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1 **Title**

2 Impact of maternal age on intrapartum caesarean delivery rate in nulliparas with spontaneous
3 labour

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14

15

16 **Abstract**

17 **Background:** The advanced maternal age rate increases in developed countries. Older
18 women have more pre-existing condition than youngest women and develop more frequently
19 obstetrical pathologies responsible for a higher rate of caesarean delivery before labour and
20 labour induction. For aged nulliparous without pathology who experience spontaneous
21 labour, there is few data on the mode of delivery and on physiological labour according to
22 maternal age.

23 **Objective:** To compare the intrapartum caesarean delivery rate according to maternal age, for
24 nulliparous with planned vaginal delivery and spontaneous labour at term.

25 **Methods:** Retrospective cohort in a single academic institution between January 2000 and
26 June 2017. All nulliparous women with planned vaginal delivery with live singleton in
27 cephalic presentation at and after 37 weeks of gestation with spontaneous labour were
28 included (n=10,611). Two groups were compared: nulliparous women aged 20 to 34 and
29 nulliparous women aged 35 and over. The main outcome was the intrapartum caesarean
30 delivery rate. A subgroup analysis was performed for nulliparous with more advanced
31 maternal age defined as women over 40.

32 **Results:** Among the 10,611 women included in this analysis, 8,993 (84.8%) were aged 20 to
33 34 and 1,618 (15.2%) were aged over 35. From the latter 367 (22.7%) were over 40 years old.
34 The intrapartum caesarean delivery rate was similar between women aged between 20 and 34
35 and women aged over 35 (10.8% compared to 8.8%; cOR 0.91, 95% CI 0.76-1.08; aOR 0.91,
36 95% CI 0.76-1.09). The indications of caesarean were similar in both groups. No differences
37 were found between both groups for mean labour duration (430.9 min for the [20-34] years
38 group compared to 428.0 min for the over 35 years group, p=0.654). The subgroup analysis
39 performed on nulliparous with more advanced maternal age yielded similar results.

40 **Conclusion:** For nulliparous at term in spontaneous labour, an advanced maternal age was
41 not associated with an increased intrapartum caesarean delivery rate.

42

43 **Keywords**

44 Nulliparous, caesarean delivery, duration of labour, labour outcome, advanced maternal age,
45 trial of labour

46

47

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50 commercial, or not-for-profit sectors.

51

52 **Introduction**

53 Advanced maternal age has been defined as an age ≥ 35 years at the time of delivery. The
54 proportion of births in women aged 35 and over has been steadily rising in recent years in
55 developed countries [1–3]. In France it accounted for about 21.3% of all births in 2016
56 compared with 15.9% in 2003 [2]. The increased caesarean rate observed recently has been
57 explained by the increased maternal age. Indeed pregnancy among older women is associated
58 with a variety of adverse obstetric diseases [4–6] partly because these women have pre-
59 existing medical conditions. These latter are responsible for a higher rate of planned
60 caesarean before labor and induction of labor. In this population of aged women, the
61 induction of labor has been associated with a high rate of failure and so of caesarean [7]. A
62 biologic plausibility was advanced to explain that: the aged uterus function differently in
63 labor, contributing to labor dysfunction and ultimately to a caesarean delivery [8–10].

64 Aged parturients constitute a heterogenous group stratified by different obstetrical
65 complications and modes of onset of labour. Indeed, few studies analyzed the physiological
66 labour outcomes for women without pathology requiring a planned caesarean or a labour
67 induction[11,12]. Furthermore, very few studies stratify the risk of caesarean delivery by
68 parity and even fewer studies report whether a trial of labour was attempted[13,14].

69 Our aim was to compare the intrapartum caesarean delivery rate between nulliparous aged
70 over 35 and nulliparous aged 20 to 34, with planned vaginal delivery and spontaneous labour
71 at term.

72

73 **Material and methods.**

74 **Study population**

75 Using hospital birth records, we identified all nulliparous delivering at a single academic
76 institution between January 2000 and June 2017, of live singleton in cephalic presentation.

77 The study was limited to nulliparous women to remove the potential confounding effects of
78 multiparity and previous caesarean section on the risk of caesarean delivery. Nulliparas aged
79 less than 20 were excluded. Women with planned caesarean delivery, preterm labour before
80 37 weeks of gestation and labour induction were excluded.

