# The effect of maternal age and duration of labor on perinatal and neonatal outcomes: a retrospective cohort study

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**Background:** This study aimed to investigate the effect of maternal age and duration of labor on perinatal and neonatal outcomes. The results of this study are expected to provide a basis to aid maternal and child health care personnel to implement health education for late childbearing women.

**Methods:** This was a retrospective observational study, wherein 9,241 parturients were included from 2016 to 2018. Parturients were divided into three groups based on age: <28 (n=2,911), 28–30 (n=3,631), and >30 (n=2,699) years. According to the total duration of labor, those who did not undergo cesarean section (CS) were subgrouped into <420 minutes (n=4,065) and ≥420 minutes (n=4,094) groups. A multivariate logistic regression model was used to investigate associations between age/total duration of labor group factors to different postpartum outcomes, including a switch to emergency CS, puerperal morbidity, abnormal fetal heart rate, and meconium-stained amniotic fluid (MSAF).

**Results:** The rates of postpartum outcomes significantly differed in maternal age groups, including switch to emergency CS (9.07% *vs.* 13.03% *vs.* 11.23%; P<0.001), puerperal morbidity (6.32% *vs.* 6.46% *vs.* 5.00%; P=0.035), and abnormal fetal heart rate (25.34% *vs.* 28.21% *vs.* 25.67%; P=0.017). Of the comparisons between labor time groups, it was found that participants with longer labor time were also significantly higher in the use of episiotomy/forceps (46.61% *vs.* 69.77%; P<0.001), bleeding amount (381.35±108.02 *vs.* 389.60±146.40 mL; P=0.004), oxytocin use (25.03% *vs.* 39.56%; P<0.001), puerperal morbidity (1.98% *vs.* 6.86%; P<0.001), abnormal fetal heart rate (20.07% *vs.* 25.15%; P<0.001), and MSAF (26.53% *vs.* 31.91%; P<0.001). Multivariate logistic regression analysis showed that as age increased, the ORs of switching to emergency CS (1.58 and 1.87, both P<0.001) and having abnormal fetal heart rate (1.20 and 1.38; both P<0.01) also increased. Participants with longer labor time groups the ORs of puerperal morbidity (2.33; P<0.001) and MSAF (1.13; P=0.023) also increased.

**Conclusions:** With the adjustment of covariates. Higher maternal age seems associated to the risk of switching to emergency CS and having abnormal fetal heart rate; longer total duration of labor seems associated to the risk of puerperal morbidity and MSAF.

**Keywords:** Maternal age; duration of labor; perinatal outcomes; neonatal outcomes

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## Introduction

An increasing trend in childbearing age worldwide has been observed in the past few decades (1,2), especially in developed nations (3,4). China is a developing country with unique socioeconomic characteristics (5), and a 2017 national fertility survey demonstrated that from 2006 to 2016, the mean ages at first marriage and first birth increased by 2.7 and 2.6 years, respectively (6). Moreover, the mean age of parturients at first birth increased from 24.3 to 26.9 years whereas at second birth this increased from 29.2 years [2014] to 30.2 years [2016] (6). In 2016, advanced pregnancies (age ≥35 years) accounted for approximately 31% of total pregnancies in China (7). This trend can be partially attributed to changes in social habits, such as higher education, careers, financial stability, late marriage, and contraception use (8-11). The Chinese government has relaxed its family planning policy and implemented a universal two-child policy in 2015 to address the country's aging problem (12), which also contributes to advanced pregnancies. With the increase of age, the aging of human reproductive system is inevitable, and the functions of ovaries, uterus and other organs of elderly women are significantly reduced. The fertility, glucose and lipid metabolism decreased. The incidence rate of physical disease, surgical disease and gynecological disease is higher and higher. The above risk factors increase maternal and fetal adverse pregnancy outcomes, including gestational diabetes mellitus, hypertensive disorder complicating pregnancy, placenta previa, placenta increta, fetal malformation, miscarriage, preterm birth, macrosomia, intrauterine growth restriction and other pregnancy complications. In addition, the work pressure and life pressure make the elderly women bear all kinds of burdens brought by society and family. The changes from physiology to psychology make the women with advanced age become the high-risk group of pregnancy complications and complications. Understanding the influencing factors of pregnancy outcome of the women with advanced age can help obstetricians to manage elderly pregnant women well, and is also the key to reduce the occurrence of various complications. While maternal age has been shown to play a crucial role in pregnancy-related complications and adverse obstetric and perinatal outcomes (13-19), studies examining its effect on pregnancy outcomes in the Chinese population are scarce (20,21).

