

Influence of Maternal Age on Selected Obstetric Parameters

Der Einfluss des maternalen Alters auf ausgewählte geburtshilfliche Parameter



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ABSTRACT

Introduction In recent decades, there has been a continuous rise in the average age at which women give birth. A maternal age of 35 years and above is considered an independent risk factor in pregnancy and birth, due to higher rates of intervention. This study investigates the influence of maternal age on birth procedure, gestational age, and rate of interventions during delivery. The influence of maternal parity is also analyzed.

Material and Methods Data from the Austrian Register of Births was retrospectively collected and evaluated. The collected data was the data of all singleton live births in Austria between January 1, 2008 and December 31, 2016 (n = 686272). Multiple births and stillbirths were excluded from the study. Maternal age and parity were analyzed in relation to predefined variables (birth procedure, gestational age, episiotomy in cases of vaginal delivery, epidural anesthesia in both vaginal and cesarean deliveries, and intrapartum micro-blood gas analysis). Statistical data was evaluated using (1) descriptive univariate analysis, (2) bivariate analysis, and (3) multinomial regression models.

Results The cesarean section rate and the rate of surgically-assisted vaginal deliveries increased with advancing maternal age, especially in primiparous women, while the rate of spontaneous deliveries decreased with increasing maternal age. A parity of ≥ 2 had a protective effect on the cesarean section rate. The rate of premature births also increased with increasing maternal age, particularly among primiparous women.

Discussion Although higher maternal age has a negative effect on various obstetric parameters, it was nevertheless not possible to identify a causal connection. Maternal age should not be assessed as an independent risk factor; other factors such as lifestyle or prior chronic disease and parity must be taken into consideration.

ZUSAMMENFASSUNG

Einleitung Das durchschnittliche Alter Gebärender in Österreich ist in den letzten Jahrzehnten deutlich angestiegen. Ein mütterliches Alter ab 35 wird aufgrund einer höheren Interventionsrate als unabhängiger Risikofaktor für Schwangerschaft und Geburt diskutiert. In dieser Arbeit wird der Einfluss mütterlichen Alters auf den Geburtsmodus, die Schwangerschaftsdauer und die Interventionsrate während der Geburt untersucht. Zudem wird der Einfluss der mütterlichen Parität analysiert.

Material und Methoden Als Methode wurde eine retrospektive Datenerhebung und Auswertung aus dem Geburtenregister Österreich gewählt. Die vorliegende Arbeit bezieht sich auf Daten aller Einlings-Lebendgeburten in Österreich im

Zeitraum vom 01.01.2008 bis 31.12.2016 (n = 686272). Ausgeschlossen wurden Mehrlings- und Totgeburten. Das Alter und die Parität der Mutter wurden mit vorab definierten Variablen (Entbindungsmodus, Schwangerschaftswoche, Episiotomie bei Vaginalgeburt, Periduralanästhesie bei Vaginalgeburt oder Sectio sowie Mikrobiuntersuchung) untersucht. Die statistische Datenauswertung erfolgte mittels (1) deskriptiver Abbildung der Häufigkeiten, (2) bivariater Analyse sowie (3) der Anwendung multinomialer Regressionsmodelle.

Ergebnisse Die Raten an Sectiones und vaginal-operativen Geburtsbeendigungen steigen mit zunehmendem Alter der Mutter vor allem bei Erstgebärenden an, dementsprechend

sinkt die Rate an Spontangeburt mit Anstieg des maternalen Alters. Eine Parität von ≥ 2 hat einen protektiven Einfluss auf die Sectionrate. Ebenso erhöht ist vor allem bei Erstgebärenden die Rate an Frühgeburten mit zunehmendem mütterlichen Alter.

Diskussion Wenngleich erhöhtes mütterliches Alter diverse geburtshilfliche Parameter negativ beeinflusst, ist ein Kausalzusammenhang nicht verifizierbar. Das Alter der Mutter kann nicht als unabhängiger Risikofaktor gewertet werden, vielmehr muss neben Faktoren wie Lifestyle oder chronische Vorerkrankungen die Parität in die Betreuungsplanung einbezogen werden.

