Original Article

Comparative study of pregnancy risks in different maternal age groups

Amala Sunder, MRCPI, MRCOG, *Yusuf Khaled Hadi,* MBBCH, BAO, *Noor Ammar Alkhuzaei,* MBBCh, BAO, *Nayla Jamal Bushaqer,* MD, *Haya Isa Al Khalifa,* MD, *Basma Darwish,* MD, *Nawal Dayoub,* MD, MSc, FRCOG.

ABSTRACT

الأهداف: تقييم ومقارنة مضاعفات الحمل المرتبطة بفئات عمرية مختلفة للأمهات.

المنهجية: أجرينا تحليل رجعي لنتائج الحمل بجنين واحد في مستشفى قوة دفاع البحرين على مدى اثني عشر شهرًا خلال الفترة من يناير إلى ديسمبر 2022م. صُنفت عينة الدراسة إلى أربع فئات عمرية للأمهات: أقل من 25 عامًا، 25–29 عامًا، 30–34 عامًا، وأكبر من 35 عامًا. جُمعت بيانات عن التركيبة السكانية وخصائص الأم والجنين ومتغيرات أخرى. حُددت الدلالة الإحصائية بقيمة احتمالية (p) أقل من 0.05. أجري تحليل الانحدار اللوجستي أحادي المتغير لنتائج الأم والوليد بعد تعديل خصائص الأم.

النتائج: وجدت الدراسة، التي شملت 2،972 امرأة تتراوح أعمارهن بين 17 و55 عامًا، ارتباطات مهمة بين عمر الأم ونتائج مختلفة. ارتبط عمر الأم ارتباطًا وثيقًا بمؤشر كتلة الجسم (p<0.01) (BMI)، حيث كان مؤشر كتلة الجسم لدى 87.8% من النساء دون سن 25 عامًا أقل من 35 كجم/م^2، بينما كان مؤشر كتلة الجسم لدى 34.3% من النساء فوق سن 35 عامًا أكبر من 35 كجم/م^2. كان سكري الحمل أكثر شيوعًا لدى النساء في سن 35 عامًا فأكثر (11.5%)، مقارنةً بـ 6.6% لدى من تقل أعمارهن عن 25 عامًا (قيمة الاحتمال=0.027). كما وُجد ارتباط وثيق بتقييد نمو الجنين داخل الرحم (FIUGR) (قيمة الاحتمال=0.041)، حيث كان معدل الإصابة به لدى النساء دون سن 25 عامًا أقل مقارنةً بالفئات العمرية الأكبر. في الانحدار اللوجستي أحادي المتغير، كان خطر الإصابة بداء السكري الحملي لدى النساء اللواتي تتراوح أعمارهن بين 30 و34 عامًا أقل بكثير (نسبة الأرجحية: 0.544، فاصل الثقة: 0.365–0.811). بالإضافة إلى ذلك، كانت النساء دون سن 25 عامًا أكثر عرضة للولادة المبكرة (نسبة الأرجحية: 1.365، فاصل الثقة: 1.015 – 1.837).

الخلاصة: يُعد عمر الأم عامل خطر مستقل لمختلف النتائج السلبية للأم والوليد. تفاوتت المخاطر باختلاف الفئات العمرية، حيث كانت النساء دون سن 25 عامًا أكثر عرضة للولادة المبكرة ومتلازمة تأخر النمو في الرحم (IUGR)، بينما كانت معدلات الإصابة بداء السكري الحملي لدى النساء اللواتي تتراوح أعمارهن بين 35 عامًا وأكبر من ذلك عالية.

Objectives: To evaluate and compare pregnancy complications associated with varying maternal age groups.

Methods: A retrospective analysis of singleton pregnancy outcomes at Bahrain Defense Force Hospital from January to December 2022. The study population was divided into 4 age groups: <25 years, 25-29 years, 30-34 years, and ≥35 years. Data on demographics, maternal and fetal characteristics were collected, and statistical significance was set at $p<0.05$. Univariate logistic regression was performed to analyze maternal and neonatal outcomes, adjusting for maternal factors.

Results: The study included 2,972 women aged 17-55. Significant associations were found between maternal age and outcomes. Body mass index (BMI) was significantly linked to age ($p<0.01$), with younger women having lower BMI. Gestational diabetes mellitus (GDM) was more common in women ≥35 years (11.5%) vs. those <25 years (6.6%, $p=0.027$). Intrauterine growth restriction (IUGR) was more prevalent in the <25 years age group ($p=0.041$). Logistic regression showed women 30-34 years had a lower risk of GDM compared to 25-29 years (odds ratio [OR]: 0.544, CI: 0.365-0.811), and women <25 years had a higher risk of preterm delivery (OR: 1.365, CI: 1.015-1.837).

Conclusion: Maternal age is an independent risk factor for various adverse outcomes. Younger women (<25) are at higher risk for preterm delivery and IUGR, while older women (≥35) have higher rates of GDM.

Keywords: maternal age, advance maternal age, adolescent pregnancy, maternal outcomes, neonatal outcomes

Saudi Med J 2025; Vol. 46 (4): 378-387
doi: 10.15537/smj.2025.46.4.20240555

From the Department of Obstetrics & Gynecology (Sunder, Bushaqer, Al khalifa,Darwish), Bahrain Defense Force Hospital, Riffa, Bahrain; (Hadi, Alkhuzaei), Royal College of Surgeons in Ireland, Busaiteen, and (Dayoub), Assisted Reproductive and Gynecology Centre, London.

Received 4th July 2024. Accepted 2nd March 2025.

Address correspondence and reprint request to: Dr. Amala Sunder, Department of Obstetrics & Gynecology, Bahrain Defense Force Hospital, Riffa, Bahrain. E-mail: sunderamala1@yahoo.co.in
ORCID ID: https://orcid.org/0000-0003-2314-3592

OPEN ACCESS

Age is an important factor to consider in any woman planning to conceive and plays an instrumental role in dictating the course of the pregnancy. Early, teenage or adolescent pregnancy is universally accepted as pregnancies in women less than 20 years of age.[1] United Nations International Children's Emergency Fund reported that 13% of all adolescent girls experienced a teenage pregnancy, as illustrated in their 2023 report.[2] Nationally, in the Kingdom of Bahrain, 9 out of every 1000 girls aged 15 - 19 years gave birth in 2021, according to The World Bank.[3] Meanwhile, extreme age pregnancies represent a complex and challenging case for obstetricians to manage and oversee. They carry a great risk of adverse outcomes to both the mother and the neonate.