In this paper, the clinical data of pregnant women who gave birth in the General Hospital of Northern Theater Command in recent years were retrospectively analyzed to explore the effects of maternal age and total labor process on perinatal and neonatal outcomes. The results of this study are expected to provide a basis to aid maternal and child health care personnel to implement health education for late childbearing women and provide evidence-based knowledge support regarding women's reproductive choices. Furthermore, it aims to aid health policymakers to prevent the increase in the trend of advanced maternal age and adverse pregnancy outcomes when designing plans and strategies. We present the following article in accordance with the STROBE reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-22-4404/rc).

## Methods

### Study subjects

This was a retrospective observational study. A total of 9,241 parturients who delivered in the General Hospital of Northern Theater Command between January 2016 and December 2018 were included and divided into three groups based on age as follows: <28 years (n=2,911), 28–30 years (n=3,631); and >30 years (n=2,699). Based on the total duration of labor, parturients were also subgrouped into <420 minutes (n=4,065) and ≥420 minutes (n=4,094) groups. In addition to oxytocin, Dinoproston was used to induce labor by promoting cervical ripening.

This study was approved by the institutional review board of General Hospital of Northern Theater Command [No. Y(2020)025], and written informed consent was obtained from the patients. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

### Data collection

The clinical data of patients during hospitalization were collected from patient record files. Data collected included labor of each stage, labor outcome (delivery method), bleeding amount, use of oxytocin, episiotomy/forceps during delivery, puerperal morbidity, 1-min and 5-min Apgar score, birth weight, abnormal fetal heart rate incidence, and meconium-stained amniotic fluid (MSAF) incidence. Gravidity was defined as the number of times a woman has been pregnant, and parity as the number of births at or above 28 weeks of gestation, regardless of whether the child was born alive or stillborn. Puerperal

**Table 1** Participant characteristics among age-based groups

| Parameters | Age group (years) | | | | P |
|---|---|---|---|---|---|
| | <28 (n=2,911) | 28–30 (n=3,631) | >30 (n=2,699) | All (n=9,241) | |
| Age, years | 25.63±1.61 | 28.90±0.80 | 33.27±2.39 | 29.15±3.41 | <0.001 |
| Gestational age, week | 39.71±1.10 | 39.70±1.09 | 39.63±1.07 | 39.68±1.09 | 0.006 |
| Gravidity | 1.36±0.67 | 1.42±0.73 | 1.98±1.07 | 1.56±0.87 | <0.001 |
| Median (IQR) | 1 (1 to 2) | 1 (1 to 2) | 1 (2 to 3) | 1 (1 to 2) | <0.001 |
| Parity | 0.06±0.24 | 0.10±0.31 | 0.39±0.51 | 0.17±0.39 | <0.001 |
| Median (IQR) | 0 (0 to 0) | 0 (0 to 0) | 0 (0 to 0) | 0 (0 to 0) | <0.001 |
| Epidural anesthesia use | 1,448 (49.74%) | 1,727 (47.56%) | 947 (35.09%) | 4,122 (44.61%) | <0.001 |
| Cervix dilation at epidural anesthesia, cm | 2.52±0.79 | 2.48±0.71 | 2.47±0.74 | 2.49±0.75 | 0.281 |

Data are reported as mean ± standard deviation (SD) or n (%); IQR, inter-quartile range.

morbidity was defined as the occurrence of ≥2 times body temperature ≥38 ℃ upon monitoring four times daily (oral) at 4 h intervals within 10 days after 24 h of delivery (22). The intrapartum abnormal fetal heart rate was defined as electronic fetal heart rate monitoring showing category III fetal heart rate tracing or category II fetal heart rate tracing which did not improve or was changed to category III fetal heart rate tracing after intrauterine resuscitation (23). Indications to switch to emergency CS were prolonged labor, lagged labor, abnormal fetal heart rate, abnormal bleeding during labor, placental abruption, and uterine rupture. The criteria for inclusion by age group were gestational age ≥28 and singleton, while those with multiple pregnancies and severe complications of internal medicine and surgery were excluded. The criteria for inclusion by labor stage were primipara, gestational age ≥28 years, and singleton birth, and the exclusion criteria were multiple pregnancies, cesarean delivery, and severe complications of internal medicine and surgery.

