Heliyon 10 (2024) e24608

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Impact of advanced maternal age on perinatal outcomes in Tanzania: Insights from Kilimanjaro Christian Medical Center Birth Registry

Lilian Remigius Mnabwiru[a,1], Yeon Seo Cho[b,1], Michael Johnson Mahande[c], Nicholous Mazugun[d], Bariki Lawrence Mchome[e], Eun Young Park[b,*]

[a] *Department of Obstetrics and Gynecology, Muhimbili National Hospital, Ilala, Upanga Magharibi, Tanzania*
[b] *Department of Obstetrics and Gynecology, Yonsei University Wonju College of Medicine, Wonju, Gangwondo, Republic of Korea*
[c] *Institute of Public Health, Department of Epidemiology & Biostatistics, Kilimanjaro Christian Medical University College, Moshi, Tanzania*
[d] *Department of Obstetrics and Gynecology, Kilimanjaro Fertility Institute (KFI), Tanzania*
[e] *Department of Obstetrics and Gynecology, Kilimanjaro Christian Medical University College, Moshi, Tanzania*

ARTICLE INFO

Keywords:
Sub-Saharan Africa
Perinatal maternal outcome
Perinatal birth outcome
Apgar score

ABSTRACT

The increasing prevalence of advanced maternal age (AMA) births necessitates the exploration of associated pregnancy outcomes within the healthcare-limited context of northern Tanzania to elucidate potential region-specific risks and implications. This study explored the influence of AMA on pregnancy outcomes in northern Tanzania, where healthcare resources and infrastructure are constrained in comparison to developed countries. This cross-sectional hospital-based study utilized maternally linked data from the Kilimanjaro Christian Medical Center (KCMC) Medical Registry and included 32,798 women who delivered single infants between 2004 and 2013. Multiple logistic regression models were used to determine adjusted odds ratios (aORs) and 95 % confidence intervals (CIs) for AMA-associated adverse pregnancy outcomes. A total of 16 % of mothers belonged to AMA with increased odds of undergoing a cesarean section (aOR: 1.32; 95%CI [1.24–1.41]; $P < 0.001$), gestational diabetes (aOR: 13.16; 95%CI [3.28–52.86]; $P < 0.001$) or pregestational diabetes (aOR: 3.15; 95%CI [1.87–5.31]; $P < 0.000$), and developing pre-eclampsia (aOR: 1.63; 95%CI [1.41–1.89]; $P < 0.000$). More women with AMA reported alcohol use during pregnancy and had preexisting conditions before conception than did younger women. Maternal education level, employment status, urban residency, and Christianity were statistically significant. This study establishes a connection between AMA and higher odds of cesarean section, gestational diabetes, pregestational diabetes, and pre-eclampsia. Women with AMA were more inclined to consume alcohol during pregnancy and exhibited preexisting conditions before conception. Moreover, AMA was linked to increased odds of low birth weight, stillbirths, and NICU transfers.

* Corresponding author. Department of Obstetrics and Gynecology, Yonsei University, Wonju College of Medicine, Wonju, Gangwondo, 26426, Republic of Korea.

E-mail address: evenezer@yonsei.ac.kr (E.Y. Park).

[1] Equal contribution by these authors.

https://doi.org/10.1016/j.heliyon.2024.e24608
Received 6 November 2023; Received in revised form 10 January 2024; Accepted 10 January 2024
Available online 14 January 2024

1. Introduction

Women with an advanced maternal age (AMA) are 35 years or older at the time of delivery. Studies from developed countries have shown that AMA has significantly increased over the past 30–40 years [1]. However, information on this topic must be more precise in developing countries, especially sub-Saharan Africa.

AMA ranges from 2.8 % in Nepal to 31.1 % in Japan. In a multicountry assessment report by the World Health Organization (WHO), the overall prevalence of AMA is 12.3 % [2]. Another study conducted in South Africa showed that the prevalence of advanced-aged pregnancies is 17.7 %, with a mean age of 38.1 years. Moreover, the prevalence of AMA is found to be 3 % in Yaoundé Cameroon.

Conception at an AMA occurs for several reasons, including delaying marriage due to career development and opportunities for further studies, female empowerment, availability of effective contraceptive options, and child policy in some countries [3,4]. Previous studies have demonstrated that advancements in Assisted Reproductive Technologies (ART) have made it possible for several women, including women with AMA [5]. Like other age groups, women with AMA can have good pregnancy outcomes and cope with the physical and emotional stress of pregnancy and parenting [6].

