The Effect of Maternal Age and Duration of Labor on Perinatal and Neonatal Outcomes

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Abstract

Purpose

This study aimed to investigate the effect of maternal age and duration of labor on perinatal and neonatal outcomes.

Methods

From 2016 to 2018, 9,241 parturients (mean age = 29.15 ± 3.41) were included and divided into the age < 28 group (n = 2911), age 28–30 group (n = 3631); and age > 30 years (n = 2699). According to the total duration of labor, the parturients who did not undergo cesarean section (CS) were subgrouped into the < 420 minutes group (n = 4065) and the ≥ 420 minutes group (n = 4094). The perinatal and neonatal outcomes were compared among groups.

Results

Higher age groups were more likely to switch to emergency cesarean section (CS) ($P < 0.001$). The incidence of postpartum fever was significantly higher in age < 28 and 28–30 groups ($P = 0.035$). The age 28–30 group was more likely to have abnormal fetal heart rate ($P = 0.017$). The ≥ 420 minutes group had higher rate of side cut/forceps during delivery, more bleeding volume, higher rate of using oxytocin, postpartum fever, abnormal fetal heart rate, and meconium-stained amniotic fluid (MSAF) as compared with the < 420 minutes group (all $P < 0.05$). The multivariate logistic regression analysis showed that as age increased, the rates of switch to emergency CS and abnormal fetal heart rate also increased, while parturients with longer total duration of labor had higher risk of postpartum fever and MSAF (all $P < 0.01$).

Conclusion

Maternal age was an independent factor associated with switch to emergency CS and abnormal fetal heart rate, while total duration of labor was an independent factor associated with postpartum fever and MSAF.

Introduction

There has been an increasing trend in childbearing age worldwide in the past few decades [1, 2], especially in the developed nations [3, 4]. China is a developing country with unique socioeconomic characteristics [5]. The China fertility survey 2017 demonstrates that from 2006 to 2016, the mean ages at first marriage and first birth increased by 2.7 and 2.6 years, respectively [6]. The mean age of parturients at first birth increased from 24.3 to 26.9 years, and the mean age of parturients at second birth increased from 29.2 years (2014) to 30.2 years (2016) [6]. In 2016, advanced pregnancies (age ≥ 35

years) accounted for approximately 31% of the total pregnancies in China [7]. This trend can partially be attributed to changes in social habits, such as high education, careers, financial stability, late marriage, use of contraception [8–11]. The Chinese government has relaxed the 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. Maternal age has been shown to play a crucial role in, pregnancy-related complications, and adverse obstetric and perinatal outcomes [13–17]. However, the studies on maternal age on pregnancy outcome in the Chinese population are relatively limited [18, 19]. Therefore, the purpose of this study was to investigate the impact of maternal age and total duration of labor on perinatal and neonatal outcomes.

Methods

Study subjects

This was a retrospective observation study. A total of 9241 parturients who delivered in the General Hospital of Northern Theater Command of the Chinese People's Liberation Army from January 2016 to December 2018 were included and divided into three groups based on age as follows: age < 28 group (n = 2911), age 28–30 group (n = 3631); and age > 30 years (n = 2699). Meanwhile, according to the total duration of labor, the parturients were subgrouped into the < 420 minutes group (n = 4065) and the $\geq$ 420 minutes group (n = 4094).

This study was approved by the institutional review board of our hospital (approval no Y(2020)025). Written informed consent was obtained from the patient.

Data Collection

Data included labor of each stage, labor outcome (delivery method), bleeding amount, use of oxytocin, side cut/forceps during delivery, postpartum fever, 1-min and 5-min Apgar score, the body weight of newborn, the incidences of abnormal fetal heart rate and meconium-stained amniotic fluid (MSAF) were collected.

Statistical analysis

Continuous variables were reported with mean $\pm$ standard deviation (SD). Means between two groups were compared using Student's independent t-test, for over 3 groups were compared using one-way ANOVA. Categorical variables were presented as number and percentage and were compared using the Chi-square test or Fisher's exact test (if expected value ≤ 5 was found). The multivariate logistic regression model was used to investigate the associations between age/total duration of labor group factors to different postpartum outcomes, including switch to emergency CS, postpartum fever, abnormal fetal heart rate, and MSAF. All analyses were done using IBM SPSS Version 25 (SPSS Statistics V25, IBM

Corporation, Somers, New York). The statistical significance level for all the tests was set at a P-value < 0.05, two-tailed.