### Statistical analysis

Continuous variables are reported as mean ± standard deviation (SD). Means between two groups were compared using the Student's independent *t*-test, while three or more groups were compared using a one-way analysis of variance. Categorical variables are presented as numbers and percentages and were compared using the Chi-square test or Fisher's exact test (if the expected value was ≤5). A multivariate logistic regression model was used to investigate associations between age/total duration of labor group factors to different postpartum outcomes, including

a switch to emergency CS, puerperal morbidity, abnormal fetal heart rate, and MSAF. All analyses were performed using IBM SPSS version 25 (SPSS Statistics V25, IBM Corporation, Somers, New York), and the statistical significance level for all tests was set at P value <0.05, two-tailed.

### Results

#### Participant characteristics among age groups

The mean age of the included 9,241 parturients was 29.15±3.41 years, and the mean gestational age was 39.64±1.09 weeks. The average gravidity and parity were 1.56±0.87 and 0.17±0.39 times, respectively. Epidural anesthesia during delivery was applied in 44.61% of parturients, and the mean cervix dilation at epidural anesthesia was 2.49±0.75 cm.

As shown in *Table 1*, parturients were grouped by age as follows: <28 years (n=2,911), 28–30 years (n=3,631); and >30 years (n=2,699), with percentile (PR)33 and PR66 as the cut-off. Significant differences in gestational age, gravidity, parity, and epidural use were seen among the three groups (all P<0.01). Gestational age was found to be slightly decreased as age increased whereas gravidity and parity increased as age increased. Further, younger parturients were more likely to use epidural anesthesia.

#### Postpartum outcomes among age groups

Perinatal and neonatal outcomes were compared among the three age groups, including labor duration at each

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**Table 2** Postpartum outcomes among age-based groups

| Parameters | Age group (years) | | | | P |
|---|---|---|---|---|---|
| | <28 (n=2,911) | 28–30 (n=3,631) | >30 (n=2,699) | All (n=9,241) | |
| Labor time | | | | | |
| Stage 1 | 355.68±158.04 | 358.70±167.68 | 330.76±163.81 | 349.56±163.92 | <0.001 |
| Stage 2 | 64.45±48.88 | 65.65±52.56 | 54.91±53.59 | 62.12±51.92 | <0.001 |
| Stage 3 | 8.36±3.34 | 8.47±3.55 | 8.68±3.74 | 8.50±3.54 | 0.006 |
| All stage | 428.87±178.61 | 433.31±190.53 | 394.35±190.44 | 420.49±187.48 | <0.001 |
| Labor outcome | | | | | <0.001 |
| NSD | 947 (33.19%) | 1,145 (32.15%) | 1,283 (48.43%) | 3,375 (37.24%) | |
| CS | 264 (9.25%) | 473 (13.28%) | 303 (11.44%) | 1,040 (11.48%) | |
| Episiotomy/forceps | 1,642 (57.55%) | 1,943 (54.56%) | 1,063 (40.13%) | 4,648 (51.29%) | |
| Switch to emergency CS | 264 (9.07%) | 473 (13.03%) | 303 (11.23%) | 1,040 (11.25%) | <0.001 |
| Bleeding, mL | 369.28±129.27 | 366.87±163.84 | 368.85±136.45 | 368.21±145.75 | 0.773 |
| Oxytocin use | 923 (32.65%) | 1,228 (35.08%) | 850 (32.79%) | 3,001 (33.64%) | 0.070 |
| Puerperal morbidity | 183 (6.32%) | 233 (6.46%) | 134 (5.00%) | 550 (5.99%) | 0.035 |
| Apgar score | | | | | |
| 1$^{st}$ minute | 9.97±0.31 | 9.98±0.23 | 9.97±0.32 | 9.98±0.29 | 0.263 |
| 5$^{th}$ minute | 9.99±0.21 | 10.00±0.10 | 9.99±0.18 | 9.99±0.17 | 0.526 |
| Birthweight, g | 3,412.02±390.11 | 3,441.73±390.88 | 3,451.23±399.49 | 3,435.14±393.46 | <0.001 |
| Abnormal fetal heart rate | 723 (25.34%) | 1,002 (28.21%) | 677 (25.67%) | 2,402 (26.56%) | 0.017 |
| MSAF | 833 (29.18%) | 1,033 (29.06%) | 771 (29.20%) | 2,637 (29.14%) | 0.991 |

Data are reported as mean ± standard deviation (SD) or n (%). NSD, normal spontaneous delivery; CS, cesarean section; MSAF, meconium-stained amniotic fluid.

stage, labor outcome (delivery method), bleeding amount, oxytocin use, puerperal morbidity, Apgar score of newborns at the 1$^{st}$ and 5$^{th}$ min, birth weight, abnormal fetal heart rate occurrence, and MSAF incidence. As shown in *Table 2*, parturients in the >30 years age group were more likely to have shorter stages one and two of labor, and total duration of labor (all P<0.05). These parturients also had a higher rate of normal spontaneous delivery (NSD) as a labor outcome (P<0.001), and higher age groups were more likely to switch to CS (P<0.001). The incidence of puerperal morbidity was significantly higher in the <28 and 28–30 age groups (P=0.035), and birth weight slightly increased as age increased (P<0.001). Furthermore, the 28–30 years age group was more likely to show an abnormal fetal heart rate in comparison to other groups (P=0.017), while Apgar scores showed no difference among the three age groups (P>0.05).