81 This analysis included 10,611 women. Two groups were compared: nulliparous women aged
82 20 to 34 (n=8,993; 84.8%) and nulliparous women aged over 35 (n=1,618; 15.2%) (Figure 1).

83 Social and demographic characteristics, pregnancy characteristics, obstetrical, maternal and
84 neonatal outcomes were collected prospectively. All data were prospectively reported in a
85 computerized database at each consultation, during pregnancy, labour and after delivery by
86 health professional including midwives and obstetrician in care of the patient. These data
87 were checked for validity for each parturient in staff during the following day after delivery.

88

89 **Outcomes**

90 The main outcome was the intrapartum caesarean delivery rate. It was treated as a binary
91 variable. Secondary outcomes were total labour duration, and labour phases duration. In
92 agreement with the last recommendation we chose as the latent phase the period between the
93 onset of labour and 6 cm of cervical dilation, the active phase was between 6 cm and
94 complete dilation [15]. The second phase was defined as the duration between complete
95 dilation and expulsion. Labour phases duration were analysed regardless of the mode of
96 delivery (caesarean or vaginal delivery) and then specifically for vaginal deliveries. These
97 different phases were determined from the partographs. Partographs were prospectively filled
98 during labour by practitioners. Once the labour started, the partograph started, and all women
99 were examined every hour or before if progress dilatation was suspected, if women was
100 painful, and in cases of abnormalities on CTG. Cardiotocography, with continuous electronic
101 fetal heart rate and uterine contraction registration, was applied to all women. The whole

102 management of each labor and delivery was undertaken by the physician on duty. Oxytocin
103 was administered in case of labor arrest with a lack of uterine contractility. Caesarean section
104 for arrest of labor was indicated in case of stagnation of cervical dilation despite ruptured
105 membranes and a correct uterine activity in term of frequency and intensity, without a
106 threshold of duration being predetermined. In case of abnormal fetal heart rate, a second-line
107 exam was not systematic to decide a caesarean, and its indication was left to the obstetrician
108 in care of the patient. During the study period, the obstetrical practices have not been
109 modified. In this maternity, maternal age is not an element considered in the management of
110 labor and in the decision of caesarean section.

111

112 **Subgroup analysis**

113 In subgroup analysis, we focused specifically on the older part of the study population and
114 defined more advanced maternal age group as women aged at least 40. This analysis included
115 367 women.

116

117 **Statistical analysis**

118 We compared the characteristics of the women, pregnancies, labors and neonates, according
119 to maternal age, based on Chi² or Fisher exact tests for categorical variables and Student's or
120 Wilcoxon rank sum tests for quantitative variables, as appropriate. To assess the relation
121 between maternal age and the caesarean delivery rate, while controlling for confounding by
122 indication, we first used multivariate logistic regression to estimate OR and 95% CI to adjust
123 for prognostic covariates. Potential confounders determined from the previous literature
124 included: body mass index before pregnancy (continuous variable), gestational diabetes
125 (binary variable), gestational hypertensive pathologies (binary variable), gestational age at
126 delivery (continuous variable), and birth weight (continuous variable).

127 All tests were two-sided with P -values ≤ 0.05 defined as statistically significant. STATA 13
128 software (StataCorp LP, College Station, TX) was used for the descriptive and multivariate
129 analyses.

130

131 **Results**

132 Our study population included 10,611 women: 8,993 (84.8%) aged 20 to 34 and 1,618
133 (15.2%) aged over 35. In the [20-34] years old group, 2,066 (23.0%) were aged 20 to 24,
134 3,688 (41.0%) were aged 25 to 29, 3,239 (36.0%) were aged 30 to 34. In the ≥ 35 years old
135 group, 1,251 (77.3%) were aged 35 to 39, 338 (20.9%) were aged 40 to 44 and 29 (1.8%)
136 were aged 45 or more. Women aged ≥ 35 years old, compared with women aged 20 to 34
137 were more often obese, smokers and had more pre-existing hypertension, pregnancies
138 obtained by in vitro fertilisation, gestational diabetes and gestational hypertensive pathologies
139 (Table 1). They also gave birth at a later gestational age. Both groups had similar labour
140 characteristics.