Results

Participant’s characteristics among age groups

From 2016 to 2018, a total of 9,241 parturients were included. The mean age was 29.15 ± 3.41 years, the mean gestational age was 29.15 ± 3.41 weeks. The gravidity and parity for all parturients were 1.56 ± 0.87 and 0.17 ± 0.39 times, respectively. Of them, 44.61% of parturients underwent epidural anesthesia in delivery, 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: age < 28 group (n = 2911), age 28–30 group (n = 3631); and age > 30 years (n = 2699) based on PR33 and PR66 (PR: percentile) as the cut-off among groups. There were significant differences in gestational age, gravidity, parity, and the use of epidural anesthesia among the three groups (all P < 0.01). It was found that gestational age slightly decreased as age increased. Gravidity and parity increased as age increased. Younger parturients were more likely to use epidural anesthesia.

Table 1
Participant’s characteristics among age groups

Age group					
Parameters	< 28 (n = 2911)	28–30 (n = 3631)	> 30 (n = 2699)	All (n = 9241)	P
Age, year	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
Parity	0.06 ± 0.24	0.10 ± 0.31	0.39 ± 0.51	0.17 ± 0.39	< 0.001
Epidural anesthesia using	1448 (49.74%)	1727 (47.56%)	947 (35.09%)	4122 (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

Postpartum Outcomes Among Age Groups

The perinatal and neonatal outcomes were compared among the three groups, including duration of labor of each stage, labor outcome (delivery method), bleeding amount, oxytocin using, postpartum fever, Apgar score of newborns at 1st and 5th minute, the body weight of newborn, the occurrence of abnormal fetal heart rate and MSAF.

As shown in Table 2, parturients in the age > 30 group were more likely to have shorter labor at stage 1, 3 and total duration of labor (all $P < 0.05$). These parturients also had a higher rate of normal spontaneous delivery (NSD) as labor outcome ($P < 0.001$). Higher age groups were more likely to switch to cesarean section (CS) ($P < 0.001$). The incidence of postpartum fever was significantly higher in age < 28 and 28–30 groups ($P = 0.035$). The bodyweight of newborn was slightly increased as age increased ($P < 0.001$). The age 28–30 group was more likely to have abnormal fetal heart rate ($P = 0.017$). Apgar scores were not different among the three age groups (both $P > 0.05$).

Table 2
Postpartum outcomes among age groups

Age group					
Parameters	< 28 (n = 2911)	28–30 (n = 3631)	> 30 (n = 2699)	All (n = 9241)	P
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%)	1145 (32.15%)	1283 (48.43%)	3375 (37.24%)	
CS	264 (9.25%)	473 (13.28%)	303 (11.44%)	1040 (11.48%)	
Side cut/forceps	1642 (57.55%)	1943 (54.56%)	1063 (40.13%)	4648 (51.29%)	
Switch to emergency CS	264 (9.07%)	473 (13.03%)	303 (11.23%)	1040 (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 using	923 (32.65%)	1228 (35.08%)	850 (32.79%)	3001 (33.64%)	0.070
Postpartum fever	183 (6.32%)	233 (6.46%)	134 (5.00%)	550 (5.99%)	0.035
Apgar score					
1st minute	9.97 ± 0.31	9.98 ± 0.23	9.97 ± 0.32	9.98 ± 0.29	0.263
5th minute	9.99 ± 0.21	10.00 ± 0.10	9.99 ± 0.18	9.99 ± 0.17	0.526
Body weight of newborn, g	3412.02 ± 390.11	3441.73 ± 390.88	3451.23 ± 399.49	3435.14 ± 393.46	< 0.001
Abnormal fetal heart rate	723 (25.34%)	1002 (28.21%)	677 (25.67%)	2402 (26.56%)	0.017
Abbreviations: NSD, normal spontaneous delivery; CS, caesarean section; MSAF, meconium-stained amniotic fluid.					

Age group					
MSAF	833 (29.18%)	1033 (29.06%)	771 (29.20%)	2637 (29.14%)	0.991
Abbreviations: NSD, normal spontaneous delivery; CS, caesarean section; MSAF, meconium-stained amniotic fluid.					

Participant's Characteristics Between The Two Duration Of Labor Groups

According to the median of the total duration of labor, the parturients were subgrouped into the < 420 minutes group (n = 4065) and the $\geq$ 420 minutes group (n = 4094). In these analyses, parturients who underwent CS were excluded due to lack of total duration of labor data. As shown in Table 3, the < 420 minutes group ($\geq$ 420 minutes group) had significantly younger age, longer gestational age, lower gravidity and parity, higher rate of using epidural anesthesia, and smaller cervix dilation at epidural anesthesia as compared with the < 420 minutes group (all $P < 0.05$).