*Participant characteristics between the two groups based on the duration of labor*

According to the median of the total duration of labor, parturients were subgrouped into <420 minutes (n=4,065) and ≥420 minutes (n=4,094) groups. In these analyses, those who underwent CS were excluded due to a lack of total duration of labor data. As shown in *Table 3*, the ≥420 minutes group were of a significantly younger age, had longer gestational age, lower gravidity and parity, higher epidural anesthesia use, and smaller cervix dilation at epidural anesthesia compared with the <420 minutes group (all P<0.05).

*Postpartum outcomes between the two groups based on duration of labor*

Perinatal and neonatal outcomes were also compared

**Table 3** Participant characteristics between the two groups based on total labor time

| Parameters | Total labor time group (min) | | | P |
| --- | --- | --- | --- | --- |
| | <420 (n=4,065) | ≥420 (n=4,094) | All (n=8,159) | |
| Age, years | 29.49±3.75 | 28.77±3.09 | 29.13±3.45 | <0.001 |
| Gestational age, week | 39.56±1.10 | 39.73±1.08 | 39.64±1.09 | <0.001 |
| Gravidity | 1.75±0.97 | 1.41±0.75 | 1.58±0.88 | <0.001 |
| Median (IQR) | 1 (1 to 2) | 1 (1 to 2) | 1 (1 to 2) | <0.001 |
| Parity | 0.33±0.49 | 0.06±0.24 | 0.19±0.41 | <0.001 |
| Median (IQR) | 0 (0 to 1) | 0 (0 to 0) | 0 (0 to 0) | <0.001 |
| Epidural anesthesia use | 1,139 (28.02%) | 2,337 (57.08%) | 3,476 (42.60%) | <0.001 |
| Cervix dilation at epidural anesthesia, cm | 2.56±0.77 | 2.49±0.75 | 2.52±0.76 | 0.023 |

Data are reported as mean ± standard deviation (SD) or n (%); IQR, inter-quartile range.

between the <420 and ≥420 minutes groups. As shown in *Table 4*, the ≥420 minutes group had a higher rate of episiotomy/forceps during delivery, a larger volume of bleeding, and higher rates of oxytocin use, puerperal morbidity, abnormal fetal heart rate, and MSAF compared with those in the <420 minutes group (all P<0.05). Birth weight was also slightly higher in the ≥420 minutes group (P<0.001). However, Apgar scores did not differ between the two groups (P>0.05).

### Postpartum outcomes in multivariate models

To investigate the association between age/total duration of labor and postpartum outcomes, the significant variables among groups (*Tables 1,3*) were adjusted in a multivariate logistic regression model. For the age-based groups, the gestational age, gravidity, and parity were adjusted, while for the total duration of labor-based groups, the adjusted covariates were age, gestational age, gravidity, parity, and use of epidural anesthesia.

As shown in *Table 5*, as age increased, rates of the switch to emergency CS and abnormal fetal heart rate also increased (all P<0.01). Furthermore, parturients with a longer total duration of labor (≥420 minutes group) were more likely to have puerperal morbidity [odds ratio (OR): 2.33, 95% confidence interval (CI): 1.79–3.04; P<0.001], and MSAF (OR: 1.13, 95% CI: 1.02–1.26; P=0.023).

### Discussion

This study investigated the effect of maternal age and total

duration of labor on perinatal and neonatal outcomes. The results showed older age groups were more likely to switch to emergency CS, and the incidence of puerperal morbidity was significantly higher in the <28 years and 28–30 years age groups. Moreover, the 28–30 years age group was more likely to show an abnormal fetal heart rate. The ≥420 minutes group had a higher rate of episiotomy/ forceps during delivery, a larger volume of bleeding, and higher rates of oxytocin use, puerperal morbidity, abnormal fetal heart rate, and MSAF compared with those in the <420 minutes group. The multivariate logistic regression analysis showed that as age increased, the rates of the switch to emergency CS and an abnormal fetal heart rate also increased, while parturients with a longer total duration of labor were more likely to experience puerperal morbidity and MSAF.