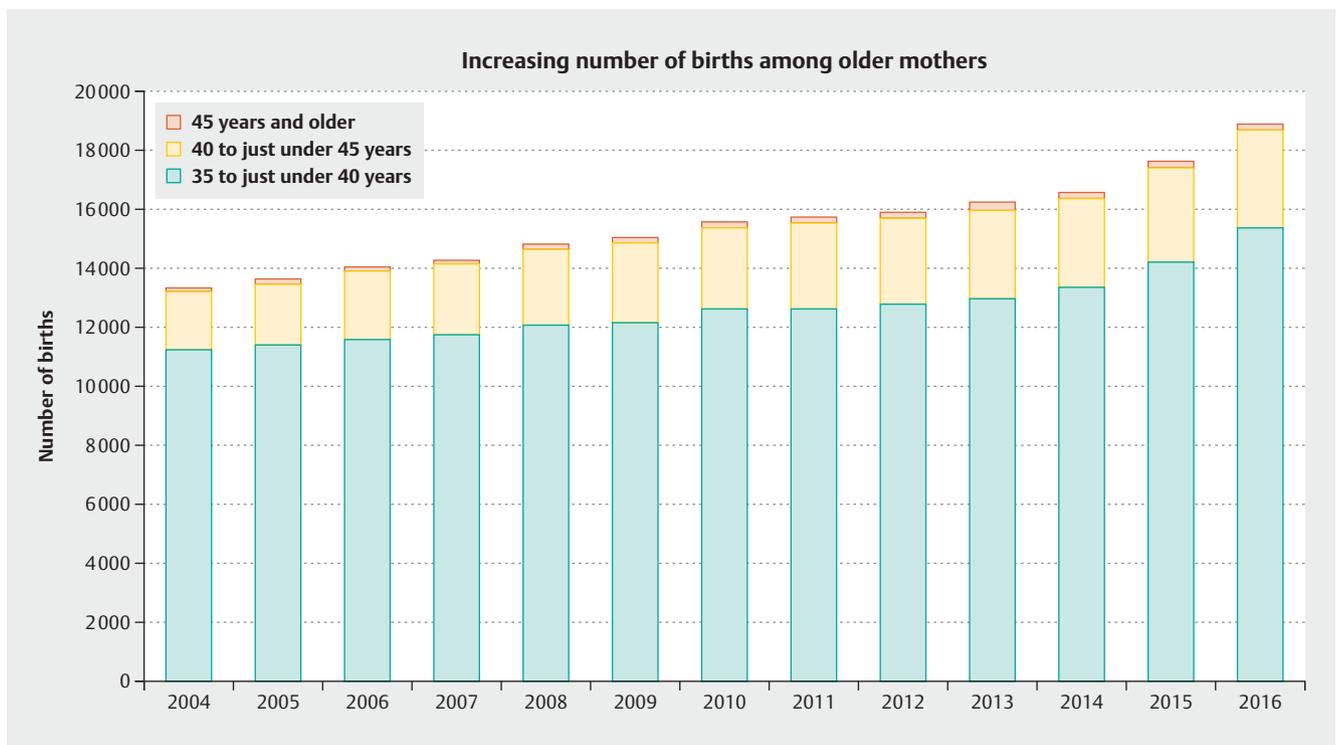
Introduction

In recent decades, the age at which women give birth has continually increased. In Austria, the average age of primiparous women in 2016 was 29.4 years. By comparison, in 1984 the average age of primiparous women in Austria was 23.8 years [1] (► Fig. 1).

Factors which have contributed to the higher maternal age at the birth of the first child include increased life expectancy, higher levels of education and better career opportunities for women, more birth control options, the availability of reproductive medicine, changed attitudes to sexuality and partnership, and late marriage as well as higher rates of divorce [2, 3]. The percentage of women who only start trying for a baby at the age of 35 years

or above has increased, especially in the last three decades. The trend to delay having children is particularly evident in countries with high per-capita incomes [4, 5].