Table 3
Participant's characteristics between total labor time groups

Total labor time group				
Parameters	< 420 (n = 4065)	$\geq$ 420 (n = 4094)	All (n = 8159)	P
Age, year	29.49 $\pm$ 3.75	28.77 $\pm$ 3.09	29.13 $\pm$ 3.45	< 0.001
Gestational age, week	39.56 $\pm$ 1.10	39.73 $\pm$ 1.08	39.64 $\pm$ 1.09	< 0.001
Gravidity	1.75 $\pm$ 0.97	1.41 $\pm$ 0.75	1.58 $\pm$ 0.88	< 0.001
Parity	0.33 $\pm$ 0.49	0.06 $\pm$ 0.24	0.19 $\pm$ 0.41	< 0.001
Epidural anesthesia using	1139 (28.02%)	2337 (57.08%)	3476 (42.60%)	< 0.001
Cervix dilation at epidural anesthesia, cm	2.56 $\pm$ 0.77	2.49 $\pm$ 0.75	2.52 $\pm$ 0.76	0.023

Postpartum Outcomes Between The Two Duration Of Labor Groups

The perinatal and neonatal outcomes were also compared between total duration of labor groups. As shown in Table 4, the ≥ 420 minutes group had higher rate of side cut/forceps during delivery, more bleeding volume, higher rate of using oxytocin, postpartum fever, abnormal fetal heart rate, and MSAF as compared with the < 420 minutes group (all $P < 0.05$). The bodyweight of newborn was also slightly higher in the ≥ 420 minutes group ($P < 0.001$). Apgar scores did not differ between the two groups (both $P > 0.05$).

Table 4
Postpartum outcomes between total labor time groups

Total labor time group				
Parameters	< 420 (n = 4065)	≥ 420 (n = 4094)	All (n = 8159)	P
Labor time				
Stage 1	231.77 $\pm$ 108.36	467.00 $\pm$ 119.36	349.49 $\pm$ 163.79	< 0.001
Stage 2	36.37 $\pm$ 32.13	87.85 $\pm$ 55.06	62.13 $\pm$ 51.92	< 0.001
Stage 3	8.49 $\pm$ 3.52	8.50 $\pm$ 3.57	8.50 $\pm$ 3.54	0.944
All stage	276.81 $\pm$ 118.99	563.14 $\pm$ 123.09	420.48 $\pm$ 187.49	< 0.001
Labor outcome				< 0.001
NSD	2124 (53.39%)	1210 (30.23%)	3334 (41.77%)	
Side cut/forceps	1854 (46.61%)	2793 (69.77%)	4647 (58.23%)	
Bleeding, ml	381.35 $\pm$ 108.02	389.60 $\pm$ 146.40	385.49 $\pm$ 128.78	0.004
Oxytocin using	968 (25.03%)	1578 (39.56%)	2546 (32.41%)	< 0.001
Postpartum fever	80 (1.98%)	279 (6.86%)	359 (4.43%)	< 0.001
Apgar score				
1st minute	9.98 $\pm$ 0.24	9.97 $\pm$ 0.30	9.98 $\pm$ 0.27	0.276
5th minute	9.99 $\pm$ 0.12	10.00 $\pm$ 0.17	9.99 $\pm$ 0.15	0.648
Body weight of newborn, g	3406.09 $\pm$ 403.04	3440.00 $\pm$ 374.90	3423.10 $\pm$ 389.52	< 0.001
Abnormal fetal heart rate	785 (20.07%)	1021 (25.15%)	1806 (22.65%)	< 0.001
MSAF	1043 (26.53%)	1294 (31.91%)	2337 (29.26%)	< 0.001
NSD, normal spontaneous delivery; MSAF, meconium-stained amniotic fluid.				

Postpartum Outcomes In Multivariate Models

To investigate the association between age/total duration of labor groups to postpartum outcomes, the significant variables among groups (Tables 1 and 3) were adjusted in a multivariate logistic regression model. For the age groups, participant's gestational age, gravidity, and parity were adjusted; For the total duration of labor groups, the adjusted covariates were age, gestational age, gravidity, and parity.

As shown in Table 5, as age increased, the rates of switch to emergency CS and abnormal fetal heart rate also increased (all $P < 0.01$); parturients with longer total duration of labor (≥ 420 minutes group) had significantly higher risk of postpartum fever and MSAF (both $P < 0.01$).

Table 5

The logistic regression results of age/total labor time group factors to clinical postpartum outcomes

Parameters	Switch to emergency CS		Postpartum fever		Abnormal fetal heart rate		MSAF	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Age group, year		< 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			3.05 (2.35 to 3.96)	< 0.001	1.09 (0.98 to 1.22)	0.112	1.17 (1.05 to 1.30)	0.003
MSAF, meconium-stained amniotic fluid.								
The multivariate models of age group were adjusted with gestational age, gravidity, and parity.								
The multivariate models of total labor time group were adjusted with age, gestational age, gravidity, and parity.								