Advanced Maternal Age (AMA) or even sometimes referred to as a geriatric pregnancy, is defined as any pregnancy conceived at 35 years and above.[1] Globally, 68 out of 1000 women aged 35 and above have had a geriatric pregnancy, with Bahrain having a seemingly higher prevalence, 108 out of 1000.[4] Everso changing demographic patterns and socio-economic trends have significantly shifted the maternal age of childbearing.[5] Nonetheless, both groups represent extremes of age in terms of pregnancy, and each group carries a unique set of pregnancy-related complications. These complications are numerous, ranging from the antepartum and extending till the postpartum period, and outreaching, even affecting neonatal morbidity and mortality.[1] Additionally, complications incurred by extreme age pregnancies remain an immense challenge on healthcare professionals and are a financial burden.

Advanced maternal age. The World Fertility Pattern has reported a steady rise in the mean childbearing age and a tendency for childbearing postponement in developed countries.[4] This is partly attributed to enhanced economic development, increased involvement of women in the workforce, better awareness and access to contraception and family planning services.[5] For this specific subset of the population, women are particularly at risk in their pregnancy, as established and reaffirmed by various studies and therefore necessitate more rigorous follow-ups during this vulnerable period. During the early pregnancy phase, these women, compared to their younger counterparts, are more likely to experience spontaneous abortions (especially from 6 - 14 weeks) and ectopic pregnancies, reaching up to 5 times the risk.[6] Added to that, age is linked with congenital and chromosomal abnormalities, famously Down Syndrome (Trisomy 21).[7] In later stages of the pregnancy, the incidence of hypertensive disorders of pregnancy including pregnancy induced hypertension (PIH) and preeclampsia, diabetes mellitus (pre-existing and gestational) are increased in comparison to younger women.[8] Similarly, worsening of preexisting medical conditions like cardiovascular, renal, coagulopathy, autoimmune, and infectious diseases and so on are possible; hence, necessitating a multidisciplinary approach when managing those pregnancies.[9] Perinatally, the newborn has a greater likelihood of being delivered preterm and a low birth weight.[10]

Adolescent pregnancy. Although adolescent pregnancies have been dramatically decreasing globally and are projected to decrease even further, they still remain a major and intricate challenge in developing regions.[4] The clinical manifestations of adolescent pregnancies on maternal and neonatal outcomes have been sufficiently reported. There is a higher prevalence of preeclampsia, gestational diabetes, anemia, postpartum depression among other conditions, when compared to pregnancies delivered between the ages of 20 to 35 years.[11] Particularly, adolescent pregnancies are complicated by infections including sexually transmitted diseases, urinary tract infections, chorioamnionitis and endometritis.[11] Similar to geriatric pregnancies, adolescent ones also share adverse neonatal outcomes like preterm deliveries, low birth weight and stillbirth.[12] In addition, societal pressures, economic constraints, lack of experience and support all strain such a complex pregnancy.

Despite the continuous efforts to investigate and ascertain the adverse maternal and neonatal outcomes of extremes of age pregnancies, there is no representative study that explores this association in the Kingdom of Bahrain. Therefore, this study aims to explore the various pregnancy risks in different female age groups, in a single tertiary center at the Kingdom of Bahrain.

Methods. This study is a retrospective analysis of singleton pregnant women in different maternal age groups, who delivered ≥24 weeks of gestational age at Bahrain Defense Force Hospital over the period of 12 months from January 2022 to December 2022. The inclusion criteria were pregnancies with the completed gestational age of ≥24 weeks. While the exclusion criteria were multiple pregnancies and major congenital anomalies. The study design was approved by the Ethical Committee Research Centre. All data included

Disclosure. Authors have no conflict of interests, and the work was not supported or funded by any drug company.

was anonymized and medical records were reviewed with confidentiality. The study population was women ranging in age from 17 to 55 and were subsequently divided into 4 age groups <25, 25-29, 30-34, and ≥35 years. Parity was subdivided into 3 categories as 0, 1, and >1. The analysis includes maternal, fetal and neonatal outcomes and maternal outcomes were further divided into antepartum, intrapartum, and postpartum periods. The demographic data, maternal characteristics (maternal age, body mass index [BMI], parity), medical comorbidities (anemia, coagulopathies, renal disease, cardiac disease, autoimmune disorders, thyroid disease, stroke, hyperlipidemia, past history of bariatric surgeries), past obstetric history outcome and complications (miscarriages, ectopic pregnancy, preeclampsia, eclampsia, gestational diabetes mellitus [GDM], intrauterine fetal demise [IUFD], stillborn and neonatal death) were studied. Furthermore, the mode of delivery of the 4 study groups was analyzed. Detailed analysis of current obstetric history, outcome and complications of the 4 age groups was done. Our recorded BMI was at the first antenatal visit and divided into 2 categories, <35 and ≥35 kg/m^2. The method of conception was reported into 3 categories including spontaneous, in-vitro fertilization (IVF), ovulation induced fertilization.

The outlined antepartum complications are GDM, hypertension, gestational hypertension, preeclampsia, eclampsia, and antepartum hemorrhage including abruptio placentae and placenta praevia. We followed our hospital departmental protocols for the identification of complications, which are based on the American College of Obstetricians and Gynecologists (ACOG) guideline recommendations for eclampsia, preeclampsia, and gestational hypertension. We reported preeclampsia when the systolic blood pressure is ≥140 mmHg or diastolic blood pressure is ≥90 mmHg on 2 occasions at least 4 hours apart after 24 weeks of gestation during pregnancy with a previously normal blood pressure. Additionally proteinuria had to be present, which was defined when ≥300 mg per 24-hour urine collection or protein/creatinine ratio of ≥0.3 mg/dl or dipstick reading of 1 and more, in the absence of proteinuria, new-onset hypertension associated with any organ disorder such as deranged hematological tests, impaired liver function tests, renal function tests or neurological deficit. In the absence of proteinuria, high blood pressure was categorized as gestational hypertension. Eclampsia is reported as any new onset of convulsions in the absence of disorders such as epilepsy and cerebral pathology. Screening of GDM was performed through a one-hour 50 g glucose challenge test at 24-28 weeks of gestation for all pregnant women. If a woman had a previous history of GDM, the screening test is performed at the booking visit. Confirmation of GDM is done by a 4-hour oral glucose tolerance test.