Higher maternal age increases the risk of obstetric complications, such as gestational diabetes, preeclampsia, placenta previa, and placental abruption (17,24,25), resulting in an increased CS rate (26-28). Advanced pregnant women are more likely to undergo CS due to a scarred uterus, a history of adverse pregnancy, difficult pregnancy, unwillingness to try vaginal delivery, psychological pressure, and a lack of confidence in vaginal trial delivery. Additionally, with an increase in gravidity, the incidences of abdominal wall relaxation, breech position, transverse position, and other abnormal fetal positions also increase. As vaginal delivery is associated with many uncertain factors, advanced pregnant women are more prone to surgical intervention, increasing the CS rate. Kim *et al.* showed advanced maternal age is an independent

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**Table 4** Postpartum outcomes between the two groups based on total labor time

| Parameters | Total labor time group (min) | | | P |
| --- | --- | --- | --- | --- |
| | <420 (n=4,065) | ≥420 (n=4,094) | All (n=8,159) | |
| Labor time | | | | |
| Stage 1 | 231.77±108.36 | 467.00±119.36 | 349.49±163.79 | <0.001 |
| Stage 2 | 36.37±32.13 | 87.85±55.06 | 62.13±51.92 | <0.001 |
| Stage 3 | 8.49±3.52 | 8.50±3.57 | 8.50±3.54 | 0.944 |
| All stage | 276.81±118.99 | 563.14±123.09 | 420.48±187.49 | <0.001 |
| Labor outcome | | | | <0.001 |
| NSD | 2,124 (53.39%) | 1,210 (30.23%) | 3,334 (41.77%) | |
| Episiotomy/forceps | 1,854 (46.61%) | 2,793 (69.77%) | 4,647 (58.23%) | |
| Bleeding, mL | 381.35±108.02 | 389.60±146.40 | 385.49±128.78 | 0.004 |
| Oxytocin use | 968 (25.03%) | 1,578 (39.56%) | 2,546 (32.41%) | <0.001 |
| Puerperal morbidity | 80 (1.98%) | 279 (6.86%) | 359 (4.43%) | <0.001 |
| Apgar score | | | | |
| 1st minute | 9.98±0.24 | 9.97±0.30 | 9.98±0.27 | 0.276 |
| 5th minute | 9.99±0.12 | 10.00±0.17 | 9.99±0.15 | 0.648 |
| Birthweight, g | 3,406.09±403.04 | 3,440.00±374.90 | 3,423.10±389.52 | <0.001 |
| Abnormal fetal heart rate | 785 (20.07%) | 1,021 (25.15%) | 1,806 (22.65%) | <0.001 |
| MSAF | 1,043 (26.53%) | 1,294 (31.91%) | 2,337 (29.26%) | <0.001 |

Data are reported as mean ± standard deviation (SD) or n (%). NSD, normal spontaneous delivery; MSAF, meconium-stained amniotic fluid.

**Table 5** Logistic regression analysis results of age/total labor time-based group factors to clinical postpartum outcomes

| Parameters | Switch to emergency CS | | Puerperal morbidity | | Abnormal fetal heart rate | | MSAF | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P |
| Age group, years | | <0.001 | | 0.803 | | <0.001 | | |
| <28 | ref. | | ref. | | ref. | | | |
| 28–30 | 1.58 (1.34 to 1.85) | <0.001 | 1.06 (0.86 to 1.29) | 0.589 | 1.20 (1.07 to 1.34) | 0.002 | | |
| >30 | 1.87 (1.56 to 2.24) | <0.001 | 1.07 (0.85 to 1.36) | 0.553 | 1.38 (1.21 to 1.57) | <0.001 | | |
| Total labor time group, minute | | | | | | | | |
| <420 | | | ref. | | ref. | | ref. | |
| ≥420 | | | 2.33 (1.79 to 3.04) | <0.001 | 1.08 (0.96 to 1.21) | 0.204 | 1.13 (1.02 to 1.26) | 0.023 |

The multivariate models of the age-based groups were adjusted with gestational age, gravidity, and parity. The multivariate models of the total labor time-based groups were adjusted with age, gestational age, gravidity, parity, and use of epidural anesthesia. MSAF, meconium-stained amniotic fluid; CS, cesarean section. OR, odd ratio; CI, confidence interval.

risk factor of emergency CS due to a non-reassuring fetal heart rate or arrest disorder (29), and a previous study revealed it as an independent risk factor associated with conversion to an emergency CS post failed trial labor (30). Additionally, Attali *et al.* reported that advanced maternal age is an independent risk factor for intrapartum CS (15,19). Similarly, the current study showed maternal age is an independent factor associated with the switch to emergency CS, with parturients between the ages of 28–30 years having a 1.58-fold higher risk compared with those under the age of 28 years. For those over the age of 30 years, the risk elevated to 1.87-fold.