Discussion

In this study, we investigated the effect of maternal age and total duration of labor on perinatal and neonatal outcomes. The results showed that higher age groups were more likely to switch to emergency CS. The incidence of postpartum fever was significantly higher in the age < 28 and 28–30 groups. The age 28–30 group was more likely to have abnormal fetal heart rate. The ≥ 420 minutes group had higher rate of side cut/forceps during delivery, more bleeding volume, higher rate of using oxytocin, postpartum fever, abnormal fetal heart rate, and MSAF as compared with the < 420 minutes group. The multivariate logistic regression analysis showed that as age increased, the rates of switch to emergency CS and abnormal fetal heart rate also increased, while parturients with longer total duration of labor had higher risk of postpartum fever and MSAF.

Higher maternal age would increase the risk of obstetric complications, such as gestational diabetes, preeclampsia, placenta previa, placental abruption [15, 20, 21]. As a result, it is well-known that the cesarean section rate increased with increasing maternal age [22–24]. Advanced pregnant women are more likely to undergo cesarean section due to scarred uterus, a history of adverse pregnancy, difficult pregnancy, unwilling to vaginal trial delivery, psychological pressure, lack of confidence in vaginal trial delivery. In addition, with the increase of gravidity, the incidences of abdominal wall relaxation, breech position, transverse position and other abnormal fetal position also increase. Since vaginal delivery has many uncertain factors, advanced pregnant women tend to expand the surgical indications, thus increasing the cesarean section rate. Kim et al. have demonstrated that advanced maternal age is an independent risk factor of emergency CS due to nonreassuring fetal heart rate or arrest disorder [25]. Our previous study showed that maternal age is an independent risk factor associated with conversion to an emergency cesarean section in the failed trial of labor [26]. Attali et al. also reported that advanced maternal age is an independent risk factor for intrapartum Cesarean delivery [13, 17]. Consistent with these findings, this study showed that maternal age is an independent factor associated with switch to emergency CS. The parturients with age of 28–30 had a 1.58 -time higher risk of switch to emergency CS as compared with those under age of 28. For those over age of 30, the risk elevated to 1.87 times.

In this study, maternal age was also an independent risk factor for abnormal fetal heart rate, which is one sign of fetal distress [27]. Compared to parturients under age of 28, those with age of 28–30 and those above age of 30 had 1.20-time and 1.38-time higher risk of fetal heart rate abnormality, respectively. In line with this observation, Cavazos-Rehg, et al. have revealed that both younger and older parturients have an increased risk of fetal distress [28]. Ngowa et al. also reported that multiparous advanced parturients had an increased incidence of fetal distress [29].

Accumulating evidence has suggested that the prolonged duration of labor increases adverse maternal and neonatal outcomes [30, 31]. Our results showed that the parturients with a duration of labor ≥ 420 min had a significantly higher incidence of postpartum fever than those with a duration of labor < 420 min. In addition, the multivariate logistic regression model adjusted for the confounding factors including age, gestational age, gravidity, and parity showed that parturients with prolonged duration of labor had a

3.05-time higher risk of postpartum fever. This observation is in agreement with a meta-analysis by Pergialiotis et al. that included 13 studies and 337,845 parturients and demonstrated that prolonged second stage was associated with higher incidences of postpartum fever [32].

Prolonged duration of labor is a risk factor for passage of meconium in utero [33]. MSAF is also regarded as a sign of fetal distress and fetal asphyxia and its precise etiology is still unclear [34]. Cheng et al. have reported that prolonged second stage of labor increases the incidence of MSAF [35, 36]. Lee et al. also confirmed that the longer the duration of labor (first stage, second stage, or total), the higher the frequency of MSA [37]. Supporting this notion, our results showed that the risk of MSAF slightly elevated (1.17 times) in parturients with a longer duration of labor (first stage, second stage, and total).

It should be noted that this study was limited by its retrospective nature. Some confounding factors were not excluded, such as whether the puerpera used other labor inducing drugs except for oxytocin, and different time of labor analgesia. A well-designed prospective trial should be conducted to validate the findings of this study.

In summary, our results showed that maternal age was an independent factor associated with switch to emergency CS and abnormal fetal heart rate, while total duration of labor was an independent factor associated with postpartum fever and MSAF.

Declarations

Funding

This study was supported by the Natural Science Foundation of Liaoning Province (No. 2019-ZD-1037).

Conflicts of interest

The authors declare that they have no conflict of interest.

Ethics approval

This study was approved by the institutional review board of our hospital (approval no Y(2020)025).

Consent to participate

Written informed consent was obtained from the patient.

Consent for publication

Not applicable.

Availability of data and material

All data generated or analyzed during this study are included in this published article.

Code availability

Not applicable.

Author contributions

We declare that all the listed authors have participated actively in the study and all meet the requirements of the authorship. Dr. Jingli Sun designed the study, and was a director of the study. Drs. Jian Shen and Xiaoshu Wang collected the data. Dr. Jian Shen, Jia Song, and Fanyu Zeng analyzed the data. Dr. Jian Shen was a major contributor in writing and revising the manuscript. All authors read and approved the final manuscript.

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