Adverse outcomes in late pregnancy may be associated with preexisting medical conditions (such as cancers, cardiovascular, renal, autoimmune diseases, and obesity) [7], antepartum hemorrhage (placenta previa, abruption placenta, and vasa previa) [8], pregnancy-induced hypertension (PIH), and gestational diabetes mellitus (GDM) [9,10]. AMA also poses the risk of low birth weight, premature delivery, unexplained fetal death, neonatal death, complications due to ART, increased rate of cesarean section, and maternal mortality [11,12].

1.1. Stillbirth and neonatal death

A series of systematic reviews of 63 cohorts and 12 case-control studies showed a significant association between increased maternal age and stillbirth [13]. In another study, the relative risk (RR) of stillbirth increased with increasing maternal age (30–34 years, RR = 1.23; and 35–39 years, RR = 1.4, compared to women aged 20–29 years) [14]. Preterm delivery is among the predicted adverse effects in advanced-aged women. A study in California that assessed the predictors of preterm birth based on obstetric estimates of gestational age showed that women in the advanced age group were twice as likely to have preterm births compared to the reference group. Similar findings have been observed in China, where older women have a higher rate of preterm delivery [7,15].

1.2. Congenital anomalies and rate of cesarean section

Various studies have shown the association between advanced-age pregnancy and congenital abnormalities [8,16]. AMA has been associated with multiple adverse conditions, including increased cesarean section rates, breech presentation, antepartum hemorrhage, pre-eclampsia, eclampsia, and exacerbation of existing medical conditions [9,17]. In a systematic review that examined the association between AMA and cesarean sections in developed countries, there was an increased risk of cesarean births among both nulliparous and multiparous women with AMA compared with younger women (RR varied from 1.39 to 2.76) [17,18].

1.3. Abnormal placentation

AMA has also been associated with the risk of abnormal placentation. A study conducted in China showed that women with AMA were more likely to have placenta previa [7].

The population of Tanzania is rapidly aging, including reproductive-aged women. As more women delay childbirth, the impact of outcomes related to delivery at AMA on public maternal and child healthcare will become more significant. Women with AMA are at an increased risk of pregnancy complications, such as gestational diabetes, hypertension, placenta previa, and fetal distress. These complications often require expensive medical intervention and specialized care.

However, access to reproductive healthcare in Africa is limited, particularly for women living in rural areas. This makes it difficult for women to receive timely prenatal care and medical interventions when complications arise during pregnancy. In addition, children born to older mothers are at increased risk of developmental delays, genetic disorders, and other health problems. The long-term impact of these outcomes on public healthcare in Tanzania is significant as it can lead to increased healthcare costs, reduced productivity, and a substantial burden on public maternal and child healthcare.

Tanzania has dedicated significant efforts to examining teenage pregnancies. However, we encountered limited published data regarding the current AMA in the country. Furthermore, to the best of our knowledge, no previous studies have investigated the potential adverse outcomes linked to AMA. Considering the lack of information on pregnancy outcomes among Tanzanian women with AMA, we strongly advocate implementing multi-regional studies. These studies would help elucidate regional variations and establish causal relationships in this context.

The North Kilimanjaro region, which is the focus of our study, boasts the strongest economy and highest levels of education when compared to other regions in Tanzania. Consequently, conducting research on AMA in the Kilimanjaro region is particularly relevant for exploring variations among different areas within Tanzania. This research can serve as a pivotal foundation for future studies and play a vital role in shaping maternal and child health policies in the country. It is worth noting that even across Africa, there is a dearth of substantial evidence regarding the impact of AMA on pregnancy outcomes. Published data pertaining to AMA outcomes predominantly consist of small-scale descriptive studies and surveys.

Therefore, this study aimed to determine the relationship between AMA and perinatal outcomes among women in northern

Tanzania.

Problem or Issue	What is Already Known	What this Paper Adds
Impact of AMA on pregnancy outcomes in resource-limited northern Tanzania.	Previous studies have focused primarily on pregnancy outcomes related to AMA in developed countries with robust healthcare infrastructure.	This paper highlights the specific risks associated with AMA in a region with constrained healthcare resources, showing higher odds of adverse outcomes for both mother and infant in northern Tanzania. Additionally, it reveals behavioral and socio-demographic factors correlating with AMA, such as alcohol usage during pregnancy, higher education, employment status, urban residency, and religious affiliation.
Limited data from developing regions with constrained healthcare.	The known risks of AMA on pregnancy outcomes include cesarean sections, gestational diabetes, pre-eclampsia, and adverse neonatal outcomes.	This study underscores that these risks are pronounced in settings like northern Tanzania, indicating a need for targeted healthcare strategies in similar environments. It also establishes new associations specific to this demographic, such as increased alcohol consumption during pregnancy and preexisting conditions among older mothers.

