Analysis of individual-level and community-level effects on advanced maternal age pregnancy in Nigeria

Lukman Bola Solanke (✉ modebolasolanke@gmail.com)

Obafemi Awolowo University <https://orcid.org/0000-0001-5723-1174>

Olumuyiwa Adebisi Oduyoye

Obafemi Awolowo University

Tosin Olajide Oni

Obafemi Awolowo University

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Abstract

Background: Advanced Maternal Age (AMA) pregnancy refers to pregnancy in women aged 35 years or older at the time of delivery. Existing studies have been more concerned with the obstetrics implication of AMA pregnancy. The associated social factors such as the individual and community level factors have remained largely unexplored particularly in population-based studies. This study examines the individual and community level factors associated with AMA pregnancy in Nigeria.

Methods: Data were extracted from the 2018 Nigeria Demographic and Health Survey. A weighted sample of 13,105 women was analysed. The outcome variable was AMA pregnancy. The explanatory variables were individual characteristics (age, marital status, media exposure, current contraceptive use, period spent schooling, female autonomy, remarriage and income group) and community characteristics (proportion who delayed marriage in community, community level of female higher education, proportion of female in professional occupation in community, proportion of divorced or separated women in community, proportion of women in commuter marriage, type of community and geo-political zone of residence). Three mixed-effects multilevel logistic regression models were estimated.

Results: Findings reveal 10.9% prevalence of AMA pregnancy in Nigeria. While the odds of AMA pregnancy were lower among women in very advanced (AOR=0.592, $p<0.001$; 95% CI: 0.509-0.688) and extremely advanced (AOR=0.290, $p<0.001$; 95% CI: 0.239-0.353) age groups, the odds were higher among women who had high exposure to mass media (AOR=1.794, $p<0.001$; 95% CI: 1.580-2.008), long schooling period (AOR=2.680, $p<0.001$; 95% CI: 2.058-3.488), remarried (AOR=2.269, $p<0.001$; 95% CI: 1.915-2.688) and from richest households (AOR=1.271, $p<0.05$; 95% CI: 1.098-1.472). The values of the Intra-Class Correlation (ICC) across the three fitted models reveal significant effects of the community characteristics on the odds of AMA pregnancy.

Conclusion: Individual and community characteristics have important effects on AMA pregnancy. Health planners and authorities in the country should include AMA pregnancy as one of the priority areas of women's health and safe motherhood strategies in addition to raising awareness of the obstetrics implication of AMA pregnancy through community-based public health education programme.

Background

Advanced maternal age (AMA) pregnancy refers to pregnancy in women aged 35 years or older at the time of delivery [1-3]. AMA pregnancy is already a public health issue in more developed countries of Europe and North America due to steady and increasing rise in age at first marriage, divorce, cohabitation, and non-marital fertility, and the increasing levels of female education, female career progression, gender equity, efficient contraception and other features of the Second Demographic Transition [4-5] which has translated into increasing postponement of parenthood particularly among women [6-8]. For example, in the United States of America (USA), women's average age at first birth has steadily risen in the last forty years due to substantial increase in the proportion of women having their first childbirth at age 35 years or older ages [9]. Similarly, a recent study [1] observed that in Western European countries, there has been a sharp rise in the frequency of childbearing at age 35 years and above due to women's career goals.

Also, the widespread availability of assisted reproduction technology in more developed countries has also enhanced the high prevalence of AMA pregnancy across Europe and North America [1, 10-11]. In sub-Saharan Africa particularly

in Nigeria, the rising profile of AMA pregnancy may be linked to two developments. One, the persistence of high parity births among women [12-14]. Two, the proportion of women delaying motherhood for the purpose of achieving education and career enhancement is steadily increasing in the country [15]. Irrespective of the reasons for AMA pregnancy across the world, AMA pregnancy is a safe motherhood issue worthy of further investigation because evidence abounds that AMA pregnancy elevates the risks of maternal, neonatal and child mortality [16-20]. In a number of countries, numerous studies have examined different aspects of AMA pregnancy [21-26]. For example, a multi-country study examined association between AMA pregnancy and adverse pregnancy outcomes [2]. The study covered 29 countries in Africa, Asia, Latin America, and the Middle-East. Though, the study was based on records obtained from 359 health facility records, it not only estimated 12.3% AMA pregnancy across the countries, it also revealed that AMA pregnancy increased the risk of maternal adverse outcomes such as maternal near miss, maternal death, and severe maternal outcome, and risk of stillbirths and perinatal mortalities.