141 The caesarean delivery rate was 10.8% in the [20-34] years old group and 8.8% in the ≥ 35
142 years old group (cOR 0.91, 95% CI 0.76-1.08), indications and cervical dilation at
143 intervention were similar in both groups (Table 2). After adjustment for confounders, no
144 association was found between maternal age and caesarean delivery rate (aOR 0.91, 95% CI
145 0.76-1.09).

146 Labour mean duration was 430.9 min in the [20-34] years old group and 428.0 min in the ≥ 35
147 years old group ($p= 0.654$) (Table 2). The different phases of labour mean duration did not
148 differ between both groups. Similar results were found for the analysis of labour duration for
149 women who gave birth vaginally after exclusion of caesarean delivery.

150 No differences for maternal and neonatal outcomes were found between both groups (Table 2
151 and 3).

152

153 **Subgroup analysis**

154 The subgroup analysis performed on women aged over 40 yielded similar results: the
155 caesarean delivery rate was similar in both groups: 10.8% in [20-34] years group compared to
156 10.3% in ≥ 40 years group (cOR 0.96, 95% CI 0.68-1.35; aOR 0.94, 95% CI 0.66-1.34) as
157 well as labour duration (430.8 min compared to 426.9 min; $p=0.733$; Appendix A.1 to A.5).

158

159 **Discussion**

160 **Main finding**

161 This study found a similar caesarean delivery rate between women aged 20 to 34 and women
162 with advanced maternal age defined by an age over 35 years old in case of spontaneous
163 labour at term. Moreover, labour outcomes were similar in the two groups.

164

165 **Interpretation**

166 Despite the exclusion of women with planned caesarean section or labour induction due to
167 pathologies, like in previous studies, we found that women over 35 years old had more
168 pregnancy complications than youngest women: macrosomia, gestational diabetes,
169 gestational hypertensive pathologies and prolonged pregnancies [16]. Therefore, our selection
170 criteria consisting in excluding caesarean section before labour and labour induction did not
171 over-select a low-risk population of nulliparous with advanced maternal age.

172 Concerning the management of labour, our two groups displayed the same characteristics,
173 particularly for epidural use and oxytocin use, which confirms a management independent of
174 maternal age. This resulted in a similar rate of intrapartum caesarean delivery in the two
175 groups without resorting to more intrapartum intervention. Furthermore, this same rate is
176 obtained despite a low intrapartum caesarean delivery rate in line with goals set by the World

177 Health Organization [17] and low rates of induction and caesarean before labour for
178 nulliparas with advanced age.

179 It is the first time that no association was found between maternal age and caesarean rate in a
180 low-risk population. It can be explained by the fact that our results were stronger than
181 previous studies in terms of methodological limits. Indeed, to avoid confounding factors we
182 selected a population including nulliparas only to dodge the effect of parity. We excluded
183 labor induction that is a recognized risk factor of caesarean delivery and adjusted for many
184 confounding factors.

185 Our results are consistent with recent fundamental research on human uterus muscle showing
186 the same trend: two studies on uterine strips collected during planned caesarean delivery has
187 shown no differences between young and older women concerning spontaneous or
188 pharmacologically induced contractility [18,19]. Another one demonstrated that uterine
189 muscle efficiency was diminished in older non-pregnant women but was restored during
190 pregnancy probably due to the remaining high hormonal response ability of the aging
191 myometrium [20]. The absence of a change in the contractile function of the uterus with
192 maternal age is supported by the fact that we observe the same caesarean rate at the same
193 dilatation, with a same arrest of labour rate in both groups; as well as the same duration of
194 labour and the same use of oxytocin.

195 Consequently, the increase in the caesarean delivery rate with maternal age observed in
196 previous studies can be associated with practitioner's behaviour who tend to either diagnose
197 labour dystocia (more frequently or earlier during labour) in aged women or accept these
198 women preference to perform caesarean delivery. Indeed, older nulliparous women have been
199 found to have a more positive attitude towards caesarean section a higher perception of
200 pregnancy risk, even in older women without known risk factors [9]. These considerations
201 are reinforced by the fact that the rate of caesarean delivery observed in our study population

202 is lower than the overall rate of caesarean delivery that occurred in the same maternity during
203 the study period, which was about 16-17%. Thus, the increase in the caesarean delivery rate
204 in women with advanced maternal age observed in previous studies is probably due to non-
205 rigorous or uncontrolled indications to perform caesarean section.