2. Methods

2.1. Participants and procedures

In this cross-sectional analytical study, we used maternal-linked data sourced from the Kilimanjaro Christian Medical Center (KCMC) Medical Birth Registry. Our study focused on women aged ≥20 years who delivered singleton infants in the obstetrics department of the KCMC hospital between January 2004 and December 2013. Additionally, we included women aged 35 years and older in our analysis.

KCMC is one of three consulting and teaching hospitals in Tanzania. The hospital serves women from the local community and refers to clients from the nearby Kilimanjaro, Arusha, Manyara, Tanga, and Singida regions of Tanzania and nearby districts in Kenya along the Tanzania-Kenyan border. The hospital has a bed capacity of 450 and the average number of deliveries per year is 4000–4800.

Women with multiple gestations were excluded from this study. The dependent variable was the AMA. The independent variables were the mother's occupation, marital status, level of education, parity, presence of non-communicable disease, maternal outcomes, and perinatal outcomes. Maternal outcomes included cesarean section, pre-eclampsia and eclampsia (PIH), gestational hypertension, GDM, spontaneous preterm delivery, miscarriage, antepartum hemorrhage, postpartum hemorrhage, and maternal mortality. Perinatal outcomes included intrauterine fetal death, low Apgar score, prematurity, low birth weight, large-for-gestational age, small-for-gestational-age, and congenital anomalies.

2.2. Measures

The KCMC Medical Birth Registry, established in 1999, has been in operation since the year 2000. Information for all deliveries at the Department of Obstetrics and Gynecology was prospectively collected and entered into a computerized database system. A trained midwife-nurse conducted interviews using a standardized questionnaire for all women who delivered at the hospital within 24 h of delivery or as soon as the mothers recovered from complicated deliveries. Information on neonates admitted to the neonatal intensive care unit (NICU) is also recorded. A standardized form was used to obtain information regarding the demographic characteristics and immediate complications for both mothers and neonates. Our study involved retrospective extraction of stored data from the birth registry from January 2004 to December 2013. We obtained permission to conduct this study and employed a standardized checklist to extract relevant information from the database. Informed verbal consent was obtained from the participants before the interviews and enrollment.

2.3. Data analysis

Data analysis was performed using IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics were summarized using frequencies and proportions for categorical variables. The central tendency and respective measures of dispersion were computed for continuous variables. The Student's t-test was used to compare differences in means between groups for continuous outcomes. The χ^2 test was used to determine the association between a set of independent variables and categorical outcome variables in bivariate analysis. Odds ratios (ORs) with their respective 95 % confidence intervals (95 % CIs) for adverse maternal and perinatal outcomes associated with AMA were estimated using multiple logistic regression models. Two-tailed *P*-values of less than 5 % were considered statistically significant. We used the Kolmogorov–Smirnov (K–S) test and the Anderson–Darling test to evaluate the normality of our dataset. Normality tests were performed. These assessments were instrumental in gauging the normality of the data distribution, thereby facilitating selection between parametric and non-parametric tests in our statistical analysis. Consequently, we employed a parametric test.

3. Results

3.1. Characteristics of the study population

In total, 32,798 participants met the inclusion criteria. The majority (27,499, 84 %) were aged below 35 years (26.82 ± 4.05), while (5299,16 %) were older (37.56 ± 2.45). Most participants had a primary education and most (21,585, 65.8 %) were unemployed. Most of the women interviewed (29,260; 89.2 %) were married. A higher percentage of women with AMA used alcohol during pregnancy and had preexisting conditions before pregnancy than younger women, which was statistically significant (Table 1). In addition, a statistically significant proportion of women with AMA had an education beyond primary education, a job, and lived in urban areas.

3.2. Prevalence of AMA at KCMC from 2014 to 2022

The prevalence of AMA among the participants in this study was 16 % (5299 women), aged **35 years and above** (see Fig. 1).

3.3. Proportion of deliveries among age groups

Generally, births among women in both age groups increased in the later years (Fig. 2). However, the proportion of deliveries in women with AMA showed an exponential increase from 2011, when it surpassed and remained higher than that in younger women.

