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Original Research Article

Impact of advanced maternal age on obstetric and neonatal outcomes: an Indian cohort analysis

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ABSTRACT

Background: To describe clinical profile, labour characteristics, maternal and neonatal outcomes of advanced maternal age pregnancies.
Methods: This retrospective observational study evaluated maternal, labour, and neonatal outcomes among women of advanced maternal age (AMA), with comparisons across normal maternal age, very advanced maternal age (VAMA), and extremely advanced maternal age (EAMA) groups. Demographic characteristics, mode of conception, comorbidities, labour profile, and neonatal outcomes were analysed.
Results: A total of 99,467 mothers delivered during the study period (January 2013 and December 2023), with majority belonging to normal age group (91.40%). AMA accounted for 6.77%, VAMA was 0.73%, EAMA was 0.07% and teenage pregnancy accounted for 1.03%. Proportion of AMA increased significantly over time, rising from 5.79% in 2013 to 14.83% in 2023. Most AMA pregnancies were singleton (94.45%), with a mean BMI of 28.05 ± 4.99 kg/m²; 1.23% were morbidly obese. Although spontaneous conception predominated (83.15%), assisted reproduction especially IVF (12.07%) was significantly more frequent. AMA mothers had a higher comorbidity burden, with multi-system disease in 39.33%. Caesarean delivery was common with 68.03%, with higher preterm birth rates (21.13%). Neonates showed more growth abnormalities (SGA 16.28%, LGA 12.55%) and higher NICU admissions (17.43%), live birth rates remained high (98.30%). Risk severity increased progressively in VAMA and EAMA groups.
Conclusions: AMA is associated with increased maternal comorbidity, caesarean delivery, preterm birth, and neonatal morbidity. These risks escalate further with increasing maternal age, underscoring the need for targeted antenatal surveillance, individualized risk stratification, multidisciplinary care, specialized intrapartum and neonatal care pathways.

Keywords: Advanced maternal age, Maternal outcomes, Perinatal outcomes, Preterm births, India

INTRODUCTION

AMA is traditionally defined as pregnancy at 35 years or older at the time of delivery.[1] VAMA and EAMA are defined as women ≥40 and ≥45 years old, respectively.[2] According to the center for disease control and prevention (CDC), pregnancies among women of AMA are steadily increasing due to social, educational, and economic shifts, including delayed marriage, extended education, career prioritization, and wider access to assisted reproductive technologies (ART).[3,4] In India, these global trends are mirrored by demographic changes: timing of key reproductive events has shifted over recent decades, with median ages at first birth increasing, particularly among

women with higher education and in urban areas.[5] National Family Health Survey (NFHS) data indicate that reproductive patterns in India are evolving, with changes in age at first birth and fertility behaviours over three decades.[6] Although NFHS largely focuses on broader reproductive age group (15–49 years), emerging evidence suggests a growing proportion of births among women in older age groups in select regions contributing to changing maternal risk profiles in the population. Furthermore, high-risk pregnancies, defined by maternal factors including age, contribute substantially to adverse outcomes in India.[7,8]

AMA pregnancies are often associated with higher burden of pre-existing medical conditions and age-related physiological changes that may influence pregnancy progression and outcomes.[9-11]

Numerous studies have demonstrated that AMA is associated with elevated risks of complications including preeclampsia, gestational diabetes, placental abnormalities, caesarean delivery, chromosomal abnormalities, preterm birth, perinatal morbidity and mortality.[11] Elderly primigravidae have a significantly higher risk of operative delivery and prolonged hospital stay, increased risk of stillbirth even in the absence of overt complications.[12] Risk factor stratification is therefore essential to identify individuals at greater risk for adverse outcomes, enabling timely surveillance and tailored management strategies. However, outcomes within this population are heterogeneous and influenced by factors such as parity, socioeconomic status, access to antenatal care, and presence or absence of coexisting medical conditions.