The intrapartum course was analyzed in detail including mode of delivery which was subcategorized into vaginal delivery or lower segment cesarean section. Premature preterm rupture of membrane (PPROM) was considered as any rupture of the membrane before 37 weeks of gestational age. Delayed second stage of labor was reported according to our hospital departmental protocol, which is based on the recommendation of ACOG and Royal College of Obstetricians and Gynecologists (RCOG). Accordingly, delayed second stage of labor was reported upon epidural analgesia when ≥3 hours in primigravida women and ≥2 hours in multigravida women, without epidural analgesia when ≥2 hours in primigravida women and ≥1 hour in multigravida women. Estimated blood loss was calculated by means of clinical parameters, visual calculation and soaked packs. For vaginal delivery, the blood loss was either measured as <500 and ≥500 ml whereas for cesarean section <1000 and ≥1000 ml. Other parameters studied are shoulder dystocia and breech deliveries.

The postpartum parameters analyzed were venous thromboembolism, depression, pyrexia, wound infection and dehiscence, hematoma, urinary tract infection, endometritis, chorioamnionitis, hysterectomy and maternal mortality.

Neonatal outcomes were chosen according to the gestational age at delivery and were divided into preterm (<37 weeks), term (37-41 weeks) and post term (>41 weeks). Birth percentile was calculated and adjusted according to departmental references, and was classified in the following percentiles: <10, 10-50, 51-90, and >90. Subsequently, small for gestational age (SGA) was considered <10 whereas large for gestational age (LGA) was >90. In addition, abdominal circumference reference, interval growth biometry, umbilical and middle cerebral artery doppler reference, reported by fetal maternal specialists, were considered to describe intrauterine growth restricted fetuses.

Our study included stillborn, fetal death with the fetus weighing either ≥500 g or being >24 weeks of gestation. Early neonatal death was defined as any neonatal death occurring during the first 7 days of life. Congenital anomalies were categorized upon the diagnosis by fetal maternal specialists.

Univariate logistic regression analysis was done with the consideration of confounding factors such as parity,

BMI, method of conception, medical comorbidities, past history of bariatric surgeries and past obstetric complications.

Statistical analysis. Continuous variables were represented as median (1st quartile - 3rd quartile), whereas categorical variables were represented as frequencies and percentages. Depending on the data requirements, Chi-square and Fisher's exact tests were used to assess associations between categorical variables. Binary Logistic Regression was used to assess the relationship between each of maternal and neonatal outcomes with maternal age. SPSS (version 26.0) software was used to conduct all analyses. A *p*-value of less than 0.05 was considered statistically significant.

Results. The study included 2,972 women, aged between 17 and 55, with a median age of 29 and an interquartile range of 25 to 34. Most births were vaginal, with 1914 (64.4%) having vaginal deliveries and 1055 (35.5%) having cesarean deliveries. Demographics and the history of maternal co-morbidities and surgeries are represented as frequencies and percentages N (%) in Table 1.

The majority of women were between the ages of 25 and 29 (914, 30.8%) and 30 to 34 (771, 25.9%). A total number of 1914 (64.4%) women had vaginal deliveries and 1055 (35.5%) had cesarean deliveries, exact numbers of patient's mode of delivery by their age group are illustrated in Figure 1.

Maternal characteristics, co-morbidities, complications, and outcomes association with maternal age are represented in Table 2.

Women's BMI had a statistically significant association with their age (p<0.01), with 87.8% of women <25 years old having a BMI of <35 kg/m^2, and 34.3% of those who are ≥35 years old had a BMI of more than 35 kg/m^2. Pre-delivery (Antepartum), diabetes (GDM) had a statistically significant association with maternal age (p=0.027), with ≥35-year-old women having the highest rate of 11.5% compared to <25-year-old women (6.6%) as shown in Table 2.

Fetal and neonatal characteristics, complications and outcomes association with maternal age are represented in Table 3.

Women aged 30 to 34 years old were found to have a lower risk of diabetes (odds ratio [OR]: 0.544, confidence interval [CI]: 0.365 - 0.811) when compared to women aged 25 to 29 years old. Women aged <25 were statistically significantly more likely to have a pre-term deliveries (OR: 1.365, CI: 1.015 - 1.837) than women aged 25-29 years, as represented in Table 4.

Table 1 - Demographics and maternal history of study participants.

Variables	n (%)
Maternal characteristics	
Age (years)	
<25	591 (19.9)
25 – 29	914 (30.8)
30 – 34	771 (25.9)
≥35	696 (23.4)
Body mass index (kg/m^2)	
< 35	2265 (76.2)
≥ 35	707 (23.8)
Parity	
0	588 (19.8)
1	712 (24.0)
> 1	1672 (56.3)
Maternal history	
Intrauterine fetal death & stillborn	91 (3.1)
Neonatal death	38 (1.3)
Previous miscarriage	783 (26.4)
Ectopic	9 (0.3)
Post-partum hemorrhage	32 (1.1)
Eclampsia & preeclampsia	34 (1.1)
Gestational diabetes mellitus	264 (8.9)
Maternal previous co-morbidities:	
Anemia	180 (6.1)
Coagulopathy	13 (0.4)
Cardiac disease	17 (0.6)
Renal disorder	10 (0.3)
Autoimmune disease	10 (0.3)
Stroke	1 (0.03)
Thyroid disorder	115 (3.9)
Hyperlipidemia	9 (0.3)
Surgical history: Bariatric	47 (1.6)

Discussion. The understanding of pregnancy related complications is very crucial for expectant mothers and healthcare workers to aid in prevention, early detection, and appropriate management. This study focuses on identifying pregnancy related risks and their association with different age groups.