The obstetrically relevant definition of advanced maternal age varies in the literature. On the one hand, a maternal age of ≥ 35 years is recognized as an independent risk factor for various obstetric interventions and complications [3, 6]; on the other hand, a cut-off age of ≥ 40 years has been reported to be the threshold for significantly higher risks [4, 5, 7]. Given this context, the 1958 definition of the International Federation of Gynecology and Obstetrics, which defined advanced maternal age as ≥ 35 years [2], should be reconsidered.



► Fig. 1 Increased numbers of births to mothers aged 35 years and above (Source: Statistik Austria, own research [1]).

The number of chromosomal abnormalities increase with increasing maternal age. This is especially relevant for Down's syndrome but also has an impact on Patau's syndrome and Edwards syndrome [4]. The risk of having a child with trisomy is 1:1250 for women aged 25, 1:800 for women aged 30, 1:340 for women aged 35, 1:100 for women aged 40 and 1:25 for women aged 45 years. As the overall number of aneuploid infants increases with increasing maternal age, in the 1970s a maternal age of 35 years was identified as the threshold which justified prenatal investigation due to an increased risk of aneuploidy [8]. There is no known association between advanced maternal age and non-chromosomal abnormalities [9].

The rate of miscarriages due to embryonic chromosomal abnormalities also increases with advanced maternal age [2,4].

The risk of premature delivery is significantly higher for young women aged ≤ 19 years and for women aged ≥ 40 years [10,11]. It is not yet clear whether maternal age is in itself an independent risk factor for higher rates of premature deliveries or whether age-dependent factors are primarily responsible for triggering pre-term births [4].

The duration of the birth, particularly the duration of the expulsion period, and the risk of operative vaginal delivery increase with increasing maternal age. The C-section rate, particularly the rate of primary caesarean sections, increases significantly with higher maternal age [12–18].

In addition to the parameters listed above, advanced maternal age also has an effect on the rate of multiple pregnancies, the rate of placenta previa [19], the placental abruption rate [3], the episiotomy rate [20] and the incidence of women with pregnancy-related hypertension or gestational diabetes [21]. Age-related reduced placental perfusion is considered one of the reasons for the higher percentage of low birthweight neonates and neonates with intrauterine growth retardation [3]. Overall, studies which have investigated the impact of maternal age on relevant obstetric parameters have presented varying results; the evidence for obstetric pathophysiology due to biological aging processes and for the role of parity is limited [22].

Aim and Research Questions

The aim of this study was to present the impact of advanced maternal age on selected obstetric parameters such as mode of delivery, duration of pregnancy and obstetric interventions, using basic epidemiological data. The study additionally aimed to investigate whether parity, when combined with maternal age, has an impact on selected obstetric parameters, and if so, to what extent. This gave rise to the following research questions: What effect does the maternal age of primiparous women have on the mode of delivery, the duration of pregnancy and the rate of interventions during delivery? What impact does parity have in this context?

Material and Methods

Publication of this article was approved by the Ethics Committee of Upper Austria, permission was obtained from the Austrian Register of Births, and the advisory board of the Institute for Clin-

ical Epidemiology of Tyrolean Hospitals approved the data analysis.

The Austrian Register of Births records the data of all in-hospital births which occur in Austria on an epidemiological basis. The method used in this study was retrospective data collection and evaluation.

Sample and variables

This retrospective study is based on the data of all singleton births which occurred in Austria between January 1, 2008 and December 31, 2016 ($n = 686\,272$).

The total study population was grouped into seven age cohorts (< 20 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years, 40–44 years, ≥ 45 years) and according to parity (primiparae $n = 336\,967$, secundiparae $n = 236\,103$, multiparae $n = 113\,202$). Maternal age and parity were compared for the following predefined variables: mode of delivery (spontaneous birth, vacuum extraction, forceps delivery, primary and secondary C-section), week of gestation, obstetric interventions (episiotomy, epidural and spinal anesthesia during vaginal delivery, primary and secondary C-section) and micro-blood gas analysis during the first stage of labor.