3.4. Maternal outcomes (obstetrics) associated with AMA

AMA was related to cesarean section, gestational diabetes, pregestational diabetes, and pre-eclampsia (Table 2). Women with cesarean sections were 3.86 times more likely to be in the advanced age group than those under 35 years of age (OR 3.86; 95%CI 1.30–1.49; $P < 0.001$). Women with gestational diabetes were 10.29 times more likely to have AMA than those aged <35 years (OR 10.29; 95%CI 2.57–41.18; $P < 0.001$). Women with AMA were 1.67 times more likely to have pre-eclampsia than the reference group. Although not statistically significant, maternal death was 3.86 times more likely in women with AMA. Table 2 presents the results for the other variables.

The results of the multivariable logistic regression analysis for predicting maternal death, cesarean section, gestational diabetes, pregestational diabetes, and pre-eclampsia by maternal age, alcohol use, area of residence, and antenatal visits are summarized in Table 2. AMA was significantly associated with cesarean section, gestational diabetes, pregestational diabetes, and pre-eclampsia.

Table 1
Characteristics of the study participants by maternal age groups (N = 32,798).

Characteristics	Total	Maternal age, y		χ^2 *P*
		20–34, n (%)	≥35, n (%)	
Mother's education				
None	546	442 (2)	104 (2)	<0.001
Primary (Grade 1–7)	17,895	14,725 (54)	3170 (60)	
Secondary (Grade 8–11)	3036	2679 (10)	357 (7)	
Higher (Grade 12+)	11,216	9570 (35)	1646 (31)	
Occupation				
Unemployed	21,585	18,086 (66)	3499 (66)	<0.001
Employed	8678	7133 (26)	1545 (29)	
Other	2495	2253 (8)	242 (5)	
Marital status				
Married	29,260	24,339 (89)	4921 (81)	<0.001
Single	3357	3024 (11)	333 (19)	
Alcohol use in pregnancy				
Yes	8518	6714 (24)	1804 (34)	<0.001
No	24,164	20,695 (76)	3469 (66)	
Residence				
Rural	12,613	10,169 (37)	2444 (46)	<0.001
Urban	20,106	17,269 (63)	2837 (54)	
Pregestational diabetes				
Yes	18,766	15,632 (57)	3134 (59)	0.001
No	13,992	11,840 (43)	2152 (41)	
Attended ANC in pregnancy				
Yes	32,509	27,265 (99)	5244 (99)	0.88
No	169	141 (1)	28 (1)	
Religion				
Christian	25,829	21,513 (79)	4316 (82)	<0.001
Muslim	6738	5795 (21)	943 (18)	

Abbreviation: ANC, antenatal care.

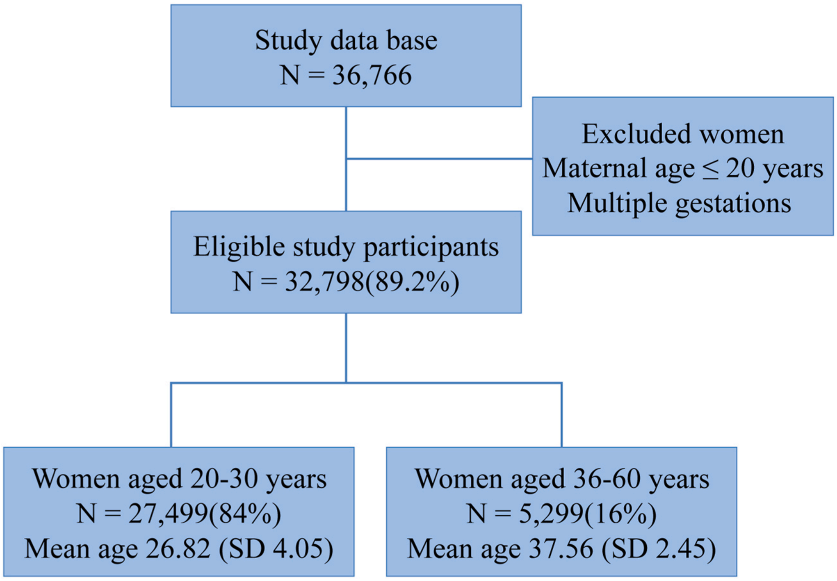

Fig. 1. Study flow chart.