206

207 **Strengths**

208 Our study has several strengths. The long period data collection allowed the inclusion of a
209 large number of women, which gave a substantial power to highlight a difference between
210 both groups of maternal age if it exists. Attending practitioners prospectively collected the
211 data about the management of the pregnancy, labor and delivery, and these data were
212 ascertained routinely by medical staff the day after the delivery, so that thorough and accurate
213 information was available. We have detailed information about the patients labour. The
214 hospital database allowed us the collection of numerous covariates to address many potential
215 confounding factors in the logistic regression models and to estimate the association between
216 maternal age and caesarean delivery rate with greater precision. This study was limited to
217 nulliparous women to eliminate the confounding effects of multiparity and previous
218 caesarean delivery.

219

220 **Limitations**

221 This study is not without limitation. Its retrospective design can limit the generalization of the
222 results, but the characteristics of women and labor are similar to these described in the ENP
223 suggesting a good external validity [2]. Furthermore, the unicentric design of the study
224 allowed having a homogeneous management of the women in the follow-up of the pregnancy
225 and the management of labor and delivery, by a team for whom maternal age is not taken into
226 account in labor management. The sample size did not allow us to study women aged over 40

227 as a separate group with good precision, but it is the case for numerous other studies. In
228 addition, studies which have found an increased risk of caesarean delivery with advanced
229 maternal age have shown a linear increase and an absence of cut-off.

230 This study was conducted in France, which may limit the external validity of the results for
231 other countries. However, the rate and practices of caesarean delivery in France are similar to
232 those in other high resource countries [21].

233

234 **Clinical impact**

235 For aged women, planned vaginal delivery must be encouraged because the rate of success is
236 high. Moreover, maternal and neonatal complications are scares while caesarean delivery is
237 associated with more severe acute maternal morbidity, especially if maternal age is high.
238 Consequently, planned caesarean delivery and induction of labour must be limited to strict
239 medical indications only and the possibility of few or no subsequent pregnancies for these
240 aged women should not contribute to the easy achievement of a caesarean delivery.

241 These results emphasize that any woman should be managed in a way that results in the best
242 possible outcomes for both mother and baby, irrespective of age. The group of women aged
243 over 35 should be managed during labour as their younger counterparts, with finally the same
244 caesarean delivery rate without compromising the health and wellbeing of mothers and
245 babies.

246

247 **Disclosure of interest**

248 The authors declare that they have no competing interest.

249

250

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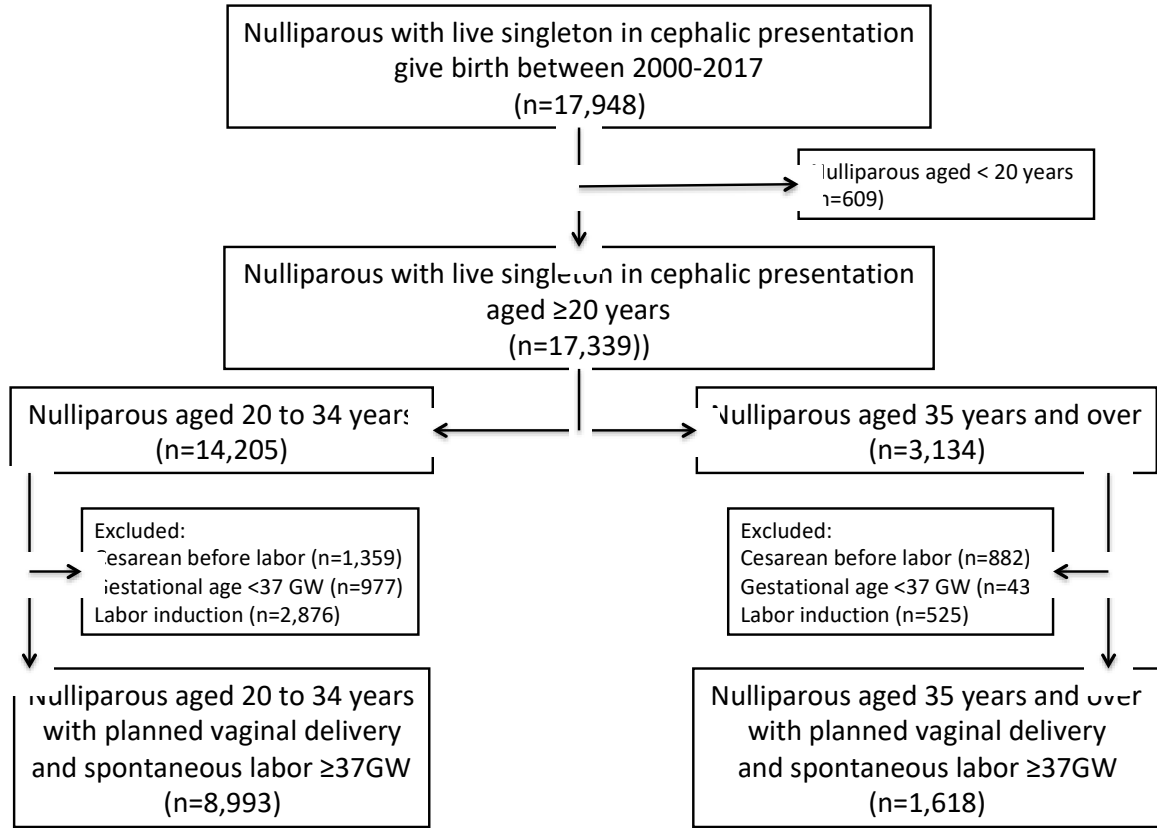
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317