Multiple births and stillbirths were excluded.

Data were first evaluated by descriptive analysis, which calculated the frequencies for the various maternal age cohorts. The impact of maternal age on selected variables was evaluated using column and row percentages of contingency tables, with the χ^2 statistic as the measure of association for row and column variables.

Multinomial models [23] were used to further evaluate the datasets, with maternal age taken as the explanatory variable and the different obstetrically relevant parameters as the dependent variables. The estimated coefficients can be interpreted as odds ratios for the selected categories compared to the reference category. If the dependent variables were found to be based on only two categories, the statistical model resulted in the special case of logistic regression.

The reference category used to calculate the odds ratio was based on women aged 20–24 years of age and of varying parity who had a physiological birth (depending on the investigated variable: spontaneous delivery, delivery at term or no obstetric intervention).

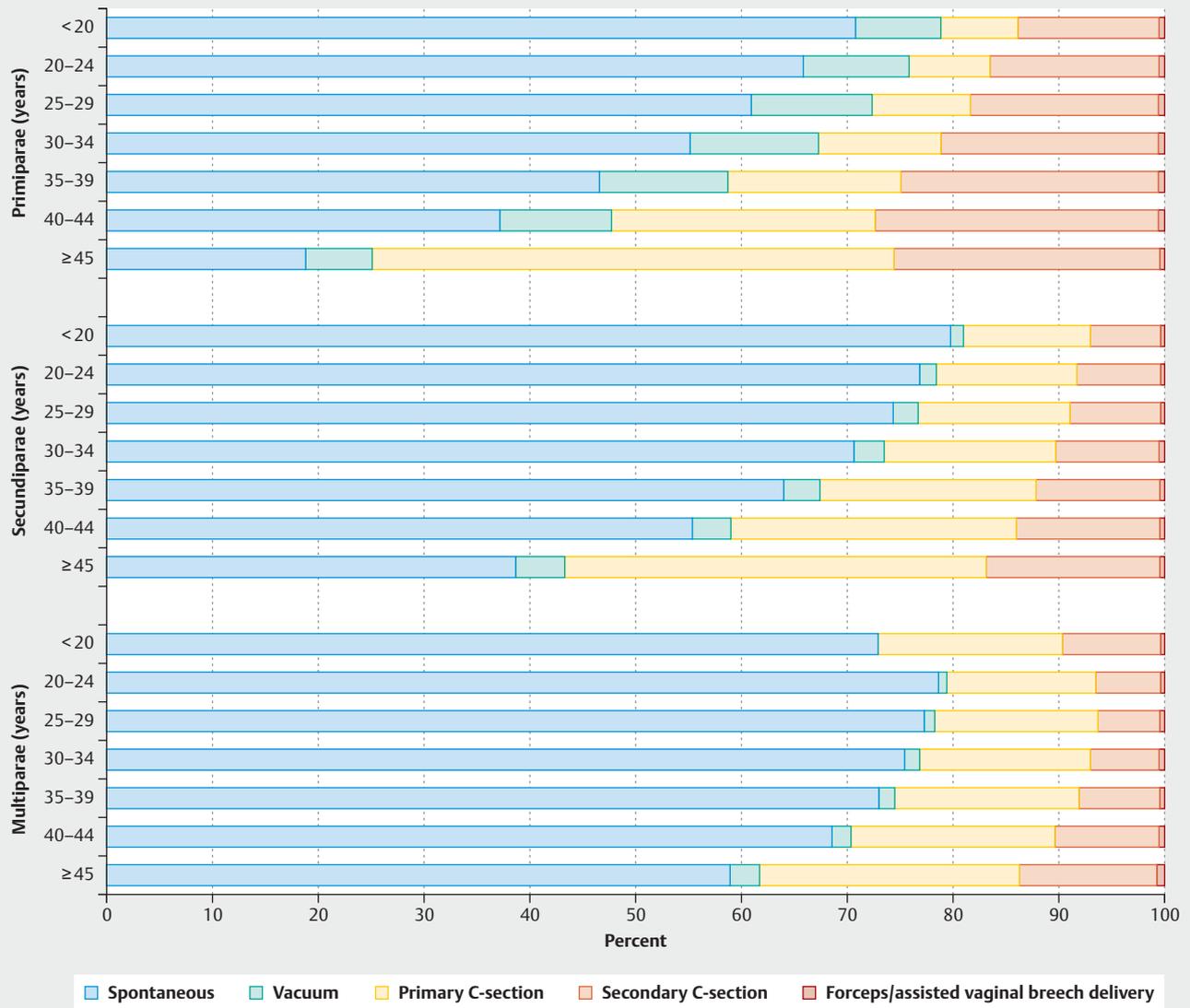
Results

Mode of delivery

In primiparous women, the rate of spontaneous deliveries decreased continuously with increasing maternal age. The percentage of spontaneous births for the total group of primiparae was 58.3%; the figure was 70.9% for the group of primiparous women aged less than 20 years and 18.9% for the group of women aged more than 45 years.

The reverse was found for the rate of primary C-sections: in this case, the average rate rose from 7.3% (OR: 0.87) for primiparae under the age of 20 to 49.6% (OR: 22.12) for primiparous women above the age of 45.

Mode of delivery according to maternal age of primiparae, secundiparae and multiparae (3+)



► Fig. 2 Correlation between mode of delivery and age and parity, in % (own research).

Similarly, the rate of secondary C-sections in the group of primiparous women increased from 13.5% (OR: 0.79) for mothers aged less than 20 years to 25.1% (OR: 5.52) for mothers aged more than 45 years.

When the study evaluated the rates of surgically assisted vaginal deliveries using vacuum extraction, the risk in the group of primiparous women also increased with increasing maternal age; the rate for primiparous women aged < 20 years was 8.1% (OR: 0.75), and 6.23% in the group of primiparous women aged ≥ 45 years (OR: 2.19).