In this study, maternal age was also an independent risk factor for an abnormal fetal heart rate, which is a sign of fetal distress (31). Compared to parturients under the age of 28 years, those in the 28–30 and >30 years groups had a 1.20-fold and 1.38-fold higher risk of fetal heart rate abnormality, respectively. Cavazos-Rehg *et al.* also reported both younger and older parturients have an increased risk of fetal distress (32), while Ngowa *et al.* found this risk was increased in multiparous advanced parturients (33).

Furthermore, in this study, gestational age decreased with an increase in maternal age. Gestational age is currently recognized as an important factor affecting the prognosis of newborns, especially premature infants. The main complications of premature infants are hyperbilirubinemia, neonatal pneumonia, acidosis, hypocalcemia, apnea, and neonatal scleroderma. The incidence of complications and mortality of premature infants with gestational age ≥34 weeks was lower than those with gestational age <34 weeks (34). Moreover, the complications of premature infants at 28–31+6 weeks of gestation are mainly hyperbilirubinemia, acidosis, and neonatal anemia, while those of 32–33+6 weeks of gestation are mainly hyperbilirubinemia, neonatal pneumonia, and acidosis. The incidence of complications in the 28–31+6 gestational week group is higher than in the 32–33+6 gestational week group. Therefore, with older maternal age, the gestational age may be lower, increasing neonatal complications and mortality (35).

Accumulating evidence suggests the prolonged duration of labor increases adverse maternal and neonatal outcomes (36,37). Here, parturients with a duration ≥420 min showed a significantly higher incidence of puerperal morbidity than those with a duration <420 min. Additionally, the multivariate logistic regression model adjusted for confounding factors including age, gestational age, gravidity, parity, and use of epidural anesthesia showed parturients with prolonged duration of labor had a 2.33-fold higher risk of puerperal morbidity. This is consistent with a meta-analysis by Pergialiotis *et al.* that included 13 studies and 337,845 parturients and demonstrated a prolonged second stage was associated with a higher incidence of puerperal morbidity (38).

The prolonged duration of labor is a risk factor for the passage of meconium in utero (39). MSAF is regarded as a sign of fetal distress and fetal asphyxia, although its precise etiology remains unclear (40). Cheng *et al.* reported a prolonged second stage of labor increases the incidence of MSAF (41,42) while Lee *et al.* confirmed a longer duration (first stage, second stage, or total) was associated with a higher risk of MSAF in term singleton pregnancies (43). Supporting this notion, this study showed the incidence of MSAF was slightly elevated (1.13-fold) in parturients with a longer duration of labor (first stage, second stage, and total), and logistic regression showed it was associated with puerperal morbidity and MSAF but not with abnormal fetal heart rate. Although the duration of labor does not significantly affect the abnormal fetal heart rate, this does not mean it does not affect neonatal outcomes. Therefore, even in the absence of a pathological cardiotocograph, the risk of neonatal acidemia is directly proportional to the duration of the second stage of labor (44).

It should be noted that this study was limited by its retrospective nature. Some confounding factors were not excluded, such as whether the parturient used labor inducing drugs other than oxytocin, such as the use of dinoproston to promote cervical ripening, water sac, and other labor induction methods. In addition, different analgesia delivery times, such as the early delivery of analgesia which may lead to a prolonged labor process, were not explored. Furthermore, due to the limited sample size (subjects aged >35 or >40 years accounted for only 4.8% and 0.4% of the total number of parturients, respectively), advanced maternal age groups were not included in this study. Moreover, data regarding pregnancy complications were incomplete, which may have impacted on perinatal and neonatal outcomes. Therefore, a well-designed prospective trial should be conducted to validate the results.

## Conclusions

This study showed maternal age is an independent factor associated with the switch to emergency CS and an abnormal fetal heart rate, while the total duration of labor is an independent factor related to puerperal morbidity and MSAF. The older the maternal age and longer the

labor process, the greater the risk of emergency CS, fetal distress, and other adverse perinatal and neonatal outcomes. Therefore, health education should be implemented for late childbearing women and the monitoring of elderly mothers should be strengthened to reduce the incidence of adverse outcomes. A major limitation of this study was the lack of controlling potential clinical covariates that may bias the effects of maternal age and duration of labor (such as whether to perform labor analgesia and the timing of labor analgesia). Therefore, only relative association of maternal age and duration of labor could be confirmed. More delicate study design with potential confounders should be done to clarify the independent effects of factors in future work.

