there were no
142 statistically significant differences between the two groups in maternal mortality.

Table 3 Association between SPPH and severe postpartum complications

postpartum complication	SPPH(n=532)		Controls (n=33 646)		OR	95%CI	P
	No.	Percentage (‰)	No.	Percentage (‰)			
ICU admission	39	73.3	294	8.7	8.97	6.35-12.68	<0.01
Hysterectomy	109	204.9	48	1.4	180.37	126.75-256.67	<0.01
Acute renal failure	2	3.8	4	0.1	31.74	5.80-173.65	<0.01
Sepsis	4	7.5	39	1.2	6.53	2.33-18.33	<0.01

144 **Discussion**

145 **Prevalence of SPPH**

146 In our study, the prevalence of SPPH was 1.56%, which was following a known prevalence
147 of 0.3-5.1% [4, 10, 11, 13]. The incidence of SPPH varied among reports, which might be partly
148 due to different definitions, discrepancies of areas and recording practices. The most commonly
149 accepted definition of PPH is based on the amount of blood loss after birth. The WHO recommends
150 visual estimation of blood loss as the standard for blood loss measurement; yet, visual estimate
151 underestimates blood loss volume by 33-50% when compared with spectrophotometry [14, 15]. We
152 used a cutoff for SPPH of blood loss volume ≥ 1000 mL and blood transfusions ≥ 4 units to make our
153 results more reliable. Most of the previous studies included pregnancies from 24 weeks, while our
154 study consisted of mothers from 28 weeks. Such factors might explain the different prevalence in
155 our population.

156 Common causes of PPH are uterine atony, placental cause, trauma and failure of the blood
157 coagulation system. In our study, uterine atony without other associated causes was identified in
158 only 38.91% of mothers, which was much lower than the reported prevalence of 70-80% [4, 16, 17].
159 Meanwhile, abnormal placentation was responsible for the majority (55.83%) of SPPH, which was

160 much higher than the previously reported prevalence of 10% [4, 17]. This might be explained by
161 our rules of classification and the special population in our hospital. In our study, women who had
162 atony due to retained placental tissues were categorized in the group of placental related cause. For
163 another reason, our hospital was Guangzhou Medical Centre for Critical Pregnant Women, which
164 received a large quantity of critically ill obstetric patients transferred from other hospitals of
165 Southern China, including a high proportion of PAS and dangerous placenta previa. As previous
166 studies reported, the prevalence of PAS and placenta previa were 0.1-11 per 1000 deliveries and 5.5
167 per 1000 deliveries, respectively [18]. In our study, there were 306 mothers (57.52%) with PAS and
168 332 cases (62.41%) with placenta previa in SPPH group, which were much higher than other
169 hospitals. Our findings suggested that placental related cause might be a more prominent cause of
170 SPPH than previous reports. Trauma accounted for only 2.82%, which was less than the figure
171 reported of 20% [11]. This could be partly due to proper obstetric care though labor and vaginal
172 delivery procedures. Coagulopathy prevalence was relatively in accordance with a known
173 prevalence of 1% [11].

174 **Risk factors for SPPH**

175 The risk factors for SPPH were maternal age<18y, previous cesarean section, history of PPH,
176 conception through IVF, pre-delivery anemia, stillbirth, prolonged labor, placenta previa, placent
177 abruption, PAS and macrosomia. Previous cesarean section, pre-delivery anemia, stillbirth, prolong
178 labor and macrosomia were associated with SPPH, which were compatible with previous reports [4,
179 9-11, 19-21]. With antenatal anemia affecting up to 25% pregnant women, initiatives may be
180 necessary to promote anemia correction [22]. Severe societies, including The Royal College of
181 Obstetricians and Gynecologists (UK) and the French College of Gynecologists and Obstetricians,
182 have published PPH guidelines recommending that a hemoglobin level above 8g/dL is a therapeutic
183 goal [23]. Macrosomia is known to over-distend the uterus which is associated with uterine atony.
184 Macrosomia is an increasingly common lifestyle problem needing public health intervention, and
185 is associated with high BMI, elderly pregnant women and diabetes mellitus [24, 25].

186 Numerous studies have reported that elderly maternal age (≥ 35 y or ≥ 40 y) was a risk factor of
187 PPH, while few studies suggested that young age might be a risk factor as well [26]. In our study,
188 the results showed that elderly maternal age (≥ 35 y) increased the incidence of SPPH in univariate
189 analysis. Nevertheless, maternal age<18y was actually associated with increased SPPH. Women
190 with a history of PPH had 4.94-fold increased odds of SPPH. Likewise, a study from Australia

191 reported a recurrence rate of 28% from medical audits [27]. A study from Sweden reported that the
192 recurrence of PPH might be explained by environmental and genetic factors [28]. The risk of SPPH
193 elevated in women who conceived through IVF, which was in accordance with previous studies.
194 Zhu et al. reported that placental adherence occurred more frequently in a group after using assisted
195 reproductive technology [29].

196 Our study showed that cesarean section was associated with SPPH, together with an increased
197 incidence of SPPH in the univariate analysis. However, the risk of SPPH decreased by 43% in
198 women with cesarean delivery in the multivariate model. The protective effect of cesarean section
199 was contrary to the results in most previous studies. However, a few studies reported the protective
200 effect of cesarean section against PPH when compared with vaginal births [30]. Our study showed
201 that the risk of SPPH elevated significantly for women with placenta previa, placental abruption
202 and PAS, which was consistent with previous studies [4, 9-11, 19-21]. Placenta related factors
203 contributed significantly to severe forms of PPH, such as PPH with blood transfusion and PPH with
204 hysterectomy.