318 **Figure 1: Flow chart**

319



320

321

323 **Table 1: Maternal, pregnancy and labour characteristics**

	< 35 years N=8993 n (%)	≥ 35 years N=1618 n (%)	P
Maternal characteristics			
Age (years) (mean ± SD)	28.2 ± 3.8	38.2 ± 2.6	<0.0001
Body mass index before pregnancy (kg/m ²)			
Mean ± SD	22.1 ± 4.1	22.5 ± 4.3	0.0002
<18,5	1149 (13.6)	160 (10.2)	
[18.5-24]	5606 (66.2)	1060 (67.5)	0.001
[25-29]	1232 (14.5)	242 (15.4)	
≥30	478 (5.6)	108 (6.9)	
Weight gain (kg) (mean ± SD)	12.7 ± 5.8	12.00 ± 5.3	< 0.001
< 9	1224 (19.3)	267 (21.5)	
[9-11]	1394 (21.9)	291 (23.4)	0.048
≥ 12	3737 (58.8)	685 (55.1)	
Smoker	1294 (14.4)	282 (17.4)	<0.001
Chronic hypertension	65 (0.7)	25 (1.5)	0.001
Diabetes mellitus	70 (0.8)	19 (1.2)	0.108
Characteristics of current pregnancy			
In vitro fertilisation	271 (3.0)	216 (13.4)	<0.001
Gestational diabetes	277 (3.1)	106 (6.5)	<0.001
Hypertensive gestational diseases	206 (2.3)	62 (3.8)	<0.001
Preterm labour	649 (7.2)	115 (7.1)	0.876
Premature rupture of membrane	82 (0.9)	20 (1.2)	0.218
Prenatal corticotherapy	373 (4.1)	61 (3.8)	0.48
Supected intrauterine growth restriction	26 (0.3)	4 (0.25)	0.77
Suspected macrosomia	546 (7.1)	109 (7.6)	0.517
Labor characteristics			
Gestational age at delivery (weeks)			
Mean (± SD)	39.9 ± 1.2	40.0 ± 1.2	<0.001
37 0/7 - 38 6/7	1859 (20.7)	288 (17.8)	<0.001
39 0/7 - 40 6/7	5279 (58.7)	904 (55.9)	
41 0/7 - 41 6/7	1583 (17.6)	343 (21.2)	
≥ 42 0/7	272 (3.0)	83 (5.1)	
Cervical dilation at first examination (cm)			
Mean (± SD)	3.2 ± 1.4	3.1 ± 1.4	0.303
Median (Q1-Q3)	3 (2-3)	3 (2-3)	0.175
Peridural anesthesia	7818 (86.9)	1432 (88.5)	0.082
Cervical dilation at pose of peridural anesthesia (cm)			
Mean (± SD)	4.2 ± 1.8	4.2 ± 1.8	0.852
Median (Q1-Q3)	4 (3-5)	4 (3-5)	0.3
Oxytocin use	4810 (53.5)	874 (54.0)	0.693
Maximal oxytocin dose (UI)			
Mean (± SD)	38.3 ± 24.1	38.5 ± 23.5	0.855
Median (Q1-Q3)	30 (20-50)	30 (20-50)	0.689