However, virtually all existing studies [24-27, 2, 19-20] focused on the obstetric risks associated with AMA pregnancy without giving prominence to the individual-level and community-level factors associated with AMA pregnancy. In Nigeria, studies [28-30] have also been more concerned with the obstetric implications of AMA pregnancy particularly among women nursing their first pregnancy. The associated social factors such as the individual and community level factors have remained largely unexplored particularly in population-based studies. These factors may have both independent and joint effects on AMA pregnancy. Hence, the paucity of information on the factors may have limited the understanding of the underlying factors to target in the development of specific strategy to curtail AMA pregnancy in the country. The objective of the study was thus to examine the individual and community level factors associated with AMA pregnancy in Nigeria. The study was guided by the question: what are the individual and community characteristics associated with AMA pregnancy in Nigeria? Answer to this question may provide fresh impetus for strengthening existing population and health programmes particularly women's health and safe motherhood services bearing in mind that existing policy and strategy [31-32] did not give specific prominence to AMA pregnancy in the country.

Methods

Data and Sample

This study analysed data extracted from the 2018 Nigeria Demographic and Health Survey (NDHS). The data were collected in the survey through a two-staged selection process across the 36 administrative units and the Federal Capital Territory. Samples were randomly selected from clusters which represented the primary sampling unit of the survey. The questionnaires used to collect information in the survey were adapted to the Nigerian population and health situation and pretested before the fieldwork. Total eligible women in the survey were 42,121 women. However, 41,821 women were interviewed which results in a 99.3% response rate. Other methodological steps of the survey have been published [33]. Out of the 41,821 women covered in the survey, this study target women in advanced reproductive age of 35-49 in line with literature description of the age group in which AMA pregnancy occurs [12-13, 34]. All women less than 35 years were excluded from the analysis. This yielded a weighted sample of 13,105 women.

Outcome Variable

Though, some researchers [35-36] advocated 40 years as a better cut off point for advanced maternal age, however, the dominant cut off point for AMA in literature is 35 years [21, 1, 16-17, 19-20]. In line with the dominant description of AMA, in this study, advanced reproductive age range from 35 to 49 years, thus, the outcome variable of study

(AMA pregnancy) was conceptualised as either being currently pregnant or being age 35 or older at the time of child delivery. The two possibilities are measured in the 2018 NDHS. On the one hand, women were asked if they were pregnant as at the time of the survey for which the response was either yes or no. On the other hand, women were asked their age at births for which they responded in exact age at birth. If a woman falls in any of the above-stated category, she is grouped as 'yes' and coded '1'. Women who fall outside the category are grouped as 'no' and coded '0'. The study focused on the 'yes' category as the outcome of interest.

Explanatory Variables

Two sets of explanatory variables were examined in the study. The first sets were the individual characteristics of the respondents. These are age, marital status, media exposure, current contraceptive use, period spent schooling, remarriage, female autonomy and income group. These variables were selected based on literature either suggesting that the variables may shape the incidence of AMA pregnancy or confirming the variables as a covariate [37-38, 5, 7, 39-42]. The second sets were the community characteristics. These are proportion who delayed marriage in community, community level of female higher education, proportion of female in professional occupation in community, proportion of divorced or separated women in community, proportion of women in commuter marriage, type of community and geo-political zone of residence. The community characteristics were not derived directly from the respondents but derived by aggregating relevant individual response at the cluster level and dividing the resulting distribution into two or three equal parts. This method has been widely used in deriving community characteristics from the Demographic and Health Survey (DHS) data [43-44]. Table 1 provides more information on the research variables.