With regard to spontaneous deliveries, the results were similar for the group of women giving birth for the second time. Here too, the rate dropped from 79.9% for the group aged < 20 years to 38.8% for the group aged ≥ 45 years. In contrast, the risk of primary cesarean section increased in these respective age cohorts

from 12.27% (OR: 0.89) to 39.95% (OR: 5.99); the risk of secondary C-section increased from 6.7% (OR: 0.81) to 16.36% (OR: 4.07), and the risk of vacuum extraction rose from 1.13% (OR: 0.66) to 4.67% (OR: 5.63).

The cohort of women who were giving birth for the third time or more had the highest rates of spontaneous births in all age groups aged > 20 years and the lowest rate of surgically assisted vaginal and abdominal deliveries.

In the group of women aged 35 or above, the risk of primary cesarean section decreased with increasing parity. While the OR for primiparae in the group of women aged 35–39 years was still 3.04, the risk dropped to OR 1.33 for the women in this age cohort who were giving birth for the third time. In the group aged 40–44 years, the risk decreased from OR 5.646 to OR 1.58 and in the group aged ≥ 45 years from OR 22.12 to OR 2.32.

► **Table 1** Odds ratios (OR) for the correlation between the mode of delivery and parity and maternal age (own research).

	Maternal age	Vacuum extraction	Forceps delivery	Assisted vaginal breech delivery	Primary C-section	Secondary C-section
		OR	OR	OR	OR	OR
1 para	<20	0.75***	0.69	1.19	0.87***	0.79***
	25–29	1.23***	1.25	2.23***	1.29***	1.21***
	30–34	1.45***	1.08	3.76***	1.8***	1.54***
	35–39	1.72***	1.8***	3.5***	3.04***	2.16***
	40–44	1.89***	1.44	3.84***	5.65***	2.98***
	≥45	2.19***	3.74	0	22.12***	5.52***
2 para	<20	0.67	0	0	0.89	0.81
	25–29	1.53***	0.93	1.15	1.12***	1.12***
	30–34	1.86***	1.06	1.8**	1.34***	1.34***
	35–39	2.35***	1.08	2.12***	1.85***	1.76***
	40–44	3.07***	2.6	1.91*	2.83***	2.36***
	≥45	5.63***	12.1*	0	5.99***	4.07***
3+ para	<20	0	0	0	1.34	1.66
	25–29	1.32	0.41	1.52	1.11*	0.96
	30–34	1.9**	0.54	2.08	1.2***	1.1
	35–39	2.55***	0.67	2.18	1.33***	1.33***
	40–44	3.08***	1.42	2.37	1.58***	1.81***
	≥45	5.41***	4.06	4.87*	2.32***	2.82***