Having health complications or multiple chronic conditions amplifies the risk of having adverse outcomes including perinatal and neonatal complications.[13]. For example, high BMI plays a predominant role in determining the risk of developing unfavorable pregnancy outcomes.[14]

We outlined the statistically significant relationship between BMI and increasing age in which the percentage of patients having a BMI ≥ 35 increased from 12.2% to 34.3% (p<0.01) across the age groups. Our results clearly demonstrate how BMI increases with maternal age explaining how older women are at a higher risk of developing complications during their pregnancy. The current literature affirms that pregnancy-related risks including thrombosis, GDM, pre-eclampsia, cesarean

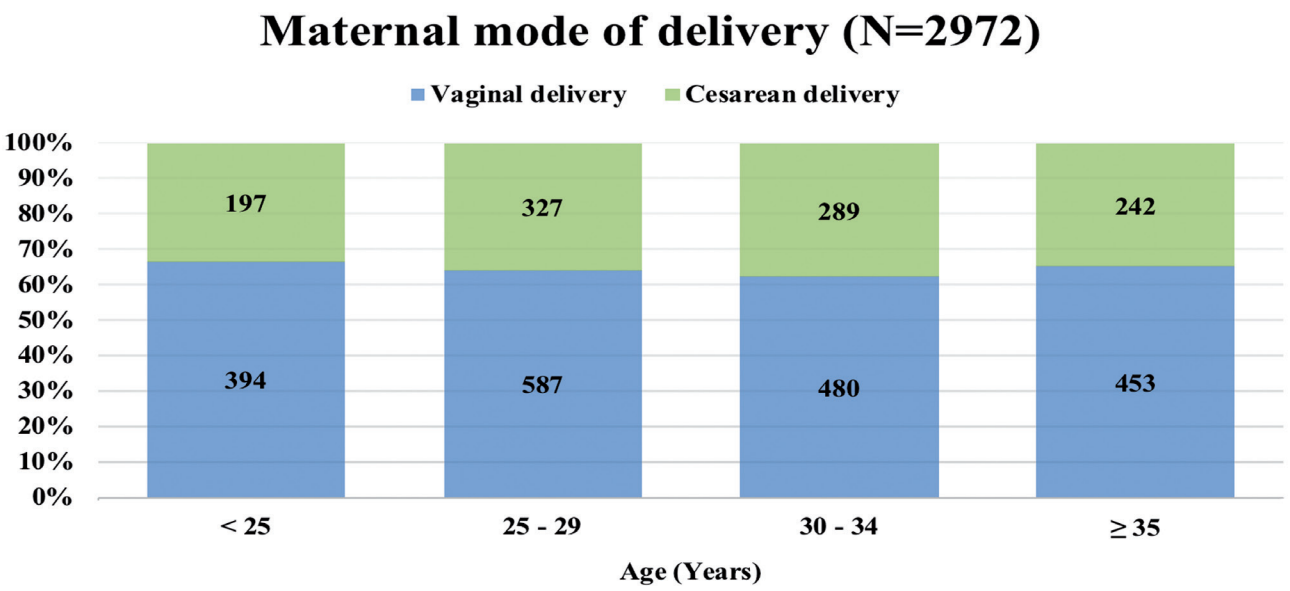

Figure 1 - The frequency and percentage of maternal mode of delivery by age group. Three women delivered before arrival.

births and many others like postpartum hemorrhage, eclampsia and macrosomia are highly associated with raised BMI.[14,15] Additionally, having a higher BMI increases the risk of stillbirths, miscarriages as well as various health issues to the child including congenital disorders, growths problems, childhood asthma, cognitive problems, or childhood obesity.[16] This further proves how older women are more vulnerable to having a risky pregnancy. A study carried out in China explores the risks associated with obesity in pregnancy. It depicts that a rise of 1-standard diviation (SD) in BMI (OR=1.64, p=5.05 × 10^{-17}) and waist-to-hip ratio (OR=1.57, p=2.27 × 10^{-14}), increases the likelihood of GDM.[17] Their results further support the notion that BMI is associated with pregnancy related complications. The pathophysiology behind the weight changes that ensue with age can be explained by various mechanisms. Firstly, the body undergoes crucial endocrinological changes with age like a decrease in certain hormones namely growth hormone, IGF-1, testosterone, DHEA, and estrogen coupled with resistance to leptin and insulin. All of these hormonal changes favor weight gain and fat redistribution.[18] Additionally, the gradual loss of skeletal muscle that accompanies age contributes to a decrease in the basal metabolic rate by 2-3% per decade approximately, starting from the age 20.[18] Also, aging causes reduced physical activity, mobility and overall energy expenditure which are all contributory factors.

Another example of how advanced maternal age increases the risk of pregnancy related complications is the development of GDM. Our statistically significant results depict how the number of mothers who developed GDM during their pregnancy increased from 6.6% to 11.5% (p=0.027) across the age groups as shown in Table 2. A meta-analysis was conducted to investigate the risk of GDM with advanced maternal age and their results align with the results of our study. Their study demonstrates how the likelihood of developing GDM in the overall population increases by 7.9% with every one-year increase in maternal age.[19] These results affirm the notion of how successive age groups increase the chance of having GDM. The development of GDM is a risk factor for developing further complications involving both the mother and the baby.[20] As displayed by the statistically significant results of a case-control study conducted in China, the incidence of adverse maternal (maternal dystocia, cesarean section, abnormal amniotic fluid, premature rupture of membranes) and neonatal outcomes (fetal distress, macrosomia, preterm children) was higher amongst the GDM group in comparison to the control group.[21] Another study conducted in China highlights how older women with GDM are more likely to develop GDM-related complications such as c-sections, polyhydramnios, postpartum hemorrhage, and lower APGAR scores when compared to their younger counterparts.[22] Although a definite mechanism has not been implicated in linking GDM and age, multiple mechanisms and theories have been proposed. As mentioned, with age insulin sensitivity is worsened, pro-inflammatory markers including adipokines are raised in the blood which aggravate insulin resistance. The progressive and continued destruction

Table 2 - Maternal characteristics, comorbidities, complications, and outcomes association with maternal age.