Data Analysis

Data were analysed at the univariate, bivariate and multivariate levels. At the univariate level, frequency distribution and percentages were used to present respondents' individual and community characteristics as well as the prevalence of AMA pregnancy. At the bivariate level, the research variables were cross-tabulated to show variation in AMA pregnancy due to changes in the values of the explanatory variables. The unadjusted binary logistic regression coefficient was used to examine the nature (positive or negative) of the associations between AMA pregnancy and the explanatory variables. The Variance Inflation Factor (VIF) was performed to detect and eliminate multi-collinear variables. This was done by examining the VIF for each variable. Though, there is rarely consensus on the appropriate cut off point for the value of the VIF [47], the study adopted the rule of 10 [48] which is dominant in literature. Any variable with a VIF score of 10 or higher score was dropped from further analysis due to statistical assertion that variables with such score may bias the estimation of the regression coefficients. At the multivariate level, three mixed-effects multilevel logistic regression models were estimated to examine the hierarchies of factors (individual and community) influencing AMA pregnancy.

The mixed-effects multilevel model was fitted by the *xtmelogit* command using Stata 14 [49]. Model 1 included only the individual characteristics while controlling for the community characteristics. Model 2 included only the community characteristics while controlling for the individual characteristics. Model 3 included both the individual and community characteristics. This model informs the study discussion. The effects of the multilevel model were estimated in two ways. One, the fixed effects were estimated using Adjusted Odds Ratio (AOR) of binary logistic regression. Two, the random effects were estimated using the Intra-Class Correlation (ICC). The ICC was manually

$$\rho = \frac{\sigma_u^2}{\sigma_u^2 + \frac{\pi^2}{3}}$$

calculated using the formula: [50], where σ_u^2 refers to the variance at the community level and σ_u^2

simplified to 3.29. The ICC was expected to range between 0 and 1 but could be expressed in percentage with a closer value to 1 or 100 indicating stronger effects of the community characteristics. The goodness-of-fit of the multilevel models were examined through the Log-likelihood. This parameter is expected to reduce in values as more variables are added to the model to confirm its adequacy. Statistical significance was set at $p < 0.05$.

Ethical Review

Ethical considerations were examined in the conduct of the 2018 NDHS. The survey protocol was approved in the USA by ICF Institutional Review Board (ICF IRB FWA00000845). The conduct of the survey was also approved in Nigeria by National Health Research Ethics Committee of Nigeria (NHREC/01/01/2007). Participants in the survey provided both verbal and written consent during the fieldwork. Access to the data was requested and granted by MEASURE DHS. The analyses are anonymous with no link to any individual or community. The data analysed may be accessed via <https://dhsprogram.com/data/>.

Results

Univariate Result

Table 2 presents the socio-demographic profile of the respondents. Slightly more than one-tenth (10.9%) of the respondents had AMA pregnancy. Slightly more than two-fifths (41.7%) of the respondents were in the AMA age group compared to the 30.1% in the VAMA group and the 28.2% in the EAMA group. The majority of respondents were currently married. Less than one-third of the women (31.0%) had low exposure to mass media compared to proportions that had moderate (46.0%) or high (23.0%) exposure. The majority of the respondents were not currently using any method of contraception. Nearly two-thirds (61.8%) of the women either did not have formal education or spent not more than six years schooling compared to the slightly more than one-tenth (11.4%) who spent between 14 to 20 years schooling. The majority of the respondents were married only once. Nearly two-fifths of the women had low autonomy on household decisions while nearly half of them had moderate autonomy. The proportion of respondents who had high autonomy was slightly more than one-tenth (13.6%). There are more respondents in the richer and richest income groups compared to the poorest and poorer income groups.

Nearly half of the respondents (48.1%) live in communities with low proportion of women who delayed first marriage compared to those who live in communities with high proportion (31.5%) of those that delayed first marriage. More than half of the women (53.6%) live in communities with low level of female higher education. However, about one-third of the women (33.2%) live in communities with high level of female higher education. Likewise, more than half (53.1%) of the respondents live in communities with low level of females in professional occupation but a substantial proportion (35.4%) live in communities with high level of females in professional occupation. The majority of the women live in communities with low level of commuter marriage, though more than a quarter of them (30.4%) live in communities with high level of commuter marriage. The majority of the respondents live in communities with low proportion of divorced or separated women. More than half of the respondents reside in rural communities compared to the 47.0% who were urban dwellers. The distribution of respondents by geo-political zone of residence was nearly equal except for respondents from the North-west and South-west zones.