Reference category: women aged 20–24 years who gave birth spontaneously. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

The results were similar for secondary C-sections. Here too, the risk in all age groups aged 35 and above decreased with increasing parity. In the group aged 35–39 years, the risk dropped from OR 2.16 for primiparous women to OR 1.33 for women giving birth for the third time or more, from OR 2.98 to OR 1.815 in the group of women aged 40–44 years and from OR 5.52 to OR 2.82 for women aged ≥ 45 years (► Fig. 2 and ► Table 1).

Duration of pregnancy

During the period surveyed, a total of 91.8% of primiparous women gave birth at term, i.e., between the end of the 37th and the 41st week of gestation. On average, 0.7% of primiparous women gave birth after the end of the 42nd week of gestation.

The risk of premature delivery was higher for primiparous women aged < 20 years and subsequently decreased in all age cohorts up to the age of 35 years. From the age of 35, the risk of preterm delivery increased continuously with increasing maternal age; this also applied to the risk of delivering extremely preterm infants, very preterm infants, and late preterm infants.

There were similar trends for the cohort of women giving birth for the second time and for women giving birth for the third time or more.

The impact of parity on the risk of preterm delivery was also investigated. Primiparous women had a higher risk in all age groups of delivering extremely preterm infants, very preterm infants and late preterm infants compared to women giving birth

for the second or third time and multiparous women. The most significant results were for primiparous women.

Women giving birth for the second or third time and multiparous women between the ages of 25 and 44 years had a lower risk of prolonged pregnancy and post-term delivery (after GW 42 + 0) than primiparous women (► Table 2).

Interventions

The mean episiotomy rate for all primiparous women who delivered vaginally was 28.88%; it was 9.3% for women giving birth the second time and 3% for women giving birth the third time and multiparous women. The episiotomy rate increased with increasing maternal age, irrespective of parity.

A total of 20.71% primiparous women who delivered vaginally had epidural or spinal anesthesia; the rate for women giving birth the second time was 8.22% and the rate for women giving birth the third time and multiparae was 4.76%. When evaluated with regard to maternal age, the rate of women who had epidural or spinal anesthesia during vaginal delivery increased with increasing maternal age, irrespective of parity.

In the group of women who had a C-section, epidural or spinal anesthesia was administered to 84.52% of primiparous women, to 84.81% of women giving birth for the second time and to 79.33% of women giving birth the third time and multiparous women. Again, the rate increased with increasing maternal age and irrespective of parity.

► **Table 2** Odds ratios (OR) for the correlation between the week of gestation at delivery and parity and maternal age (own research).

	Maternal age	GW <27+6	GW 28–31	GW 32–36	GW >42+0
		OR	OR	OR	OR
1 para	<20	1.26	1.27*	1.22***	1.13
	25–29	0.91	1.15*	1.15***	1.01
	30–34	1.04	1.40***	1.31***	1.15*
	35–39	1.61***	1.78***	1.40***	1.36***
	40–44	2.37***	2.36***	1.68***	1.24
	≥45	3.29**	3.83***	2.75***	0.88
2 para	<20	1.19	0.44	2.09***	1.62
	25–29	0.55***	0.8	0.92*	1
	30–34	0.63**	0.89	0.99	1.06
	35–39	0.87	1.08	1.24***	1.07
	40–44	1.13	1.62**	1.50***	1
	≥45	0	4.23***	2.50***	0.74
3+ para	<20	4.13	0	0.95	0
	25–29	0.85	1.05	0.67***	0.9
	30–34	0.8	1.06	0.68***	0.97
	35–39	1.08	1.25	0.81**	1.04
	40–44	1.33	1.64*	1.07	1.08
	≥45	2.57	3.37**	1.52**	1.84

Reference category: women aged 20–24 years who gave birth having completed the 37th–41st week of gestation; *** p < 0.001, ** p < 0.01, * p < 0.05

► **Table 3** Odds ratios (OR) correlating interventions with parity and maternal age (own research).