Understanding the interplay between clinical profile, risk factor stratification, maternal-fetal outcomes in AMA pregnancies is crucial for optimizing antenatal care and improving prognostic counselling. This study aims to contribute to existing evidence of advanced pregnancies, by systematically evaluating various maternal and parameters, thereby supporting informed clinical decision-making and the development of targeted interventions for the growing obstetric population of women conceiving at advanced maternal age in India.

METHODS

Study design, duration and approval

This cross-sectional observational hospital-based study included all consecutive births between January 2013, and December 2023 performed at a tertiary perinatal referral center network in India. In accordance with standard hospital protocol, patients or their guardians completed a consent form for electronic data sharing during registration. None of the data utilized for analysis contained identifiable patient parameters. The study adhered to the Declaration of Helsinki and was approved by the Institutional Ethics Committee (IRB Approval No.03_2026). The clinical information of each patient who received a thorough obstetric examination utilizing a standardized template was recorded by trained obstetricians into a browser-based electronic medical records system.

Cases

The electronic medical records system was screened with gestational age of 24 weeks and above and who birthed at the referral center network during the study period. A total of 102,683 babies birthed by 99,467 mothers that fulfilled this criterion were labelled as cases and the data was included for further analysis.

Data mining and synthesis

The information from 102,683 births analyzed in this study was extracted from the electronic medical record database and organized into a unified excel spreadsheet. This spreadsheet comprised columns containing patient demographic details, clinical presentations, systemic disorders which were analyzed as per the mother and mode of delivery, birth outcomes were analyzed as per births. Subsequently, the excel spreadsheet containing the necessary data was utilized for analysis employing suitable statistical software. The mothers were defined as per the following age groups at the time of delivery. AMA pregnancy at 35 years or older, VAMA and EAMA defined as women ≥40 and ≥45 years old, respectively. The outcomes defined for the births were mode of delivery, pre-term births, birth centile, maternal mortality and perinatal mortality.

Statistical methods

Statistical analyses were conducted to explore the relationships between various variables and outcomes. Continuous variables were summarized using measures such as means and standard deviations, while categorical variables were summarized using frequencies and percentages. Stata (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP) and Microsoft Excel (Microsoft Corporation. (2021)) were used for the data analysis.

RESULTS

Overall, the data of 102,683 babies birthed by 99,467 mothers were analysed during the study period.

Distribution of pregnancies across age groups

A statistically significant increase in the proportion of AMA, VAMA, and EAMA pregnancies was observed over the study period ($p<0.001$). The proportion of births among women of AMA showed upward trend over time, rising from 5.8% in 2013 to 14.8% in 2023. A similar pattern was observed in VAMA group, with proportions increasing from 5.9% in 2013 to 15.7% in 2023. Although

EAMA group constituted small proportion of total births, notable year-to-year fluctuations were observed, with peaks in 2017 (15.5%) and 2023 (11.3%) (Table 1).

Pregnancy plurality and mode of conception

Singleton pregnancies were most common among women of normal reproductive age (97.1%) and declined with increasing age, 94.5% in AMA, 89.8% in VAMA, and 71.8% among EAMA. Conversely, proportion of multifetal pregnancies rose sharply with age, from 2.9% in normal-age group to 5.6% in AMA, 10.2% in VAMA, and 28.2% in EAMA women, indicating a nearly tenfold increase compared with younger women. Spontaneous conceptions accounted for 91.6% pregnancies in women of normal reproductive age, declined steadily with advancing age, to 83.2% in AMA, 69.8% in VAMA, and 9.9% in EAMA. In contrast, the use of ART increased with age. IVF constituted to 2.7% of conceptions in normal-age group, 12.1% in AMA, 27.8% in VAMA, and becoming the predominant mode of conception in EAMA, accounting for 88.7% of all pregnancies. The use of ART, particularly IVF increased significantly in AMA, VAMA, and EAMA groups ($p<0.001$), reflecting a strong age-related shift toward ART (Table 2).

Parity and maternal age distribution

In the study population parity distribution varied markedly across age groups. Multigravidity was most common among women of AMA, with 67.7%, followed by VAMA group (58.7%). In contrast, primigravidity predominated among EAMA women (74.7%) reflecting higher proportion of first pregnancies in these groups. Among women of normal reproductive age, 58.7% were primiparous and 41.3% were multiparous.