Clear amniotic fluid color	6903 (77.2)	1252 (78.2)	0.57
Manual rotation	878 (9.8)	156 (9.6)	0.879

Table 2: Delivery characteristics

	< 35 years N=8993 n (%)	≥ 35 years N=1618 n(%)	P
Delivery mode			0.27
Vaginal	8026 (89.2)	1459 (90.2)	
Caesarean section	967 (10.7)	159 (9.8)	
Caesarian section			
Indications			0.896
Abnormal fetal heart rate	389 (40.2)	64 (40.3)	
Arrest of labor	547 (56.6)	91 (57.2)	
Others	31 (3.2)	4 (2.5)	
Cervical dilation at CS (cm)			
Mean (± SD)	6.1 ± 2.5	6 ± 2.3	0.642
Median (Q1-Q3)	6 (4-8)	6 (4-7)	0.561
Labor duration (minutes)			
Total labor			
Mean (± SD)	430.8 ± 220.1	428 ± 212.2	0.654
Median (Q1-Q3)	422 (274-570)	420 (284-554)	0.689
Latent phase			
Mean (± SD)	191.9 ± 131.9	190.2 ± 130.5	0.651
Median (Q1-Q3)	182.5 (84-275)	180 (85-271)	0.611
Active phase			
Mean (± SD)	150.1 ± 110.4	148.0 ± 104.8	0.498
Median (Q1-Q3)	125 (70-201)	120 (69-198)	0.510
Second phase			
Mean (± SD)	55.3 ± 57.3	56.35 ± 57.0	0.510
Median (Q1-Q3)	40 (0-110)	42.8 (0-110)	0.445
Vaginal delivery			
Total labor duration (minutes)			
Mean (± SD)	421.6 ± 213.6	419.5 ± 209.0	0.723
Median (Q1-Q3)	414 (271-557)	409 (277-543)	0.614
Latent phase duration (minutes)			
Mean (± SD)	191.9 ± 131.9	190.2 ± 130.5	0.651
Median (Q1-Q3)	182.5 (84-275)	180 (85-271)	0.611
Active phase duration (minutes)			
Mean (± SD)	150.1 ± 110.4	148.0 ± 104.8	0.498
Median (Q1-Q3)	125 (70-201)	120 (68.5-198)	0.510
Second phase duration (minutes)			
Mean (± SD)	55.3 ± 57.3	56.3 ± 57.0	0.510
Median (Q1-Q3)	40 (0-110)	42.8 (0-110)	0.457
Operative vaginal delivery	3368 (42.0)	603 (41.3)	0.652
Indications			0.101
Abnormal cardiac foetal rate	1904 (57.0)	352 (58.9)	
Slow progression	1433 (42.9)	244 (40.8)	
Other	2 (0.1)	2 (0.3)	
Third or fourth perineal laceration	23 (0.3)	3 (0.2)	0.887
Postpartum complications			

Postpartum hemorrhage	358 (4.0)	76 (4.7)	0.181
Blood transfusion	118 (1.3)	35 (2.2)	0.008
Nalador	317 (3.5)	66 (4.1)	0.271
Uterine arteries embolisation	2 (0.02)	1 (0.06)	0.383
Vascular ligation	2 (0.02)	1 (0.06)	0.383
Compressive uterine sutures	11 (0.1)	5 (0.3)	0.075
Hysterectomy	0 (0)	0 (0)	-