Variables	Maternal age (years) <25 (n=591) n (%)	25–29 (n=914) n (%)	30–34 (n=771) n (%)	≥35 (n=696) n (%)	*P*-value
Maternal characteristics					
Body mass index(kg/m^2)					
<35	519 (87.8)	728 (79.6)	561 (72.8)	457 (65.7)	< 0.01*
≥35	72 (12.2)	186 (20.4)	210 (27.2)	239 (34.3)	
Conception					
Spontaneous	579 (98.0)	880 (96.2)	735 (95.3)	676 (97.3)	
In-vitro fertilization	10 (1.7)	28 (3.1)	32 (4.2)	18 (2.6)	0.118
Ovulation induced fertilization	2 (0.3)	6 (0.7)	4 (0.5)	1 (0.1)	
Antepartum					
Gestational diabetes mellitus	39 (6.6)	83 (9.1)	71 (9.2)	80 (11.5)	0.027*
Hypertension	4 (0.7)	10 (1.1)	12 (1.6)	12 (1.7)	0.320
Gestational hypertension	4 (0.7)	11 (1.2)	6 (0.8)	10 (1.4)	0.464
Eclampsia & preeclampsia	11 (1.9)	12 (1.3)	9 (1.2)	12 (1.7)	0.667
Antepartum hemorrhage					
None	587 (99.3)	906 (99.1)	766 (99.4)	690 (99.1)	
Placenta praevia	1 (0.2)	3 (0.3)	3 (0.4)	2 (0.3)	0.954
Abruption	3 (0.5)	5 (0.5)	2 (0.3)	4 (0.6)	
Intra-partum					
Premature preterm rupture of membrane	4 (0.7)	13 (1.4)	10 (1.3)	9 (1.3)	0.607
Delayed 2nd stage of labor	7 (1.2)	9 (1.0)	6 (0.8)	4 (0.6)	0.662
Mode of delivery					
Vaginal	394 (66.7)	587 (64.2)	480 (62.4)	453 (65.2)	0.418
Cesarean	197 (33.3)	327 (35.8)	289 (37.6)	242 (34.8)	
Vaginal delivery estimated blood loss (ml)					
<500	364 (97.6)	584 (98.5)	482 (99.4)	456 (98.5)	0.191
≥500	9 (2.4)	9 (1.5)	3 (0.6)	7 (1.5)	
Cesarean delivery estimated blood loss (ml)					
<1000	207 (94.5)	308 (96.0)	240 (92.3)	240 (94.1)	0.309
≥1000	12 (5.5)	13 (4.0)	20 (7.7)	15 (5.9)	
Post-partum					
Venous thromboembolism	0 (0.0)	1 (0.1)	1 (0.1)	0 (0.0)	0.670
Depression	2 (0.3)	5 (0.5)	2 (0.3)	2 (0.3)	0.758
Pyrexia	0 (0.0)	4 (0.4)	5 (0.6)	2 (0.3)	0.255
Wound infection & dehiscence	8 (1.4)	8 (0.9)	8 (1.0)	8 (1.1)	0.845
Hematoma	1 (0.2)	1 (0.1)	0 (0.0)	3 (0.4)	0.226
Urinary tract infection	11 (1.9)	17 (1.9)	15 (1.9)	8 (1.1)	0.625
Endometritis	0 (0.0)	1 (0.1)	1 (0.1)	0 (0.0)	0.670
Chorioamnionitis	1 (0.2)	3 (0.3)	0 (0.0)	2 (0.3)	0.463
Hysterectomy	0 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)	0.559
Mortality	0 (0.0)	0 (0.0)	1 (0.1)	0 (0.0)	0.414

*Significant *p*-value <0.05, *p*-value was calculated using Chi-square and Fisher's exact test as appropriate. In-vitro fertilization had one un-applicable patient, and mode of delivery had 3 un-applicable patients. Vaginal and cesarean delivery estimated blood loss, are only applicable for 1914 and 1055 patients, respectively.

of pancreatic β-cell function has a linear association with age. Oxidative stress and theories pertaining to its detrimental effect on glycemic control have also been theorized.[22] Meanwhile our study did not exhibit any significance in terms of antepartum complications such as preeclampsia, eclampsia and antepartum hemorrhage in various maternal age comparison.

Pregnancy-related complications, either maternal or neonatal, are not strictly associated with advanced maternal age; younger age groups can be more prone to developing certain adverse outcomes. These include eclampsia, systemic infections, postpartum endometritis, and many others.[23] In addition, babies of adolescent mothers are at higher risk of prematurity, congenital malformations, and perinatal mortality.[24] As demonstrated by the results of our study, IUGR and preterm deliveries were associated with younger maternal age groups. Table 3 represents a statistically

Table 3 - Fetal and Neonatal characteristics, complications, and outcomes association with maternal age.

Variables	Maternal age (Years) <25 (n=591)	25–29 (n=914)	30–34 (n=771)	≥35 (n=696)	*P*-value
Neonatal characteristics					
Gestational age					
Pre-term	96 (16.2)	116 (12.7)	94 (12.2)	90 (12.9)	
Term	328 (55.5)	536 (58.6)	438 (56.8)	406 (58.3)	0.338
Post-term	167 (28.3)	262 (28.7)	239 (31.0)	200 (28.7)	
Birth centile					
<10	36 (6.1)	58 (6.4)	52 (6.8)	37 (5.3)	
10–50	169 (28.6)	253 (27.7)	251 (32.6)	197 (28.3)	0.253
51–90	240 (40.6)	383 (42.0)	317 (41.2)	297 (42.7)	
>90	146 (24.7)	218 (23.9)	149 (19.4)	165 (23.7)	
Delivery complications					
Shoulder dystocia	0 (0.0)	1 (0.1)	1 (0.1)	1 (0.1)	0.851
Breech	22 (3.7)	19 (2.1)	23 (3.0)	24 (3.4)	0.236
Transverse	1 (0.2)	4 (0.4)	5 (0.6)	0 (0.0)	0.147
Oblique	1 (0.2)	1 (0.1)	2 (0.3)	1 (0.1)	0.898
Neonatal outcome[‡]					
Overall fetal complications	166 (28.1)	230 (25.2)	171 (22.2)	172 (24.7)	0.097
Miscarriage	4 (0.7)	2 (0.2)	1 (0.1)	0 (0.0)	0.075
Stillborn	4 (0.7)	3 (0.3)	7 (0.9)	5 (0.7)	0.503
Early neonatal death	4 (0.7)	1 (0.1)	5 (0.6)	1 (0.1)	0.123
Pre-term	87 (14.7)	136 (14.9)	92 (11.9)	79 (11.4)	0.087
Post-date	20 (3.4)	18 (2.0)	19 (2.5)	24 (3.4)	0.212
Large for gestational age	5 (0.8)	11 (1.2)	3 (0.4)	7 (1.0)	0.337
Small for gestational age	4 (0.7)	4 (0.4)	11 (1.4)	3 (0.4)	0.071
Intrauterine growth restriction	19 (3.2)	14 (1.5)	10 (1.3)	11 (1.6)	0.041*
Congenital anomalies	48 (8.2)	62 (6.8)	43 (5.6)	51 (7.4)	0.295

Values are presented as number and percentages (%). *Significant $p<0.05$, *P*-value was calculated using Chi-square and Fisher's exact test as appropriate. [‡]Some women had more than one neonatal outcome. Birth centile had 4 un-applicable patients.

significant decrease of the IUGR rate from 3.2% to 1.6% ($p=0.041$) across the age groups. This conveys how neonates belonging to younger mothers (<25 years) have a profoundly higher chance of developing IUGR.