	Maternal age	Episiotomy	Epidural + spinal anesthesia during vaginal delivery	Epidural + spinal anesthesia during C-section delivery	Micro-blood gas analysis
		OR	OR	OR	OR
1 para	<20	0.84***	1.06***	0.84	0.94
	25–29	1.15***	0.96**	1.23***	0.94*
	30–34	1.17***	1.05**	1.49***	0.91**
	35–39	1.24***	1.24***	1.66***	0.97
	40–44	1.22***	1.30***	1.78***	0.91
	≥45	1.45*	2.01***	2.26***	0.33**
2 para	<20	0.68*	0.95	0.87	1.01
	25–29	1.47***	1.09*	1.18***	1.02
	30–34	1.82***	1.30***	1.44***	0.99
	35–39	2.15***	1.77***	1.53***	1.04
	40–44	2.36***	2.11***	1.51***	1.16
	≥45	2.89***	2.26***	1.69*	0.83
3+ para	<20	1.18	1.93	0.54	0.00
	25–29	1.29	1.25*	1.34**	1.02
	30–34	1.89***	1.51***	1.41***	1.15
	35–39	2.45***	2.01***	1.45***	1.28
	40–44	2.77***	2.12***	1.41***	1.67**
	≥45	3.34***	2.62***	1.67**	2.64**

Reference category: women giving birth aged 20–24 years (1: without episiotomy during spontaneous birth; 2: without epidural and spinal anesthesia during vaginal delivery; 3: without epidural and spinal anesthesia during C-section, 4: without micro-blood gas analysis); *** p < 0.001, ** p < 0.01, * p < 0.05

Micro-blood gas analysis to evaluate fetal oxygenation intra-partum was carried out irrespective of maternal age in 3.45% of primiparous women, in 10.50% of women giving birth for the second time, and in 0.92% of women giving birth for the third time and multiparae. While the intervention rate among primiparous and secundiparous women decreased with increasing maternal age, the odds ratio for women giving birth for the third time increased with increasing maternal age from OR 1.02 for the cohort aged 25–29 years to OR 2.64 for the cohort aged ≥ 45 years (► **Table 3**).

Discussion

Our analysis of the data obtained from the Austrian Register of Births showed that the cesarean section rate increased with increasing maternal age. Although this increase was most obvious in the group of primiparous women, the rate of cesarean sections also increased with advanced maternal age in the group of women who have birth for the second time and in the group of multiparous women giving birth for the third time or more.

When the mode of delivery was analyzed with regard to parity and maternal age, the evaluation suggested that higher parity rates may function as a protective factor despite increasing maternal age: on average, the rate of Austrian primiparous women aged 25–29 years who gave birth by spontaneous vaginal delivery was almost the same (61.13%) as that of the group of multiparae giving birth for the third time or more who were aged 45 years and above (59.16%).

In the literature, a maternal age of 40 years and above is considered an independent risk factor for delivering by cesarean section [4]. In their study, Smith et al. assumed that 37.6% of C-sections carried out between 1980 and 2005 would not have been necessary if the average maternal age of primiparous women had not increased over the years [24].

Reduced uterine activity has been cited as one possible reason for the increase in the rate of C-sections with increasing maternal age [12]. Other proposed causes discussed in the literature are a reduced myometrial function and a lower number of oxytocin receptors [3]. In their publication, Ritzinger et al. noted that primary cesarean section was often carried out in older women even if there were no medically justified indications, primarily out of concerns for the health of the infant [4].