SD: standard deviation

Q1-Q3 : first quartile, third quartile

CS : caesarean section

Table 3: Neonatal outcomes

	< 35 years N=8993 n (%)	≥ 35 years N=1618 n(%)	P
Gender			0.721
Feminine	4352 (48.4)	795 (49.1)	
Masculine	4639 (51.6)	823 (50.9)	
Birth weight (grams)			
Mean (±) SD	3282.6 ± 439.1	3292 ± 451.3	0.407
< 2500	271 (3.0)	57 (3.5)	
[2500-3799]	7649 (85.1)	1334 (82.4)	0.027
≥ 3800	1072 (11.9)	227 (14.0)	
SGA < 10 th percentile	1011 (11.2)	202 (12.5)	0.148
pH at umbilical cord			
< 7.10	116 (1.3)	24 (1.5)	0.550
< 7.00	19 (0.2)	2 (0.1)	0.459
Respiratory resuscitation			
Ventilatory assistance	476 (5.3)	115 (7.1)	0.003
Mask ventilation	294 (3.3)	67 (4.1)	0.075
Nasal ventilation	31 (0.3)	11 (0.7)	0.048
Continuous positive pressure	99 (1.1)	25 (1.5)	0.126
Tracheal intubation	117 (1.3)	34 (2.1)	0.012
Neonatal death in labor ward	0 (0)	1 (0.06)*	-

* Severe malformations affecting heart and brain function

SGA : small for gestational age

Appendix A.1: Subgroup analysis: maternal, pregnancy and labor characteristics

	< 35 years N=8993 n (%)	≥ 40 years N=367 n (%)	P
Maternal characteristics			
Age (years)			
Mean ± SD	28.2 ± 3.8	42.1 ± 2.6	<0.001
Body mass index before delivery (kg/m ²)			
Mean ± SD	22.1 ± 4.1	22.9 ± 4.3	<0.001
<18,5	1149 (13.6)	30 (8.4)	
[18.5-24]	5606 (66.2)	238 (66.7)	0.006
[25-29]	1232 (14.5)	59 (16.5)	
≥30	478 (5.6)	30 (8.4)	
Weight gain (kg)			
Mean ± SD	12.7 ± 5.8	11.5 ± 5.3	<0.001
< 9	1224 (19.3)	78 (26.3)	
[9-11]	1394 (21.9)	74 (25.0)	0.001
≥ 12	3737 (58.8)	144 (48.6)	
Smoker	1294 (14.4)	61 (16.6)	0.004
Chronic hypertension	65 (0.7)	9 (2.4)	<0.001
Diabetes mellitus	70 (0.8)	6 (1.6)	0.073
Characteristics of current pregnancy			
In vitro fertilisation	271 (3.0)	80 (20.8)	<0.001
Gestational diabetes	277 (3.1)	33 (9)	<0.001
Hypertensive gestational diseases	206 (2.3)	22 (6)	<0.001
Preterm labour	649 (7.2)	30 (8.2)	0.488
Premature rupture of membrane	82 (0.9)	6 (1.6)	0.159
Prenatal corticotherapy	373 (4.1)	13 (3.5)	0.567
Suspected intrauterine growth restriction	26 (0.3)	0	0.302
Suspected macrosomia	546 (7.1)	25 (7.6)	0.699
Labor characteristics			
Gestational age at delivery (weeks)			
Mean ± SD	39.9 ± 1.2	40.2 ± 1.2	<0.001
37 0/7 - 38 6/7	1859 (20.7)	59 (16.1)	<0.001
39 0/7 - 40 6/7	5279 (58.7)	189 (51.5)	
41 0/7 - 41 6/7	1583 (17.6)	94 (25.6)	
≥ 42 0/7	272 (3.0)	25 (6.8)	
Cervical dilation at first examination			
Mean ± SD	3.2 ± 1.4	3.1 ± 1.4	0.499
Median (Q1-Q3)	3 (2-3)	3 (2-3)	0.175
Peridural anesthesia	7818 (86.9)	327 (89.1)	0.226
Cervical dilation at pose of peridural anesthesia (cm)			
Mean ± SD	4.2 ± 1.8	4.0 ± 1.8	0.310
Median (Q1-Q3)	4 (3-5)	4 (3-5)	0.191
Oxytocin use	4810 (53.5)	197 (53.7)	0.942
Maximal oxytocin dose (UI)			
Mean ± SD	38.3 ± 24.1	39.4 ± 23.6	0.516
Median (Q1-Q3)	30 (20-50)	30 (20-50)	0.432

Amniotic fluid color			0.729
Clear	6903 (77.2)	282 (78.3)	
Tainted	1423 (15.9)	57 (15.8)	
Meconial	617 (6.9)	21 (5.9)	
Manual rotation	878 (9.8)	33 (9)	0.879