Overall, 57.1% of the cohort were primiparous and 42.9% were multiparous, indicating substantial heterogeneity in parity patterns across age categories.

Systemic disorders

The burden of systemic diseases increased significantly with advancing maternal age ($p<0.001$). Among women of normal reproductive age, 37.7% had no systemic illness, compared with lower proportions in AMA (23.4%), VAMA (14.7%), and EAMA (8.5%) groups, indicating decline in the proportion of disease-free pregnancies with age.

Conversely, prevalence of multiple systemic comorbidities rose across age categories, from 24.8% in normal group to 39.3% in AMA, 50.7% in VAMA, and 70.4% in EAMA, highlighting substantial multimorbidity among oldest mothers. The proportion of women with single systemic condition remained similar between normal and AMA groups (37.6% vs. 37.3%) but declined in VAMA (34.6%) and EAMA (21.1%), likely reflecting a shift toward multiple comorbidities with increasing age.

When individual conditions were examined, diabetes mellitus showed strong age-related increase, affecting 25.3% of women of normal reproductive age, compared with 40.2% in AMA, 60.6% in VAMA, and 48.6% in EAMA ($p<0.001$). A similar pattern was observed for hypertensive disorders, which increased from 12.5% in normal-age group to 21.1% in AMA, 57.8% in VAMA, and 31.6% in EAMA ($p<0.001$). Thyroid disorders became increasingly prevalent with age, increasing from 25.4% in normal age to 34.4% in AMA, 39.4% in VAMA, and 37.6% in EAMA ($p<0.001$). Anemia showed smaller but statistically significant differences across groups ($p=0.039$), with prevalence ranging from 19.9% in normal age to 17.2% in AMA, 9.9% in VAMA, and 19.0% in EAMA (Table 3).

Labour profile

Delivery mode differed significantly across maternal age groups ($p<0.001$). Caesarean section rates increased with advancing age, from 48.6% in normal age to 68.0% in AMA, 79.7% in VAMA, and 93.5% among EAMA. In contrast, spontaneous vaginal births declined sharply with age, accounting for 40.7% of deliveries in normal-age, 26.5% in AMA, 17.1% in VAMA, and 4.4% in EAMA. Assisted vaginal births also showed marked reduction with increasing age, decreasing from 10.3% in normal age to 5.0% in AMA, 3.0% in VAMA, and none in EAMA. Postpartum haemorrhage (PPH) patterns also varied significantly by age ($p=0.005$). While most women in all age groups did not experience PPH, the proportion without PPH showed a gradual decline with age, from 93.0% in the normal-age group to 91.6% in EAMA (Table 4).

Gestational age at birth

Gestational age at delivery differed significantly across maternal age groups ($p<0.001$), showing a clear shift toward earlier births with advancing age. Term deliveries were most common among women of normal reproductive age (79.6%), declined in AMA (76.6%), VAMA (67.9%), and EAMA (33.8%). In contrast, the proportion of preterm births increased with age, from 14.1% in normal age to 21.1% in AMA, 31.7% in VAMA, and 66.2% among EAMA, indicating nearly a fivefold higher preterm birth rate compared with younger women (Table 5).

Maternal near miss and maternal deaths

MNM events were rare across all maternal age categories, with an overall prevalence of 0.71%. The highest proportion of MNM was observed among women of EAMA, with 1.41%, AMA had MNM rate of 0.83%, while both normal age and VAMA had the lowest prevalence at 0.69% each.

However, these differences were not statistically significant, suggesting that maternal age alone was not independently associated with MNM in this population. Maternal death was extremely rare across all maternal age

groups, with an overall prevalence of 0.03%. The highest proportion was observed among women of AMA (0.06%), followed by women of normal reproductive age (0.03%), while no events were recorded among the EAMA, or VAMA.