Bivariate Result

Table 3 presents the bivariate relationships. Reproductive age and AMA pregnancy reveal significant negative association with consistent decline in the level of AMA pregnancy as reproductive age increases. Similarly, current marital status and AMA pregnancy shows significant negative association ($\beta = -0.622$, $p < 0.001$; 95% CI: -0.706, -1.433)

with higher prevalence among not currently married women. The association between mass media exposure and AMA pregnancy was positive. As media exposure improved, the level of AMA pregnancy also increases. Current contraceptive use relates negatively with AMA pregnancy with higher level of AMA pregnancy among non-users of contraceptives. Period spent schooling was positively associated with AMA pregnancy. As period spent schooling increases, the level of AMA pregnancy also increased among the women. Women who remarried had higher level of AMA pregnancy compared to those that married once (18.8% vs. 9.3%) showing a significant positive relationship ($\beta=0.813$, $p<0.001$; 95% CI: 0.657-0.970). As female autonomy improves among the women, the levels of AMA pregnancy also decline consistently among the women revealing a significant negative association. Income group and AMA pregnancy had mixed relationship with positive relationship ($\beta=0.214$, $p<0.05$; 95% CI: 0.021-0.407) at the richest income group and negative relationship at other income levels. Also, AMA pregnancy was higher among women in the richest income group.

The associations between AMA pregnancy and most of the community characteristics were mixed. For example, the association between delayed marriage in the community and AMA pregnancy was negative at moderate level of delayed marriage and positive at high level of delayed marriage ($\beta=0.713$, $p<0.001$; 95% CI: 0.579-0.847). Similar patterns were reveal in the relationships between community level of female higher education and AMA pregnancy as well as in the relationship between female professional occupation in the community and AMA pregnancy with negative associations at moderate levels of female higher education and female professional occupation and positive associations at high level of community female higher education ($\beta=0.354$, $p<0.001$; 95% CI: 0.210-0.499) and high level of female professional occupation ($\beta=0.286$, $p<0.001$; 95% CI: 0.136-0.436). Proportion in commuter marriage in community was positively associated with AMA pregnancy at both moderate level of commuter marriage ($\beta=0.845$, $p<0.001$; 95% CI: 0.678-1.013) and high level of commuter marriage ($\beta=1.247$, $p<0.001$; 95% CI: 1.121-1.374) and also with higher prevalence at high level of commuter marriage in the community. Proportion divorced or separated in community was significantly negatively associated with AMA pregnancy, while type of community shows positive association with AMA pregnancy. The association between geo-political zone of residence and AMA pregnancy was mixed with higher level of AMA pregnancy among women in South-east Nigeria. The associations were further examined at the multivariate level. All the variables were included in the multivariate models because all the variables had a VIF score of less than 10.

Multivariate Result

Table 4 presents the fixed effects of the multilevel model. With the exception of current contraceptive use in Model 1, all the selected individual characteristics were significantly associated with AMA pregnancy. While the odds of AMA pregnancy was lower among women in the VAMA and EAMA groups, as well as currently married women, the odds were higher among women who had high media exposure, spent long period schooling, remarried and those who had high autonomy on household decisions and belong to the richest households. In Model 2, only the proportion of divorced or separated women in community did not reveal statistical significance. With the exclusion of type of community and geo-political zone of residence, other community characteristics showed similar pattern. The odds of AMA pregnancy were higher and significant only when the community characteristics were at high levels.

In Model 3, four individual characteristics, namely, reproductive age, exposure to mass media, period spent schooling and remarriage reveal significant effects on the likelihood of AMA pregnancy. While women in the VAMA age group were 40.8% less likely to have AMA pregnancy (AOR=0.592, $p<0.001$; 95% CI: 0.509-0.688), women in the EAMA age group were 71.0% less likely to have AMA pregnancy (AOR=0.290, $p<0.001$; 95% CI: 0.239-0.353) compared to women in the reference category. In contrast, women who had high exposure to mass media were 79.4% more likely to have AMA pregnancy compared to women who had low exposure (AOR=1.794, $p<0.001$; 95% CI: 1.580-2.008). Likewise,

women who spent long period schooling were more than twice likely to have AMA pregnancy compared to women who spent short period schooling (AOR=2.680, $p<0.001$; 95% CI: 2.058-3.488). Remarried women had higher odds of AMA pregnancy compared to those who married once (AOR=2.269, $p<0.001$; 95% CI: 1.915-2.688). Also, women in the richest households had higher likelihood of AMA pregnancy compared to women in poorest households (AOR=1.271, $p<0.05$; 95% CI: 1.098-1.472).