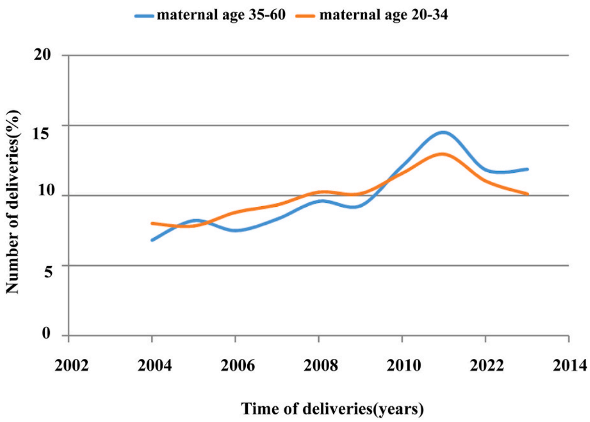

Fig. 2. Proportion of deliveries among age groups.

Table 2
Effect of advanced maternal age on different maternal outcomes (N = 32,798).

Outcome	Maternal age, y			COR [95%CI]	AOR [95%CI]
	Total	20–34, n (%)	≥35, n (%)		
Cesarean section					
No	*21,776	18,578 (67.7)	3198 (60.5)	Reference	Reference
Yes	10,936	8849 (32.3)	2087 (39.5)	1.39 [1.30, 1.49]	1.32 [1.24, 1.41]
Gestational diabetes					
No	32,789	27,496 (100)	5293 (99.9)	Reference	Reference
Yes	9	3 (0)	6 (0.1)	10.29 [2.57, 41.18]	13.16 [3.28, 52.86]
Pre-gestational diabetes					
No	32,733	27,461 (99.9)	5272 (99.5)	Reference	Reference
Yes	65	38 (0.1)	27 (0.5)	3.58 [2.15, 5.98]	3.15 [1.87, 5.31]
Pre-eclampsia					
No	31,528	26,539 (96.5)	4989 (94.1)	Reference	Reference
Yes	1270	960 (3.5)	310 (5.9)	1.67 [1.45, 1.92]	1.63 [1.41, 1.89]

Adjusted for alcohol use, area of residence, and antenatal visits.
*Missing data. Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval.

Women with AMA were 1.32 times more likely to undergo cesarean section than younger women (aOR: 1.32; 95 % CI 1.24–1.41; p-value <0.001). Women with AMA were significantly more likely to develop gestational diabetes (aOR: 13.16; 95%CI 3.28–52.86; $P < 0.001$) than younger women. Furthermore, there were higher odds for women with AMA to have pregestational diabetes (aOR: 3.15; 95%CI 1.87–5.31; $P<0.000$) than the reference group. The results for the other variables are indicated in Table 2.

3.5. AMA with associated adverse perinatal outcomes

The results of multivariable logistic regression analysis for predicting low birth weight, Apgar scores at the first and fifth minutes, neonatal ICU admission, and stillbirths by gestational age at the time of delivery, placental abruption, premature rupture of membranes, and GDM are summarized in Table 3. The analysis demonstrated that a neonate with a low Apgar score at 1 min was significantly likelier to be born to a woman with AMA than a young woman (OR, 1.28; 95%CI:1.15–1.42; $P < 0.001$). Furthermore, women with AMA had 70 % higher odds of having a neonate with a low Apgar score at 5 min than the reference group (OR, 1.70; 95% CI: 1.62–2.79, $P<0.000$). Women with AMA were 1.18 times more likely to have a low-birth-weight baby (aOR: 1.18; 95%CI: 1.07–1.31; $P<0.001$); they were also 23 % more likely to have babies transferred to the NICU (aOR: 1.23; 95%CI: 1.10–1.36; $P<0.000$) and 1.47 times more likely to have a stillbirth (aOR: 1.47; 95%CI: 1.12–1.92; $P<0.005$). Other findings are presented in Table 3.

4. Discussion

This study aimed to determine the relationship between AMA in northern Tanzania and the associated pregnancy outcomes among women delivered at the KCMC. The results from this large cohort showed that AMA was associated with an increased risk of gestational diabetes, pre-eclampsia, cesarean section, low birth weight, NICU admission, and stillbirth, even after adjusting for maternal characteristics and obstetric history.

In this study, we found that the prevalence of women who delivered at an AMA was 16 %, which is in agreement with studies in Southern Ethiopia (29.5 %) (Mersha et al., 2020) and Spain (26.2 %) for women aged 35–40 years and 3.1 % for those above 40 years of age. The slightly higher prevalence of AMA seen in Ethiopia and Spain compared to ours could be partly explained by access to advanced reproductive technologies and education during the study period. However, some studies have reported a lower prevalence of AMA than our findings due to the nature of the participants, where women with a more advanced maternal age of 40 years and above were included. For example, a study conducted in Turkey reported a prevalence of 7.1 % [19].