As reported in a study by Kalogiannidis et al. [6], analysis of the datasets from the Austrian Register of Births showed that previous births have a beneficial effect on the rate of cesarean sections.

Similarly, the results from the Austrian Register of Births point to a higher rate of preterm births in mothers aged 35 and above, particularly primiparous women. Even though other studies have also reported such results [22], no causal connection has yet been identified. However, a medium to high level of education is discussed in the literature as a possible protective factor [3, 4, 22].

Similar to the results reported in the study on Singapore by Wu et al., the analysis of the Austrian Register of Births also showed an increase in the rate of episiotomies among primiparous women. Wu et al. suggested that one of the reasons for the increased risk of episiotomy could be a decrease in tissue elasticity with increasing maternal age [20].

As the data from the Austrian Register do not permit any conclusions to be drawn about the diagnosis, the decreasing number of micro-blood gas analyses combined with a simultaneous increase in the rate of C-sections in primiparous and secundiparous women suggests that either the indications for C-section are predominantly based on maternal factors or that there is some truth behind the frequently expressed conjuncture whereby surgical abdominal delivery is often carried out without a valid risk assessment [25].

It has also been suggested that the demonstrably higher rates of intervention during pregnancy and birth which occur with advanced maternal age may be due to the increase in age-related vulnerability of the female physiology. As the incidence of chronic diseases increases with age and this can affect the course of pregnancy and delivery, it cannot be conclusively stated whether increased maternal age as such should be categorized as an independent risk factor. The normal hemodynamic changes of pregnancy run contrary to developments which occur as part of the natural ageing process. This fact makes it more difficult for older pregnant women to adapt to hemodynamic situations in pregnancy [3]. The consequence is an increased incidence of gestational hypertension among women of advanced maternal age [7]. Chronic hypertension is also found more often in older pregnant women compared to younger pregnant women. Older multiparous women appear to be affected by this even more often than older primiparae [3]. After the age of 40, the risk of developing preeclampsia increases exponentially [5]. As pancreatic beta-cell function and insulin sensitivity decrease with age, the risk of developing gestational diabetes increases from the age of about 35 years. Poorly treated diabetes can lead to numerous problems for the mother and infant, including polyhydramnios, macrosomia, placental insufficiency, IUDF and fetal hypoglycemia post partum [4].

Individual, patient-specific risk factors also play a decisive role in addition to maternal age [4]. The dataset obtained from the Register does not provide information on the existence of pre-existing conditions such as hypertension or diabetes nor does it provide information about any peripartum abnormalities or complications. This means that important information about the indications for interventions is lacking, which limits the interpretation of the results.

Conclusion

This study aimed to show the impact of advanced maternal age on selected obstetric parameters such as mode of delivery, duration of pregnancy, obstetric interventions and parity. C-sections and surgically assisted vaginal deliveries increased with increasing maternal age, particularly among primiparous women. In contrast, the mean rate of spontaneous births decreased with advanced maternal age. However, a parity of ≥ 2 appears to have a protective effect.

Similarly, the rate of preterm births was also higher with advanced maternal age, especially in primiparous women.

Because data on the indications for intervention and the planning of interventions and their association with maternal age is limited, future research must focus on investigating the effect of

maternal age and parity on obstetric outcomes while taking the underlying indications into account.

Conclusion for Clinical Practice

The existing studies appear to show that advanced maternal age should not continue to be defined as a risk factor per se during pregnancy, delivery and in the postpartum period [4]. Although the data suggests that the 1958 definition of advanced maternal age of the International Federation of Gynecology and Obstetrics remains relevant, additional influencing factors such as chronic prior conditions, lifestyle aspects and parity in particular must be included in the planning of interventions and care, particularly since maternal age affects obstetric outcomes most in primiparous women. Accordingly, it would be useful to provide information about the risks associated with advanced maternal age to ensure that adequate management of risks does not just start during pregnancy and delivery [3] but is already taken into account when planning a family and choosing when to start a family.

Conflict of Interest

The authors declare that they have no conflict of interest.

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