Correspondingly using univariate logistic regression, portrays how women aged <25 are significantly more likely to have a preterm neonate when compared to women aged 25-29 (OR 1.365 95% CI [1.015-1.837], $p=0.040$). In comparison to our results, a study conducted in Slovakia exhibits the relationship between teenage mothers (<20 years) and the development of neonatal complications. Their results lay out the statistically significant increased rates of neonatal prematurity in adolescent mothers (25.2%) compared to mothers aged between 20-34 years (17.1%) 25. Furthermore, adolescent mothers had a significantly higher risk of delivering low birth weight babies (<2500 g) ($p<0.001$), and APGAR scores <7 at 1 minute ($p=0.003$), than those aged 20-34 years.[25] The pathophysiology of preterm labor and young age has long been studied. Theories and processes that help explain the association include the immaturity of the uterus and its tendency to become sensitive and irritable.[26] Moreover, links to raised prostaglandin levels and younger women being more prone to dehydration have also been reported.[27] Additionally, insufficient uterine and cervical blood flow has also been implicated, as it makes younger women vulnerable to infections and acts as a trigger to premature labor.[27] Other links have also been made to the hormonal milieu of younger women favoring the mothers' development as opposed to the fetus'.[26]

In addition, Table 4 showcases the significantly decreased risk of GDM, among women aged 30-34 years old when compared to those aged 25-29 years old (OR 0.544 95% CI [0.365-0.811] $p=0.003$). Despite the fact that most studies and theories surrounding the association between GDM and age are a dose-response relationship, our study has yielded results that oppose that view. A study performed to analyze the association between maternal age and serum glucose levels during pregnancy established that there was a linear relationship between these 2 variables. The odds of a positive glucose screening in women ≥35 years was 2-folds the risk compared to women aged <35years.[28]

Various other risks or complications and their relation to different maternal age groups were investigated in our study. However, these results were statistically insignificant. Although some of our data comparisons were insignificant, the current literature has established these variables as complications in certain maternal age groups. For example, it has been highlighted by a retrospective cohort study carried out in Senegal that the risk of hypertension (HTN) is significantly 1.6 times higher among mothers aged ≥35 years than those aged 19-34 years.[29] Another study done in Indonesia to investigate perinatal outcomes in relation to advanced maternal age in pregnant women with pre-eclampsia. Their study reveals that the advanced maternal age preeclampsia group (≥35 years) had a significantly increased risk of postpartum hemorrhage (16.3%) when compared with the reproductive age group (25-34 years) who had a significantly lower risk (4.8%).[30]

Although our results were invalidating, many studies proclaim the association between maternal age and the indication of having a cesarean section. A study conducted in Denmark reveals that women aged 35-39 had twice the risk (2.18) whereas women aged ≥40 years had thrice the risk (3.64) in comparison to younger age groups.[31] This can be explained by the fact that older women tend to have more comorbidities such as diabetes mellitus, HTN, higher BMI, and so on which all increase the risk of cesarean births.[31,32]

In regards to post-term complications, our study opposes the general census of the literature and was found negative across all complications. One particular study conducted in Sweden aimed to examine the factors that influence a women's likelihood of developing post-term infections namely wound infections, endometritis and breast abscesses. They reported a positive association between advanced maternal age and post-partum infections.[33] Furthermore, a nationwide study in South Korea investigated the risk factors related to venous thromboembolism (VTE) development in the post-partum period. It witnessed a higher preponderance of thromboembolic disease in the puerperium with every 5-year incremental increase in age (OR 1.47 [95% CI 1.35 - 1.60] p<0.001) 20.[34] However, our results did not adhere to the well-established link and linear association of age and VTE risk.

Concerning delivery complications, several studies contradict the results of our study by accentuating the linearity between advanced maternal age and complications during labor. A retrospective study in Finland with the aim of developing a shoulder dystocia risk score tool reveals how the incidence of shoulder dystocia increases remarkably in women ≥40 years of age 21.[35] Another study established in India, outlines

Table 4 - Univariate logistic regression of maternal and neonatal outcomes for maternal age:

Outcome	Maternal age (years)						
	<25 (n=591)		25-29 (n=914)	30-34 (n=771)		≥35 (n=696)	
	OR (95% CI)	*P*-value	Reference	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Maternal outcome							
GDM	0.769 (0.556 – 1.064)	0.113	Reference	0.544 (0.365 – 0.811)	0.003*	0.781 (0.557 – 1.094)	0.151
HTN	0.631 (0.271 – 1.468)	0.285	Reference	0.388 (0.125 – 1.211)	0.103	0.901 (0.402 – 2.019)	0.800
GHTN	0.836 (0.353 – 1.979)	0.683	Reference	0.467 (0.146 – 1.498)	0.201	0.538 (0.195 – 1.488)	0.232
Eclampsia and PET	0.758 (0.339 – 1.698)	0.501	Reference	1.081 (0.473 – 2.468)	0.853	0.673 (0.282 – 1.608)	0.373
PPROM	1.101 (0.468 – 2.591)	0.825	Reference	0.520 (0.159 – 1.698)	0.279	1.003 (0.405 – 2.483)	0.995
Delayed 2nd stage of labor	1.720 (0.528 – 5.610)	0.368	Reference	2.074 (0.604 – 7.119)	0.246	1.357 (0.381 – 4.828)	0.637
Mode of delivery	1.043 (0.848 – 1.282)	0.691	Reference	0.936 (0.743 – 1.180)	0.575	1.127 (0.910 – 1.395)	0.273
Fetal and neonatal outcome							
Stillborn	0.455 (0.108 – 1.911)	0.282	Reference	0.942 (0.252 – 3.523)	0.929	1.266 (0.400 – 4.008)	0.688
Early neonatal death	0.761 (0.048 – 12.192)	0.847	Reference	4.736 (0.528 – 42.489)	0.165	4.537 (0.529 – 38.926)	0.168
Pre-term	1.365 (1.015 – 1.837)	0.040*	Reference	1.348 (0.973 – 1.869)	0.073	1.058 (0.769 – 1.457)	0.729
Post-date	0.563 (0.303 – 1.045)	0.069	Reference	0.981 (0.536 – 1.794)	0.950	0.707 (0.384 – 1.303)	0.267
LGA	1.199 (0.462 – 3.109)	0.709	Reference	0.840 (0.265 – 2.660)	0.767	0.384 (0.099 – 1.493)	0.167
SGA	1.015 (0.227 – 4.552)	0.984	Reference	1.574 (0.351 – 7.062)	0.554	3.343 (0.929 – 12.034)	0.065
IUGR	0.969 (0.437 – 2.147)	0.938	Reference	2.068 (0.976 – 4.383)	0.058	0.818 (0.345 – 1.939)	0.649
Congenital anomalies	0.918 (0.625 – 1.349)	0.663	Reference	1.119 (0.742 – 1.687)	0.591	0.748 (0.492 – 1.137)	0.174