We also observed a significant increase in the incidence of GDM in women with AMA. Women may have been misdiagnosed since we based the diagnosis on fasting and random blood glucose levels only. The prevalence of GDM is increasing in parallel with the increase in obesity and undiagnosed type 2 diabetes. Related findings have been observed in meta-analyses of Saudi Arabia, Spain, and China [4,11,20,21].

This study found a 63 % risk of pre-eclampsia in women with AMA. This result agrees with those of other studies conducted in Northern Ethiopia, Spain, and South Korea [10,11,22]. This finding can be associated with other risks of preexisting medical conditions and sedentary life, for which our database lacks information. Therefore, an inference on its association with AMA could not be drawn.

Our results are similar to those of other studies conducted in Spain and the USA [17,21]. Women with AMA showed a 32 % higher risk of delivery by cesarean section. Various factors can be attributed to this group's increased rate of cesarean section, such as precious babies, fear of known complications (such as large for gestation), intrauterine fetal death, stillbirth associated with AMA, and maternal complications. A history of cesarean section is one of the largest confounders; however, the database lacks information on the history of prior pregnancies.

Our study also found a 47 % risk for stillbirth in the AMA group. Moreover, the study found a 23 % risk of neonates born in the AMA group being admitted to the NICU, as well as the risk of having low birth weight. Other studies with similar findings were conducted in China, Spain, and Southern Ethiopia [11,12,21,23]. These findings can be attributed to the complications faced by the AMA group, such as GDM and pre-eclampsia, leading to either preterm deliveries or conditions causing these adverse effects.

The large dataset was a major strength of our study, as it increased the study power and comprised the most important variables, which enabled us to adjust for potential confounders.

Despite the strengths of this study, some limitations should be considered when interpreting our findings. This was a tertiary referral hospital-based study and, therefore, contained a selection bias that increased the likelihood of including women with complications. In addition, some data were missing; however, owing to the large volume of data, the missing data could not significantly affect our findings.

The main drawback of this study was that we could not adjust for parity, previous history of cesarean section, and unavailable information, which would be important variables for the different outcomes. The overall effects of these variables on the observed findings still require clarification.

5. Conclusions

Our study found that delivery at an AMA may be associated with an increased incidence of cesarean section, pre-eclampsia, gestational diabetes, and pregestational diabetes. Furthermore, AMA may be associated with low birth weight, stillbirth, and NICU admission. These findings are critical for all healthcare workers attending women with AMA, and they must be made aware of the risks and counsel these women accordingly. Risk stratification and preparedness are required for women with AMA. Further studies are required to determine the causal relationship between AMA and pregnancy outcomes. Universal screening for diabetes and refined

Table 3
Effect of advanced maternal age on different perinatal outcomes (N = 32,798).

Outcome	Total	Maternal age (years)			
		20–34	≥35	COR [95%CI]	AOR [95%CI]
LBW (kgs)					
No	*28,650	24,157 (88.6)	4493 (85.7)	Reference	Reference
Yes	3850	3103 (11.4)	747 (14.3)	1.32 [1.20, 1.45]	1.18 [1.07, 1.31]
Apgar score <7 at 1 min					
No	*29,467	24,803 (90.9)	4664 (88.8)	Reference	Reference
Yes	3080	2494 (9.1)	586 (11.2)	1.28 [1.15, 1.42]	0.86 [0.71, 1.05]
Apgar score <7 at 5 min					
No	*30,550	25,725 (94)	4825 (92)	Reference	Reference
Yes	2028	1599 (6)	429 (8)	1.70 [1.62, 2.79]	0.84 [0.65, 1.09]
NICU					
No	*28,217	23,763 (87)	4454 (84)	Reference	Reference
Yes	4475	3647 (13)	828 (16)	1.26 [1.15, 1.38]	1.23 [1.10, 1.36]
Stillbirth					
No	31,598	26,579 (97)	5019 (95)	Reference	Reference
Yes	1200	920 (3)	280 (5)	1.63 [1.39, 1.92]	1.47 [1.12, 1.92]

Adjusted for gestation age, placental abruption, premature rupture of membranes, and gestational diabetes.
*Missing data. Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; LBW, low birth weight; NICU, neonatal intensive care unit.

diagnostic criteria for all pregnant women with AMA are needed.

Moreover, our findings suggest that more rigorous screening measures for pre-eclampsia, gestational diabetes, and overt diabetes may need to be implemented in routine antenatal care for all pregnant women. Nonetheless, intrapartum care for all women may require more vigilance to facilitate early detection of complications and provide timely interventions.