## Footnote

*Reporting Checklist*: The authors have completed the STROBE reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-22-4404/rc

*Data Sharing Statement*: Available at https://atm.amegroups.com/article/view/10.21037/atm-22-4404/dss

*Conflicts of Interest*: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-22-4404/coif). The authors have no conflicts of interest to declare.

*Ethical Statement*: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was approved by the institutional review board of General Hospital of Northern Theater Command [No. Y(2020)025], and written informed consent was obtained from the patients. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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## References

1. Beaujouan É, Sobotka T. Late childbearing continues to increase in developed countries | Cairn International Edition. Popul Soc 2019;562:1-4.
2. Bongaarts J, Mensch BS, Blanc AK. Trends in the age at reproductive transitions in the developing world: The role of education. Popul Stud (Camb) 2017;71:139-54.
3. Nations U. World Fertility Report 2015. United Nations, New York 2017;10017:2-79.
4. Martin JA, Hamilton BE, Osterman MJK, et al. Births: Final Data for 2019. Natl Vital Stat Rep 2021;70:1-51.
5. Ren Y. Characteristics of Chinese population development from 1949 to 2018, and lessons learned. China Popul Dev Stud 2020;3:269-81.
6. He D, Zhang X, Zhuang Y, et al. China fertility report, 2006–2016. China Popul Dev Stud 2019;2:430-9.
7. The National Bureau of Statistics of China. China Statistical Yearbook. China Statistics Press, 2016.
8. Pinheiro RL, Areia AL, Mota Pinto A, et al. Advanced Maternal Age: Adverse Outcomes of Pregnancy, A Meta-Analysis. Acta Med Port 2019;32:219-26.
9. Cohen W. Does maternal age affect pregnancy outcome? BJOG 2014;121:252-4.
10. Guedes M, Canavarro MC. Characteristics of primiparous women of advanced age and their partners: a homogenous or heterogenous group? Birth 2014;41:46-55.
11. Jackson S, Hong C, Wang ET, et al. Pregnancy outcomes in very advanced maternal age pregnancies: the impact of assisted reproductive technology. Fertil Steril 2015;103:76-80.
12. Zeng Y, Hesketh T. The effects of China's universal two-child policy. Lancet 2016;388:1930-8.
13. Mariani LL, Mancarella M, Fuso L, et al. Predictors of response after a second attempt of pharmacological labor induction: a retrospective study. Arch Gynecol Obstet 2020;302:117-25.
14. Miremerg H, Frig O, Rona S, et al. Is advanced maternal age associated with placental vascular malperfusion? A prospective study from a single tertiary center. Arch Gynecol Obstet 2020;301:1441-7.
15. Attali E, Yogev Y. The impact of advanced maternal age on pregnancy outcome. Best Pract Res Clin Obstet Gynaecol 2021;70:2-9.

16. Kortekaas JC, Kazemier BM, Keulen JKJ, et al. Risk of adverse pregnancy outcomes of late- and postterm pregnancies in advanced maternal age: A national cohort study. Acta Obstet Gynecol Scand 2020;99:1022-30.

17. Rademaker D, Hukkelhoven CWPM, van Pampus MG. Adverse maternal and perinatal pregnancy outcomes related to very advanced maternal age in primigravida and multigravida in the Netherlands: A population-based cohort. Acta Obstet Gynecol Scand 2021;100:941-8.

18. Frick AP. Advanced maternal age and adverse pregnancy outcomes. Best Pract Res Clin Obstet Gynaecol 2021;70:92-100.

19. Attali E, Doleeb Z, Hiersch L, et al. The risk of intrapartum cesarean delivery in advanced maternal age. J Matern Fetal Neonatal Med 2021. [Epub ahead of print]. doi: 10.1080/14767058.2021.1940936.

20. Xie M, Lao TT, Du M, et al. Risk for Cesarean section in women of advanced maternal age under the changed reproductive policy in China: A cohort study in a tertiary hospital in southwestern China. J Obstet Gynaecol Res 2019;45:1866-75.

21. Wu Y, Chen Y, Shen M, et al. Adverse maternal and neonatal outcomes among singleton pregnancies in women of very advanced maternal age: a retrospective cohort study. BMC Pregnancy Childbirth 2019;19:3.