Model 3 further reveal that all the community characteristics with the exemption of the proportion of divorced or separated women in community had significant effects on the odds of AMA pregnancy. However, statistical significance was shown mostly when the community characteristics were at high levels. Women who live in communities with high level of delayed marriage were more than twice likely to have AMA pregnancy compared to those in communities with low level (AOR=2.173, $p<0.001$; 95% CI: 1.777-2.658). In similar vein, women who lives in communities with high levels of female higher education (AOR=1.247, $p<0.001$; 95% CI: 1.158-1.609), female professional occupation (AOR=1.981, $p<0.001$; 95% CI: 1.791-2.172), and commuter marriage (AOR=1.952, $p<0.001$; 95% CI: 1.505-2.533) had higher odds of AMA pregnancy compared to women who live in communities with low level of the attributes. Rural women were 15.2% less likely to have AMA pregnancy compared to urban women (AOR=0.848, $p<0.001$; 95% CI: 0.677-1.019). Only women in the South-east geo-political zone had higher odds of AMA pregnancy (AOR=1.538, $p<0.001$; 95% CI: 1.210-1.953).

Table 5 presents the random effects on AMA pregnancy. From the empty model through Model 3, the values of the log likelihood decline steadily indicating adequate goodness-of-fit of the fitted models. The model adequacy was further confirmed by the LR test which reveals statistical significance. The ICC expressed in percentages shows that the level of variation in AMA pregnancy across the communities was 33.4% in the absence of both the individual and community characteristics. In Model 1 which was based only on the individual characteristics, 32.2% of variations in AMA pregnancy across the community were due to community characteristics. In Model 2, the effects of the community characteristics reduced to 31.2% and further reduced to 28.0% in Model 3. The values of the ICC across the fitted models indicate significant effects of community factors on AMA pregnancy.

Discussion

This study examined individual and community effects on advanced maternal age pregnancy, a growing phenomenon with serious implications for maternal, neonatal and child morbidity and mortality [30, 16-20]. The study improved upon previous studies by examining the individual and contextual effects on AMA pregnancy which were largely ignored in most existing hospital-based studies [21-23, 25, 2, 26]. This was made possible by the use of internationally comparable DHS data which also enhance the prospect of replicating the study in other climes. The study ascertained 10.9% prevalence of AMA pregnancy in Nigeria. The prevalence observed is comparable to the 12.3% reported in a multi-country study conducted across Africa, Asia, Latin America and the Middle East [2] though the earlier study was based on records of health facilities. The prevalence of 10.9% AMA pregnancy in Nigeria should be worrisome given the poor state of health delivery system in the country. At present, the country is still one of the countries having higher numbers of maternal and neonatal deaths across the world [32-33]. Increasing prevalence of AMA pregnancy in the country may thus further aggravate the state of maternal and child health by increasing the numbers of pregnant women or newborns in need of effective obstetrics counselling or management. Furthermore, the lack of widespread availability of assisted reproductive technology in the country unlike what obtained in more developed countries [10-11] may further increase demand for obstetric management of complications arising from AMA pregnancy in the country.

Though, assisted reproductive technology does not necessarily guaranteed the absence of complications in pregnancy and delivery, it however offers much assistance to women in advanced reproductive age who still desire to conceive from their own ovary. This finding suggests need for dual attention on women with AMA pregnancy in the country. One, universal coverage of the focused antenatal programme [32] must be driven with more vigour to ensure that all women with AMA pregnancy are enrolled for proper monitoring and to ensure that there are no drop out after enrolment. Two, the health education strategy of existing antenatal programme should be expanded to raise awareness of the possible dangers of AMA pregnancy with a view to curtailing further prevalence of AMA pregnancy.