Ethics approval

The study approved by the research ethics committee of the Kilimanjaro Christian Medical University College (Protocol code 856, August 19, 2015).

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data included in article/supp. material/referenced in article. The data that support the findings of this study are available in Figshare.com (https://doi.org/10.6084/m9.figshare.24902091).

CRediT authorship contribution statement

Lilian Remigius Mnabwiru: Writing - original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yeon Seo Cho:** Writing - review & editing, Writing - original draft, Validation, Resources, Methodology, Formal analysis, Conceptualization. **Michael Johnson Mahande:** Writing - review & editing, Supervision, Resources, Methodology, Formal analysis. **Nicholous Mazugun:** Writing - review & editing, Visualization, Validation, Software, Resources, Methodology, Formal analysis, Data curation. **Bariki Lawrence Mchome:** Writing - review & editing, Validation, Software, Resources, Methodology, Investigation, Formal analysis. **Eun Young Park:** Writing - review & editing, Writing - original draft, Supervision, Resources, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank the medical and administrative staff of the KCMC hospital Gynecology, Obstetrics, and Pediatrics departments, as well as all the midwives, for their tireless efforts in collecting and entering data without whom this study would not have been achieved. Above all, the authors greatly appreciate the work of the Lee Jong-Wook Fellowship Program through Korea Foundation for

International Healthcare (KOFIH) for giving us the opportunity to turn this valuable data from Tanzania into a meaningful paper.