22. Xie X, Kong B, Duan T. Obstetrics and Gynecology, 9th ed. People's Health Publishing House; 2020.

23. Wu J, Lu AD, Zhang LP, et al. Study of clinical outcome and prognosis in pediatric core binding factor-acute myeloid leukemia. Zhonghua Xue Ye Xue Za Zhi 2019;40:52-7.

24. Zhang M, Wang Y, Qi X. Effect of Very Advanced Maternal Age on Pregnant Women and Fetuses. J Coll Physicians Surg Pak 2021;30:542-5.

25. Guarga Montori M, Álvarez Martínez A, Luna Álvarez C, et al. Advanced maternal age and adverse pregnancy outcomes: A cohort study. Taiwan J Obstet Gynecol 2021;60:119-24.

26. Mylonas I, Friese K. Indications for and Risks of Elective Cesarean Section. Dtsch Arztebl Int 2015;112:489-95.

27. Janoudi G, Kelly S, Yasseen A, et al. Factors Associated With Increased Rates of Caesarean Section in Women of Advanced Maternal Age. J Obstet Gynaecol Can 2015;37:517-26.

28. Rydahl E, Declercq E, Juhl M, et al. Cesarean section on a rise-Does advanced maternal age explain the increase? A population register-based study. PLoS One 2019;14:e0210655.

29. Kim SY, Park JY, Bak SE, et al. Effect of maternal age on emergency cesarean section. J Matern Fetal Neonatal Med 2019. [Epub ahead of print]. doi: 10.1080/14767058.2019.1593958.

30. Wang JG, Sun JL, Shen J. Factors affecting failed trial of labor and countermeasures: A retrospective analysis. World J Clin Cases 2020;8:3483-92.

31. Hornberger LK, Sahn DJ. Rhythm abnormalities of the fetus. Heart 2007;93:1294-300.

32. Cavazos-Rehg PA, Krauss MJ, Spitznagel EL, et al. Maternal age and risk of labor and delivery complications. Matern Child Health J 2015;19:1202-11.

33. Ngowa JD, Ngassam AN, Dohbit JS, et al. Pregnancy outcome at advanced maternal age in a group of African women in two teaching Hospitals in Yaounde, Cameroon. Pan Afr Med J 2013;14:134.

34. Peng ZY, Yu LL, Wang W, et al. Clinical analysis on premature and prognosis of preterm infants. Journal of Zunyi Medical University 2017;40:297-301.

35. Zhao L, Li LX, Li YH, et al. Analysis of premature delivery reasons and complications of premature infants. Chinese Journal of Obstetrics & Gynecology and Pediatrics (Electronic Edition) 2014;10:69-72.

36. Wang L, Wang H, Jia L, et al. The impact of stage of labor on adverse maternal and neonatal outcomes in multiparous women: a retrospective cohort study. BMC Pregnancy Childbirth 2020;20:596.

37. Zipori Y, Grunwald O, Ginsberg Y, et al. The impact of extending the second stage of labor to prevent primary cesarean delivery on maternal and neonatal outcomes. Am J Obstet Gynecol 2019;220:191.e1-7.

38. Pergialiotis V, Bellos I, Antsaklis A, et al. Maternal and neonatal outcomes following a prolonged second stage of labor: A meta-analysis of observational studies. Eur J Obstet Gynecol Reprod Biol 2020;252:62-9.

39. Saunders K. Should we worry about meconium? A controlled study of neonatal outcome. Trop Doct 2002;32:7-10.

40. Mohan M. Maternal risk factors and perinatal outcome in meconium stained amniotic fluid: a cross sectional study. Int J Reprod Contraception, Obstet Gynecol 2018;7:4103.

41. Cheng YW, Hopkins LM, Laros RK Jr, et al. Duration of the second stage of labor in multiparous women: maternal and neonatal outcomes. Am J Obstet Gynecol 2007;196:585.e1-6.

42. Cheng YW, Hopkins LM, Caughey AB. How long is too long: Does a prolonged second stage of labor in nulliparous women affect maternal and neonatal outcomes?

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Am J Obstet Gynecol 2004;191:933-8.

43. Lee KA, Mi Lee S, Jin Yang H, et al. The frequency of meconium-stained amniotic fluid increases as a function of the duration of labor. J Matern Fetal Neonatal Med 2011;24:880-5.

44. Cavoretto PI, Seidenari A, Amodeo S, et al. Quantification of Posterior Risk Related to Intrapartum FIGO 2015 Criteria for Cardiotocography in the Second Stage of Labor. Fetal Diagn Ther 2021;48:149-57.

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