OR: odd ratios, CI: confidence interval, GDM: gestational diabetes mellitus, HTN: hypertension, GHTN: gestational hypertensions, PPROM: Premature rupture of membrane, LGA: large for gestational age, SGA: small for gestational age, IUGR: intrauterine growth restriction, CI: confidence interval

the rate increase of breech presentation from 17.7% in women aged 20-30 years to 28.8% in women aged ≥35 years.[36]

Although IUGR has been found to be statistically significant with younger maternal age, other adverse neonatal outcomes have not been significant with either age spectrum. One particular prospective cohort study in Zambia assessed the prevalence of different adverse neonatal outcomes including preterm birth, still birth, low birth weight, death in the first 7 and 28 days after birth, need for resuscitation at birth. Both extremes of age, young or advanced, were found to be statistically significant with certain complications, which was not replicated by our study.[37]

Study strengths and limitations. Large number of the study population with the sufficient data in our electronic records added strength to the study. We addressed most of the significant maternal variables such as GDM, gestational hypertension, preeclampsia,eclampsia and antepartum hemorrhage. Additionally, we emphasized intrapartum variables such as mode of delivery, stages of labor, delivery complications, and post-partum complications. Also, we focused on fetal and neonatal variables such as gestational age at delivery, fetal growth restrictions, birth centile and neonatal outcome. As our study included singleton pregnancies with the completed gestational age of ≥24 weeks, risk of miscarriage and complications related to multiple pregnancies are not studied. Also, congenital anomalies in different age groups are unexplored in our study.

In conclusion, the findings highlight key associations between maternal age and various pregnancy outcomes. The majority of deliveries occurred within the 25 to 29 age group, but significant correlations were found between maternal age and certain risk factors. Body mass index was notably linked to age, while GDM showed a clear association with advanced maternal age. Additionally, younger mothers, particularly those under 25 years, were at a higher risk for complications like fetal IUGR and preterm delivery. To reduce the risks and improve both maternal and neonatal outcomes, it is recommended that prenatal care tailored to the specific needs of each age group, targeted counseling, appropriate interventions and preventive measures be implemented for women in these extreme age categories. This proactive strategy could help mitigate adverse outcomes and enhance overall maternal and neonatal health.

Acknowledgment. *The authors would like to express their gratitude to the Royal Bahrain Defense Force Hospital and the Crown Prince Centre for Training and Medical Research. We also extend our thanks to Fatima Buzaid and Shaima Khalid for their contributions to data analysis. Additionally, we would like to thank Proofreading Pal LLC for their assistance with English proofreading.*

References

1. Nyongesa P, Ekhaguere OA, Marete I, Tenge C, Kemoi M, Bann CM, et al. Maternal age extremes and adverse pregnancy outcomes in low-resourced settings. ***Front Glob Womens Health*** 2023; 4: 120103.
2. UNICEF. Early Childbearing. [Updated 2024. 2024 Available from: https://data.unicef.org/topic/child-health/adolescent-health/#:~:text=Globally%20in%202023%2C%20an%20estimated,their%20education%2C%20livelihoods%20and%20health
3. World Bank Group | Gender Data Portal. Bahrain. [Updated 2025; Cited 2024 June 14]. Available from: https://genderdata.worldbank.org/en/economies/bahrain
4. United Nations D epartment of Economic and Social Affairs. World fertility patterns 2015. New York: United Nations. [Updated 2015; Cited 2024 June 14].Available from: https://www.un.org/en/development/desa/population/publications/pdf/fertility/world-fertility-patterns-2015.pdf
5. Başkiran Y, Tanoğlu FB, Uçkan K, Çeleğen İ, Karaçor T. The impact of maternal age distribution on pregnancy-related complications and neonatal outcomes: a single-center retrospective experience. ***ADYÜ Sağlık Bilimleri Derg*** 2023 2023; 9: 215–222.
6. Shima H, Ashraf DM, Kourosh S, Mirhadi M, Hamzeh A, Monireh A, et al. Risk factors affecting abortion among pregnant women– A case-control study. ***J Res Med Sci*** 2024; 11: 1-13
7. Frederiksen LE, Ølgaard SM, Roos L, Petersen OB, Rode L, Hartwig T, et al. Maternal age and the risk of fetal aneuploidy: A nationwide cohort study of more than 500 000 singleton pregnancies in Denmark from 2008 to 2017. ***Acta Obstet Gynecol Scand*** 2023; 103: 351-359.
8. Smithson SD, Greene NH, Esakoff TF. Pregnancy outcomes in very advanced maternal age women. ***Am J Obstet Gynecol MFM*** 2021; 4: 100491.
9. Correa-De-Araujo R, Yoon SS. Clinical outcomes in high-risk pregnancies due to advanced maternal age. ***J Womens Health (Larchmt)*** 2020; 30: 160-167.
10. Shekari M, Shirzadfardjahromi M, Ranjbar A, Mehrnoush V, Darsareh F, Roozbeh N. Advanced maternal age and adverse obstetrical and neonatal outcomes of singleton pregnancies. ***Gynecol Obstet Clin Med*** 2022; 2: 175-180.
11. Martins MV, Karara N, Dembiński L, Jacot-Guillarmod M, Mazur A, Hadjipanayis A, et al. Adolescent pregnancy: An important issue for paediatricians and primary care providers—A position paper from the European academy of paediatrics. ***Frontiers in Pediatrics*** 2023; 11: 1119500.
12. Diabelková J, Rimárová K, Dorko E, Urdzík P, Houžvičková A, Argalášová Ľ. Adolescent pregnancy outcomes and risk factors. ***Int J Environ Res Public Health*** 2023; 20: 4113.
13. Pati S, Puri P, Sinha R, Panda M, Pati S. Profile of comorbidity and multimorbidity among women attending antenatal clinics. ***J Family Med Prim Care*** 2022; 11: 1980-1988.
14. Neal K, Ullah S, Glastras SJ. Obesity class impacts adverse maternal and neonatal outcomes independent of diabetes. ***Front Endocrinol (Lausanne)*** 2022; 13: 832678.