As evident in the study, AMA pregnancy is more pronounced among women characterised by higher levels of modernisation and empowerment such as long period of schooling, high income level and high mass media exposure. This finding provides support for the description of the characteristics of women pregnant with their first child at advanced reproductive age [39]. A number of studies [6-8] have also linked these features to postponement of parenthood which further gave credence to the postulation of the second demographic transition [4-5] that these features may give rise to delayed childbearing which is a major cause of AMA pregnancy. While it is not plausible to attenuate women's advancement (such as female attainment of higher education and professional career progression) because of childbearing, it is important that health planners and authorities in the country should include AMA pregnancy as one of the priority areas of women's health and safe motherhood strategies. The current programmes [31-32] are concerned with promoting safe motherhood through effective antenatal, delivery, and postnatal care services without recognising the special case of AMA pregnancy. There is a likelihood that attention to high parity pregnancies which is more dominant in Nigeria and other sub-Saharan African countries [12-14] may overshadow AMA pregnancy in safe motherhood programming if AMA pregnancy is not specifically set as a priority in future women's health and safe motherhood programmes.

Though, the existing programmes aim to develop measures for the detection, prevention and management of high-risk pregnancies such as pregnancies that are too closely spaced, after the fourth delivery and after age 35 but no specific initiative has been widely implemented to actualise the objective. It is imperative that such initiative be develop for implementation across the country particularly in the urban areas and using the mass media that are easily accessible to women with improved socio-demographic condition as reveal in the study. Based on the study evidence that the contextual factors exert important influence on the odds of AMA pregnancy, it is expected that future initiatives should pay attention to more community-based strategies. For example, a community-based public education programme not only to raise awareness about the obstetric implications of AMA pregnancy but also to provide the explanatory mechanism of how specific community characteristics may cause AMA pregnancy is required to discourage increasing trend of the practice. Governments at all tiers in the country need to recognise the fact that the increasing trend of female higher education enrolment, career progression as well as the emerging norm of commuter marriage will have diverse effects on childbearing in the future. It is thus important that social policies and programmes take cognisance of the evolving phenomenon with a view to providing adequate counselling and information to women involved. Governments in South-east Nigeria particularly need to pay attention to cultural or marital practices that enhance fertility postponement in the region with a view to addressing same through social and behaviour change communication programme.

The inability of the study to identify and exclude women who had involuntary delay of first pregnancy till advanced reproductive age due to fertility challenges represent a drawback to the analysis carried out. However, this non-exclusion which was due to lack of data is not likely to distort the study findings because in the general population of women in Nigeria, the prevalence of primary infertility is very low. Hence, the non-exclusion of such women may not be sufficient to override the findings.

Conclusion

This study seeks to identify the individual and community characteristics that are associated with AMA pregnancy in Nigeria. Using nationally representative data from the 2018 NDHS, age, media exposure, period of schooling, remarriage and income are important individual factors that may shape the incidence of AMA pregnancy while the proportions of women who delayed first marriage, attained higher education or high professional levels and those in commuter marriage particularly in the urban areas are important contextual factors that characterised women with AMA pregnancy in the country. These findings suggest that health planners and authorities in the country should include AMA pregnancy as one of the priority areas of women's health and safe motherhood strategies in addition to developing community-based public education programme to raise awareness of the obstetric implications of AMA pregnancy given the poor state of health delivery in the country.

Abbreviations

DHS Demographic and Health Survey

FMoH Federal Ministry of Health

NDHS Nigeria Demographic and Health Survey

SDT Second Demographic Transition

Declarations

Ethics approval and consent to participate

This study was based on the analysis of secondary data. Authorisation was requested and granted by MEASURE DHS.

Consent to publish

Not Applicable

Availability of data and materials

The dataset supporting conclusions reached in this article is widely available online via <https://dhsprogram.com/data/>.

Competing Interests

The authors declare no competing interests

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Authors Contribution

BLS developed the concept, carried out the statistical analyses, and interpreted the results. OAO and TOO reviewed literature. All authors discussed the results, read through the manuscript and approve it for submission.

Author Information

BLS has a PhD in Demography and Social Statistics from Obafemi Awolowo University, Ile-Ife, Nigeria. His research interests are fertility, contraception, and women's health issues. OAO and TOO are graduate students in the Department.