Neonatal outcomes & complications

Fetal growth patterns and early neonatal outcomes differed significantly across maternal age groups (p<0.001). The proportion of appropriately grown infants (AGA) declined with advancing age, from 75.6% in women of normal age to 70.9% in AMA, 65.3% in VAMA, and 60.9% in EAMA. Conversely, the prevalence of small-for-gestational-age (SGA) infants increased markedly with age, rising from 13.5% in normal-age to 16.3% in AMA, 20.1% in VAMA, and reaching 34.8% among EAMA.

Large-for-gestational-age (LGA) infants also showed an increase from 10.8% in normal-age to 12.6% in AMA and 14.2% in VAMA, but this proportion declined to 4.4% in EAMA. Live birth rates remained high across all age categories but showed a gradual decline with increasing maternal age, from 98.9% in the normal age to 98.3% in AMA, 98.1% in VAMA, and 97.8% in EAMA. Stillbirth rates increased with age, from 1.1% in normal age to 1.7% in AMA, 1.9% in VAMA, and 2.2% in EAMA. Neonatal intensive care unit (NICU) admissions increased with advancing age, from 14.2% in normal age to 17.4% in AMA, 21.4% in VAMA, and 37.0% in EAMA (Table 6).

Table 1: Trends in the distribution of pregnancies across normal maternal age, AMA, VAMA, and EAMA groups from 2013 to 2023.

Year	Normal		AMA		VAMA		EAMA		P value
	N	%	N	%	N	%	N	%	
2013	7109	7.82	390	5.79	43	5.91	3	4.23	
2014	7642	8.41	408	6.06	46	6.32	6	8.45	
2015	7220	7.94	460	6.83	40	5.49	8	11.27	
2016	7742	8.52	487	7.23	58	7.97	5	7.04	
2017	7966	8.76	587	8.72	49	6.73	11	15.49	
2018	8256	9.08	661	9.81	70	9.62	5	7.04	
2019	9260	10.19	745	11.06	89	12.23	8	11.27	
2020	8833	9.72	610	9.06	70	9.62	7	9.86	<0.001
2021	8593	9.45	648	9.62	80	10.99	3	4.23	
2022	9693	10.66	740	10.99	69	9.48	7	9.86	
2023	8597	9.46	999	14.83	114	15.66	8	11.27	

Table 2: Distribution of mode of conception across normal maternal age, AMA, VAMA and EAMA groups.

	Normal		AMA		VAMA		EAMA		P value
	N	%	N	%	N	%	N	%	
Singletons	88284	97.11	6361	94.45	654	89.84	51	71.83	<0.001
Multifetal	2627	2.89	374	5.55	74	10.16	20	28.17	
Conception Category									
Spontaneous	83253	91.58	5600	83.15	508	69.78	7	9.86	
Ovulation induction	3918	4.31	179	2.66	11	1.51	1	1.41	
IVF	2460	2.71	813	12.07	202	27.75	63	88.73	<0.001
IUI	1273	1.40	142	2.11	6	0.82	0	0.00	

Table 3: Distribution of systemic disorders in the mothers.

Systemic diseases	Normal maternal age		AMA		VAMA		EAMA		P value
	N	%	N	%	N	%	N	%	
Single	34135	37.55	2509	37.25	252	34.62	15	21.13	
Multiple	22497	24.75	2649	39.33	369	50.69	50	70.42	<0.001
None	34279	37.71	1577	23.41	107	14.7	6	8.45	
Diabetes mellitus	23019	25.32	2708	40.21	43	60.56	354	48.63	<0.001
Hypertensive disorders	11375	12.51	1421	21.1	41	57.75	230	31.59	<0.001
Thyroid disorders	23111	25.42	2315	34.37	28	39.44	274	37.64	<0.001
Anaemia	203	19.86	1156	17.16	7	9.86	138	18.96	0.039

Table 4: Mode of delivery and postpartum haemorrhage profile in mothers.