15. Whitley J, Dazelle W, Kripalani S, Ahmadzia H. The association between body mass index and postpartum hemorrhage after cesarean delivery. ***Sci Rep*** 2023; 13: 11998.
16. Sagi-Dain L. Obesity in Pregnancy: ACOG Practice Bulletin, Number 230. ***Obstet Gynecol*** 2021; 138: e128-e144.
17. Song X, Wang C, Wang T, Zhang S, Qin J. Obesity and risk of gestational diabetes mellitus: A two-sample Mendelian randomization study. ***Diabetes Res Clin Pract*** 2023; 197: 110561.
18. McKee AM, Morley JE. Obesity in the elderly. In: Feingold KR, Anawalt B, Blackman MR, et al. Endotext . South Dartmouth (MA): MDText.com, Inc.; 2000.
19. Li Y, Ren X, He L, Li J, Zhang S, Chen W. Maternal age and the risk of gestational diabetes mellitus: A systematic review and meta-analysis of over 120 million participants. ***Diabetes Res Clin Pract*** 2020; 162: 108044.
20. Gao L, Chen CR, Wang F, Ji Q, Chen KN, Yang Y, et al. Relationship between age of pregnant women with gestational diabetes mellitus and mode of delivery and neonatal Apgar score. ***World J Diabetes*** 2022; 13: 776–785.
21. Zhuang W, Lv J, Liang Q, Chen W, Zhang S, Sun X. Adverse effects of gestational diabetes-related risk factors on pregnancy outcomes and intervention measures. ***Exp Ther Med*** 2020; 20: 3361-3367.
22. Sun M, Luo M, Wang T, Wei J, Zhang S, Shu J, et al. Effect of the interaction between advanced maternal age and pre-pregnancy BMI on pre-eclampsia and GDM in Central China. ***BMJ Open Diabetes Res Care*** 2023; 11: e003324.
23. Chakole S, Akre S, Sharma K, Wasnik P, Wanjari MB. Unwanted teenage pregnancy and its complications: A narrative review. ***Cureus*** 2022; 14: e32662.
24. Zhang T, Wang H, Wang X, Yang Y, Zhang Y, Tang Z, et al. The adverse maternal and perinatal outcomes of adolescent pregnancy: a cross sectional study in Hebei, China. ***BMC Pregnancy Childbirth*** 2020; 20: 399.
25. Diabelková J, Rimárová K, Dorko E, Urdzík P, Houžvičková A, Argalášová Ľ. Adolescent pregnancy outcomes and risk factors. ***Int J Environ Res Public Health*** 2023; 20: 4113.
26. Perez MJ, Chang JJ, Temming LA, Carter EB, Lopez JD, Tuuli MG, et al. Driving factors of preterm birth risk in adolescents. ***AJP Rep*** 2020; 10: e247–e252.
27. Maheshwari MV, Khalid N, Patel PD, Alghareeb R, Hussain A. maternal and neonatal outcomes of adolescent pregnancy: A Narrative review. ***Cureu*** 2022; 14: e25921.
28. Yong HY, Shariff ZM, Yusof BNM, Rejali Z, Tee YYS, Bindels J, et al. Independent and combined effects of age, body mass index and gestational weight gain on the risk of gestational diabetes mellitus. ***Sci Rep*** 2020; 10: 8486.
29. Ndiaye MD, Gueye M, Diallo M, Wade M, Diakhate A, Diouf A, et al. The impact of extreme maternal ages on hypertensive disorders of pregnancy: A retrospective cohort study in Dakar, Senegal. ***Open J Obstet Gynecol*** 2020; 10: 213–20.
30. Tyas BD, Lestari P, Akbar MIA. Maternal perinatal outcomes related to advanced maternal age in preeclampsia pregnant women. ***J Family Reprod Health*** 2019; 13: 191-200.
31. Rydahl E, Declercq E, Juhl M, Maimburg RD. Cesarean section on a rise—Does advanced maternal age explain the increase? A population register-based study. ***PLoS One*** 2019; 14: e0210655.
32. Šťastná A, Fait T, Kocourková J, Waldaufová E. Does advanced maternal age comprise an independent risk factor for caesarean section? A population-wide study. ***Int J Environ Res Public Health*** 2022; 20: 668.
33. Axelsson D, Brynhildsen J, Blomberg M. Maternal obesity and the risk of postpartum infections according to mode of delivery. ***J Matern Fetal Neonatal Med*** 2023; 36: 2245102.
34. Park JE, Park Y, Yuk JS. Incidence of and risk factors for thromboembolism during pregnancy and postpartum: A 10-year nationwide population-based study. ***Taiwan J Obstet Gynecol*** 2021; 60: 103–110.
35. Heinonen K, Saisto T, Gissler M, Kaijomaa M, Sarvilinna N. Rising trends in the incidence of shoulder dystocia and development of a novel shoulder dystocia risk score tool: a nationwide population-based study of 800 484 Finnish deliveries. ***Acta Obstet Gynecol Scand*** 2020; 100: 538-547.
36. Ritu, Mini. Advanced maternal age and obstetric outcome. ***Int. J Reprod Contracept Obstet Gynecol*** 2020; 9:1159.
37. Tembo T, Koyuncu A, Zhuo H, Mwendafilumba M, Manasyan A. The association of maternal age with adverse neonatal outcomes in Lusaka, Zambia: a prospective cohort study. ***BMC Pregnancy Childbirth*** 2020; 20: 684.