Appendix A.2: Subgroup analysis: delivery characteristics

	< 35 years N=8993 n (%)	≥ 40 years N=367 n (%)	P
Delivery mode			0.810
Vaginal	8026 (89.2)	329 (89.6)	
Caesarian section	967 (10.7)	38 (10.3)	
Caesarian section			
Indications			0.485
Abnormal fetal heart rate	389 (40.2)	19 (50.0)	
Arrest of labor	547 (56.6)	18 (47.4)	
Others	31 (3.2)	1 (2.6)	
Cervical dilation at CS (cm)			
Mean ± SD	6.1 ± 2.5	5.9 ± 2.3	0.715
Median (Q1-Q3)	6 (4-8)	5.5 (4-7)	0.610
Labor duration (minutes)			
Total labor			
Mean ± SD	430.8 ± 220.1	426.9 ± 214.1	0.733
Median (Q1-Q3)	422 (274-570)	410.5 (283-556)	0.749
Latent phase			
Mean ± SD	191.9 ± 131.9	189.1 ± 132.7	0.707
Median (Q1-Q3)	182.5 (84-275)	165 (90-270)	0.511
Active phase			
Mean ± SD	150.1 ± 110.4	145.2 ± 103.7	0.422
Median (Q1-Q3)	125 (70-201)	117.5 (60-200)	0.338
Second phase			
Mean ± SD	55.3 ± 57.3	57.7 ± 57.9	0.449
Median (Q1-Q3)	40 (0-110)	45 (0-115)	0.363
Vaginal delivery			
Total labor duration (minutes)			
Mean ± SD	421.6 ± 213.6	416.1 ± 209.5	0.645
Median (Q1-Q3)	414 (271-557)	405.5 (278-536)	0.546
Latent phase duration (minutes)			
Mean ± SD	191.9 ± 131.9	189.1 ± 132.7	0.707
Median (Q1-Q3)	182.5 (84-275)	165 (90-270)	0.511
Active phase duration (minutes)			
Mean ± SD	150.1 ± 110.4	145.2 ± 103.7	0.422
Median (Q1-Q3)	125 (70-201)	117.5 (60-200)	0.338
Second phase duration (minutes)			
Mean ± SD	55.3 ± 57.3	57.7 ± 57.9	0.449
Median (Q1-Q3)	40 (0-110)	45 (0-115)	0.363
Operative vaginal delivery	3368 (42.0)	149 (45.3)	0.231
Indications			0.525
Abnormal cardiac foetal rate	1904 (57.0)	90 (61.6)	
Slow progression	1433 (42.9)	56 (38.4)	
Other	2 (0.1)	0	
Third or fourth perineal laceration	23 (0.3)	1 (0.3)	0.942
Postpartum complications			

Postpartum hemorrhage	358 (4)	16 (4.4)	0.716
Blood transfusion	118 (1.3)	8 (2.2)	0.157
Nalador	317 (3.5)	14 (3.8)	0.768
Uterine arteries embolisation	2 (0.02)	0	0.775
Vascular ligation	2 (0.02)	1 (0.3)	0.009
Compressive uterine sutures	11 (0.1)	1 (0.3)	0.431
Hysterectomy	0 (0)	0 (0)	-

Appendix A.3: Subgroup analysis: neonatal outcomes

	< 35 years N=8993 n (%)	≥ 40 years N=367 n(%)	P
Gender			0,905
Feminine	4352 (48,4)	181 (49,3)	
Masculine	4639 (51,6)	186 (50,7)	
Birth weight (grams)			
Mean ± SD	3282,6 ± 439,1	3270 ± 447,3	0,783
< 2500	271 (3,0)	13 (3,5)	
[2500-3799]	7649 (85,1)	308 (83,9)	0,027
≥ 3800	1072 (11,9)	46 (12,5)	
SGA < 10th percentile	1011 (11,2)	53 (14,4)	0,058
pH at ombilical cord			
< 7.10	116 (1,3)	4 (1,1)	0,737
< 7.00	19 (0,2)	0	0,378
Respiratory resuscitation			
Ventilatory assistance	476 (5,3)	33 (9)	0,002
Mask ventilation	294 (3,3)	20 (5,4)	0,023
Nasal ventilation	31 (0,3)	2 (0,5)	0,526
Continuous positive pressure	99 (1,1)	7 (1,9)	0,152
Tracheal intubation	117 (1,3)	9 (2,4)	0,061
Neonatal death in labor ward	0 (0)	0 (0)	-

SGA: small for gestational age