Mode of delivery	Normal age	%	AMA	%	VAMA	%	EAMA	%	P value
Caesarean section	45510	48.61	4840	68.03	640	79.7	86	93.48	
Spontaneous vaginal birth	38131	40.73	1887	26.52	137	17.06	4	4.35	
Assisted vaginal birth	9641	10.3	356	5	24	2.99	0	0	
Assisted breech delivery	221	0.24	8	0.11	1	0.12	1	1.09	
Caesarean hysterectomy	123	0.13	22	0.31	1	0.12	1	1.09	
Hysterotomy	4	0	2	0.03	0	0	0	0	<0.001
Post partum haemorrhage									
None	84549	93	6250	92.8	673	92.45	65	91.55	
Atonic	5470	6.02	390	5.79	47	6.46	5	7.04	0.005
Traumatic	786	0.86	77	1.14	7	0.96	0	0	

Table 5: Gestational age at birth across normal maternal age, AMA, VAMA and EAMA groups.

Gest age at birth	Normal age	%	AMA	%	VAMA	%	EAMA	%	P value
Term	72347	79.58	5158	76.59	494	67.86	24	33.8	
Pre-term	12770	14.05	1423	21.13	231	31.73	47	66.2	
Post-dated	5794	6.37	154	2.29	3	0.41	0	0	<0.001

Table 6: Neonatal outcomes across normal maternal age, AMA, VAMA and EAMA groups.

Growth centile	Normal age		AMA		VAMA		EAMA		P value
	N	%	N	%	N	%	N	%	
AGA	70761	75.58	5041	70.85	524	65.26	56	60.87	
SGA	12628	13.49	1158	16.28	161	20.05	32	34.78	
LGA	10104	10.79	893	12.55	114	14.20	4	4.35	
Status at birth									
Alive	92610	98.91	6994	98.30	788	98.13	90	97.83	<0.001
Still born	1020	1.12	121	1.70	15	1.87	2	2.17	
NICU admission									
Yes	13293	14.20	1240	17.43	172	21.42	34	36.96	
No	80337	85.80	5875	82.57	631	78.58	58	63.04	

DISCUSSION

This large longitudinal cohort demonstrates a significant and sustained rise in pregnancies among women of AMA, VAMA and EAMA, trend well documented globally and attributed to delayed childbearing due to socioeconomic shifts and expanded use of IVF. The findings of an age-related increase in reliance on ART align with evidence that reduced ovarian reserve, diminished oocyte quality, and age-related infertility contribute to the higher use of IVF among older women.[13-15] ART pregnancies have been associated with elevated obstetric risks, including higher cesarean section rates and adverse outcomes compared with spontaneous conceptions. A recent large IPTW-adjusted cohort study from China involving over 20,000 AMA singleton pregnancies demonstrated that IVF-ET independently increased the risk of abnormal placentation, preeclampsia, gestational diabetes, preterm birth, and neonatal morbidity.[16] Consistent with existing literature, the burden of systemic comorbidities, particularly diabetes, hypertensive disorders, and thyroid dysfunction were significantly higher in older age groups. Advanced age is a recognized risk factor for these conditions, which are independently linked to adverse pregnancy outcomes due to their impact on placentation, maternal vascular function, and metabolic regulation.[17]

In a prospective cohort of 857 pregnant women attending National Taiwan University Hospital in Taiwan, Yen et al. found that AMA was associated with clustering of metabolic abnormalities in first and second trimesters, and this clustering was significantly linked to higher rates of adverse pregnancy outcomes including LGA infants, hypertensive disorders, caesarean delivery, preterm birth, and any adverse outcome.[18] The rise in caesarean section rates with increasing age is consistent with global observations that AMA predicts higher operative delivery rates, partly due to altered obstetric physiology, increased obstetric indications, and clinician or patient preferences for surgical delivery in high-risk pregnancies. Hochler et

al conducted a retrospective multicentre cohort study involving 302,484 multiparous women who delivered between 2003 and 2021 and found that as maternal age increased, rates of caesarean delivery increased.[19] The data showing a higher prevalence of preterm births with advancing age corroborates prior findings linking maternal age with preterm delivery risk, even after adjustment for potential confounders. Fuchs et al conducted a retrospective cohort study of 165,282 singleton births from the QUARISMA trial in Canada and found that maternal age shows a U-shaped relationship with preterm birth risk, with the lowest risk at 30–34 years and significantly higher adjusted odds of preterm delivery in women ≥40 years even after controlling for confounders.[20]