References

[1] I. Glick, E. Kadish, M. Rottenstreich, Management of pregnancy in women of advanced maternal age: Improving outcomes for mother and baby, Int. J. Womens Health 13 (2021) 751–759, https://doi.org/10.2147/Ijwh.S283216.
[2] M. Laopaiboon, P. Lumbiganon, N. Intarut, R. Mori, T. Ganchimeg, J.P. Vogel, J.P. Souza, A.M. Gulmezoglu, W. H. O. Multicountry Survey on Maternal Newborn Health Research Network. Advanced maternal age and pregnancy outcomes: a multicountry assessment, BJOG 121 (Suppl 1) (2014) 49–56, https://doi.org/10.1111/1471-0528.12659.
[3] E.A. AlJahdali, N.S. AlSinani, Pregnancy outcomes at advanced maternal age in a tertiary Hospital, Jeddah, Saudi Arabia, Saudi Med. J. 43 (5) (2022) 491–499, https://doi.org/10.15537/smj.2022.43.5.20220023.
[4] H. Li, Nawsherwan, C. Fan, S. Yin, I.U. Haq, S. Mubarik, G. Nabi, S. Khan, L. Hua, Changes in adverse pregnancy outcomes in women with advanced maternal age (AMA) after the enactment of China's universal two-child policy, Sci. Rep. 12 (1) (2022) 5048, https://doi.org/10.1038/s41598-022-08396-6.
[5] H.M. Salihu, M.N. Shumpert, M. Slay, R.S. Kirby, G.R. Alexander, Childbearing beyond maternal age 50 and fetal outcomes in the United States, Obstet, Gynecol 102 (5 Pt 1) (2003) 1006–1014, https://doi.org/10.1016/s0029-7844(03)00739-7.
[6] A.Z. Steiner, R.J. Paulson, Motherhood after age 50: an evaluation of parenting stress and physical functioning, Fertil. Steril. 87 (6) (2007) 1327–1332, https://doi.org/10.1016/j.fertnstert.2006.11.074.
[7] H.K. Brown, A. McKnight, A. Aker, Association between pre-pregnancy multimorbidity and adverse maternal outcomes: a systematic review, J Multimorb Comorb 12 (2022) 26335565221096584, https://doi.org/10.1177/26335565221096584.
[8] L. Lu, J.H. Li, X.F. Dai, J.B. Wei, L.H. Chen, J.F. Hu, Impact of advanced maternal age on maternal and neonatal outcomes in preterm birth, Ginekol. Pol. 93 (2) (2022) 134–141, https://doi.org/10.5603/GP.a2021.0224.
[9] R. Correa-de-Araujo, S.S. Yoon, Clinical outcomes in high-risk pregnancies due to advanced maternal age, J. Womens Health 30 (2) (2021) 160–167, https://doi.org/10.1089/jwh.2020.8860.
[10] M.A. Mehari, H. Maeruf, C.C. Robles, S. Woldemariam, T. Adhena, M. Mulugeta, A. Haftu, H. Hagose, H. Kumsa, Advanced maternal age pregnancy and its adverse obstetrical and perinatal outcomes in Ayder comprehensive specialized hospital, Northern Ethiopia, 2017: a comparative cross-sectional study, BMC Pregnancy Childbirth 20 (1) (2020) 60, https://doi.org/10.1186/s12884-020-2740-6.
[11] M.G. Montori, A.A. Martínez, C.L. Alvarez, N.A. Cuchí, P.M. Alcalá, S. Ruiz-Martínez, Advanced maternal age and adverse pregnancy outcomes: a cohort study, Taiwan. J. Obstet. Gynecol. 60 (1) (2021) 119–124, https://doi.org/10.1016/j.tjog.2020.11.018.
[12] H. Li, Nawsherwan, A. Khan, I.U. Haq, S.Y. Mei, Do hypertensive disorders of pregnancy and abnormal placentation mediate the association between advanced maternal age and adverse perinatal outcomes?, Iran, J. Public Health 51 (5) (2022) 1057–1066, https://doi.org/10.18502/ijph.v51i5.9421.
[13] S.C. Lean, H. Derricott, R.L. Jones, A.E.P. Heazell, Advanced maternal age and adverse pregnancy outcomes: a systematic review and meta-analysis, PLoS One 12 (10) (2017) e0186287, https://doi.org/10.1371/journal.pone.0186287.
[14] L.C. Kenny, T. Lavender, R. McNamee, S.M. O'Neill, T. Mills, A.S. Khashan, Advanced maternal age and adverse pregnancy outcome: evidence from a large contemporary cohort, PLoS One 8 (2) (2013) e56583, https://doi.org/10.1371/journal.pone.0056583.
[15] A.W.G. Ratnasiri, S.S. Parry, V.N. Arief, I.H. DeLacy, S. Lakshminrusimha, L.A. Halliday, R.J. DiLibero, K.E. Basford, Temporal trends, patterns, and predictors of preterm birth in California from 2007 to 2016, based on the obstetric estimate of gestational age, Matern Health Neonatol. Perinatol. 4 (2018) 25, https://doi.org/10.1186/s40748-018-0094-0.
[16] Y.H. Weng, C.Y. Yang, Y.W. Chiu, Risk assessment of adverse birth outcomes in relation to maternal age, PLoS One 9 (12) (2014) e114843, https://doi.org/10.1371/journal.pone.0114843.
[17] E. Rydahl, E. Declercq, M. Juhl, R.D. Maimburg, Cesarean section on a rise-Does advanced maternal age explain the increase? A population register-based study, PLoS One 14 (1) (2019) e0210655, https://doi.org/10.1371/journal.pone.0210655.
[18] H. Bayrampour, M. Heaman, Advanced maternal age and the risk of cesarean birth: a systematic review, Birth 37 (3) (2010) 219–226, https://doi.org/10.1111/j.1523-536X.2010.00409.x.
[19] A.R. Benli, N. Cetin Benli, A.T. Usta, T. Atakul, M. Koroglu, Effect of maternal age on pregnancy outcome and cesarean delivery rate, J. Clin. Med. Res. 7 (2) (2015) 97–102, https://doi.org/10.14740/jocmr1904w.
[20] S.A. Alsaedi, A.A. Altalhi, M.F. Nabrawi, A.A. Aldainy, R.M. Wali, Prevalence and risk factors of gestational diabetes mellitus among pregnant patients visiting National Guard primary health care centers in Saudi Arabia, Saudi Med. J. 41 (2) (2020) 144–150, https://doi.org/10.15537/smj.2020.2.24842.
[21] R.L. Pinheiro, A.L. Areia, A. Mota Pinto, H. Donato, Advanced maternal age: adverse outcomes of pregnancy, a meta-analysis, Acta Med. Port. 32 (3) (2019) 219–226, https://doi.org/10.20344/amp.11057.
[22] J. Kim, J.Y. Nam, E.C. Park, Advanced maternal age and severe maternal morbidity in South Korea: a population-based cohort study, Sci. Rep. 12 (1) (2022) 21358, https://doi.org/10.1038/s41598-022-25973-x.
[23] A. Mersha, G. Ayele, T. Worku, Z. Zerdo, S. Shibiru, A. Bante, T. Chonka, Association between maternal age and adverse perinatal outcomes in Arba Minch zuria, and Gacho Baba district, southern Ethiopia: a prospective cohort study, BMC Pregnancy Childbirth 20 (1) (2020) 590, https://doi.org/10.1186/s12884-020-03285-0.