205 **Short-term postpartum morbidities associated with SPPH**

206 Among women with SPPH, the higher frequencies of admission to ICU, peripartum
207 hysterectomy, acute renal failure and sepsis reflected the severity and potential lethality of this
208 complication. Mothers with SPPH had 6.53 times the risk of sepsis compared with controls. The
209 association between SPPH and sepsis is partly explained by underlying factors or procedures such
210 as prolonged labor, manual removal of placenta, injuries and surgical interventions to stop bleeding
211 [31]. In addition, the consequent anemia increases the risk of postpartum infections and
212 consequently sepsis. The risk of acute renal was 31.74 times higher in mothers with SPPH, implying
213 the severe hypoperfusion of organs. In our study, the rate of maternal death increased in SPPH group
214 (1.9‰) compared with controls (0.2‰), but there was no statistical difference between the two
215 groups. Only one mother developed to death because of SPPH, which might get benefit from the
216 early-warning system and rapid response team we established. The high rates of emergency
217 peripartum hysterectomy and admission to ICU in SPPH were evidence that mothers were
218 associated with severe morbidity. It is clear that SPPH affects the mothers, their newborns, families
219 and the finances of the healthcare system.

220 **Strengths and limitations**

221 Our study has two strengths, as well as some limitations. First, a large cohort of women in
222 Guangzhou Medical Centre for Critical Pregnant Women ensured an obstetric critical representative
223 sample of Southern China. Second, we diagnosed SPPH by combining blood loss volume with blood
224 transfusion to minimize selection bias, thus analyzed the causes, risk factors and complications of
225 SPPH comprehensively and objectively.

226 The limitation of our study was the absence of data on instrumental/spontaneous vaginal
227 delivery and emergency/elective cesarean section. Although surgery codes existed for forceps,
228 vacuum, assisted breech and emergency or elective cesarean section, the operations sometimes were
229 coded by other broader surgery codes and thus failed to identify the substantial proportion of
230 different modes of delivery, which prevented us from studying the contribution of delivery mode to
231 the occurrence of SPPH. For another, we did not analyze the impact of smoking or drinking to SPPH,
232 since it was rarely among our population. Absolutely, assessing risk factors in retrospect was also a
233 limitation in our study.

234 **Conclusions**

235 The results of this study suggested that SPPH could be adopted as an indicator to assess the
236 quality of obstetric care because of its severity and potential lethality. Maternal age<18y, previous

237 cesarean section, history of PPH, conception through IVF, pre-delivery anemia, stillbirth, prolonged
238 labor, placenta previa, placental abruption, PAS and macrosomia were risk factors of SPPH. Extra
239 vigilance during the antenatal and peripartum periods is needed to identify women who have risk
240 factors and enable early intervention to prevent SPPH. It's important to remember that we have to
241 prepare for all mothers giving birth, as some get SPPH without any known risk factors.

242 **Figure1** Profile of the study population

243 **Figure 2** Causes of severe postpartum hemorrhage

244 **Abbreviations**

245 PPH: Postpartum hemorrhage; SPPH: Severe postpartum hemorrhage; PAS: placenta accrete
246 spectrum; GDM: gestational diabetes mellitus; PGDM: pre-gestational diabetes mellitus; BMI:
247 Body mass index; HELLP: Hemolysis elevated liver enzymes, low platelet count; IVF: In vitro
248 fertilization; OR: Odds ratio; aOR: adjusted odds ratio; CI: Confidence interval

249 **Ethics approval and consent to participate**

250 The study was approved by the medical research ethics committee of the third affiliated hospital of
251 Guangzhou Medical University. The approval reference number is 2020107. All information
252 obtained from the patients' medical records was anonymized and de-identified prior to analysis.

253 **Consent for publication**

254 Not applicable.

255 **Availability of data and materials**

256 The datasets used and/or analyzed during the current study are available from the corresponding
257 authors on reasonable request.

258 **Competing interests**

259 The authors declare that they have no competing interests.

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263 **Author contributions**

264 Fang He and Dunjin Chen were responsible for conception, study design and approved the final
265 version. Chenning Liu and Fubing Yu monitored data collection, analyzed the data, drafted and
266 revised the paper. Yunzhe Chen, Jinsheng Li and Zhihong Guan collected data. Mana Sun and
267 Chenan Liu analyzed the data.

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277 Appendix. Part of variables investigated in analysis

Variable	Explanation
Maternal age (y)	age of delivery; categorized into four groups: <18, 18-34.9, 35-39.9 and ≥ 40 years.
Parity	grouped into no previous deliveries (0), 1-2 previous deliveries, and ≥ 3 previous deliveries.
BMI (kg/m ²)	low weight <18.5; normal: 18.5-24.9; overweight: 25-29.9; obesity ≥ 30 .

Hypertensive disorders of pregnancy	categorized into gestational hypertension, preeclampsia and eclampsia; gestational hypertension was defined as only if she did not have codes for pre-existing hypertension or preeclampsia or eclampsia.
Anemia	hemoglobin<9g/dL before delivery.
Thrombocytopenia	platelet count<100*10 ⁹ /L.
Prolonged labor	prolonged first stage of labor was determined as deviation of cervical dilatation from the normal rate of 1 cm/hour in the active phase or slow progress of the descent of the presenting part through birth canal; prolonged second stage of labor was>1hour from complete cervical dilation to delivery if multiparous and>2hours between complete cervical dilation and delivery if nulliparous.
Precipitate labor	3 hours or less from the onset of regular contractions to birth.
Macrosomia	substituted by a birthweight of ≥4kg.

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