While some studies highlight that socioeconomic and maternal factors can attenuate age-associated risks, the overall trend of increased preterm delivery with age remains robust across populations. In a pan-Nordic population registry study of >3.6 million live singleton births from Denmark, Norway, Sweden and Finland, Aradhya et al. found that AMA compared with age 26–27 years was independently associated with higher risks of low birthweight and pre-term delivery even after adjusting for parity, sex and birth year, supporting an age-related increase in adverse perinatal outcomes across these countries.[21]

Neonatal outcomes in the cohort, characterized by increased SGA rates and higher NICU admissions with advancing maternal age, reflect global patterns of age-related neonatal vulnerability. Studies report a broad association between maternal age extremes and adverse perinatal outcomes such as SGA, low birth weight, and NICU needs. Hochler et al retrospective multicentre cohort study showed that incremental increases in maternal age from 35 years onward were independently associated with higher rates of preterm birth, NICU admission, neonatal asphyxia, mechanical ventilation, SGA, transient tachypnoea of the newborn, hypoglycemia, and neonatal jaundice, with no specific age threshold but rise in adverse maternal and neonatal outcomes as age increased.[19]

In a Swedish registry cohort study of children born to mothers with advanced age (≥40 years), and/or conceived via ART, Pettersson et al found that children of mothers with advanced age showed increased neonatal morbidity diagnoses, indicating that advanced maternal age and ART are important risk factors for early childhood health burden.[22] Although few stillbirths occurred, slight increase in stillbirth rates with age observed here aligns with reported age-associated perinatal risk gradients.[17] Overall, these findings reinforce the clinical importance of maternal age as a prognostic factor for maternal and neonatal outcomes.

From a policy and health system perspective, these findings highlight the need to recognize advanced maternal age as a distinct and growing high-risk obstetric group within maternal and newborn health programs. Antenatal care guidelines may benefit from incorporating age-specific risk stratification, enhanced surveillance for metabolic and hypertensive disorders, and standardized management pathways for pregnancies conceived both spontaneously and through. Strengthening preconception counselling, particularly for women planning pregnancy at older ages, and ensuring timely referral to higher-level facilities with multidisciplinary care and neonatal support are critical to mitigating adverse outcomes. Additionally, the rising cesarean section rates in older women underscore the importance of evidence-based intrapartum decision-making and regular audit of operative deliveries to avoid unnecessary interventions. Leveraging electronic medical record–based analytics for ongoing monitoring of trends and outcomes could further support data-driven policy formulation and improve quality of care for this expanding obstetric population.

Strengths

A major strength of this study is its large sample size and long observation period, allowing robust assessment of temporal trends in maternal age and their associations with maternal and neonatal outcomes. The stratification of older mothers into AMA, VAMA, and EAMA groups provides clinically meaningful granularity and highlights a graded risk profile rather than treating advanced age as a homogeneous category. The comprehensive inclusion of conception mode, systemic comorbidities, labour characteristics, and neonatal outcomes offers a holistic view of the clinical impact of delayed childbearing.

Limitations

However, there are a few limitations. The retrospective design limits causal inference and is subject to documentation and coding bias. This was a single-centre study, which may limit generalizability to other healthcare settings, particularly those with differing referral patterns or resource availability.

CONCLUSION

AMA is associated with increase in maternal comorbidity burden, caesarean delivery, preterm birth, neonatal morbidity, with risks escalating further in VAMA and EAMA groups. These findings highlight the need for age-specific risk stratification, enhanced antenatal surveillance, multidisciplinary care models, and individualized intrapartum and neonatal management pathways for older mothers. As delayed childbearing becomes increasingly common, healthcare systems must adapt to meet the evolving clinical and resource demands of this high-risk population.

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