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Endnote

Not Applicable

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Tables

Table 1: The Research Variables

S/No.	Variable	Description/Measure	Code/category
Outcome Variable			
1.	Advanced maternal age pregnancy	Current pregnancy or child delivery among women 35 years or older. Consistent with description in literature [2, 20].	1. Yes 0. No
Individual Characteristics			
2.	Reproductive age	The current age group of respondent categorised as advanced maternal age (AMA, 35-39 years), very advanced maternal age (VAMA, 40-44 years) and extremely advanced maternal age (EAMA, 45-49 years) based on earlier description [3, 19].	1. AMA 2. VAMA 3. EAMA
3.	Marital status	Whether respondent is not currently married (divorced, separated, widowed, single) or currently married.	1. Not currently married 2. Currently married
4.	Media exposure	Level of respondent exposure to three mass media outlets, namely, reading newspaper, listening to radio and watching television. Each outlet was assigned number 1-3 depending on respondent access per week. 1 equals less than once per week, 2 equals at least once per week, and 3 equals more than once per week. This yields a total of 9 points for the outlets. We then divide the total into three equal parts of 1-3, 4-6 and 7-9 to indicate low, moderate and high exposure so as to locate the position of respondent on media exposure.	1. Low 2. Moderate 3. High
5.	Autonomy on household decision	Level of respondent autonomy on three household decisions, namely, final say on own health care, final say on purchase of large items and final say on visits to friends and relatives. Each decision was assigned number 1-3 depending on respondent participation in the decision. 1 equals male partner or others had final say, 2 equals joint say with male partner, and 3 equals sole participation by respondent. This yields a total of 9 points for the three decisions. We then divide the total score into three equal parts of 1-3, 4-6 and 7-9 to indicate low, moderate and high autonomy.	1. Low 2. Moderate 3. High
6.	Contraceptive use	Current contraceptive use of respondent. This was grouped based on whether respondent is currently using a method of contraception or the type of contraceptive being currently used by respondent.	1. Not using 2. Using traditional 3. Using modern
7.	Remarriage	Whether respondent was married once or more than once. Included based on evidence that remarriage among divorce or separated women affects both marital and non-marital fertility level [41].	1. No 2. Yes
8.	Period spent schooling	The number of years respondent spent schooling. Women who had no education were assigned code of zero. Those who had education were grouped into three, namely, short period (six years), moderate period (seven to thirteen years) and long period (fourteen to twenty years or more). However, in the analysis we merged the zero and short period group.	1. Short period 2. Moderate period Long period
9.	Income group	The wealth group of respondent household derived from household possession and expenditure through	1. Poorest 2. Poorer 3. Middle

		principal component method [33] and categorised into five groups.	4. Richer 5. Richest
Community Characteristics			
10.	Proportion of delayed marriage in community	The proportion of women in the community whose first marriage occurred at age thirty or older years. Derived by aggregating the proportion at the cluster level and dividing into three equal groups of low, medium and high.	1. Low 2. Medium 3. High
11.	Community level of female education	The proportion of women who attained higher education in the community. Derived by first identifying individual women who attained higher education, aggregating at the cluster level, and dividing into three equal groups of low, medium and high.	1. Low 2. Medium 3. High
12.	Proportion of female in managerial occupation in community	The proportion of women who are in managerial, technical or professional occupation in the community. Derived by first identifying individual women in the occupational group, aggregating at the cluster level, and dividing into three equal groups of low, medium and high.	1. Low 2. Medium 3. High
13.	Proportion of women in commuter marriage in community	The proportion of women in the community who are not living with their spouses. Derived by first identifying individual women with such marital living arrangement, aggregating at the cluster level, and dividing into three equal groups of low, medium and high. Included because evidence suggest that women in commuting marriage may face detrimental health situation which may deter or delay childbearing [45-46].	1. Low 2. Medium 3. High
14.	Proportion of divorced/separated women in community	The proportion of women in the community who are either divorced or separated. Derived by first identifying individual women in either group, aggregating at the cluster level, and dividing into two equal groups of low and high.	1. Low 2. Medium
15.	Type of community	Whether respondent lives in urban or rural community	1. Urban 2. Rural
16.	Geo-political zone of residence	The geo-political zone where respondent reside as at the time of the survey	1. North-central 2. North-east 3. North-west 4. Southeast 5. South-south 6. South-west

Table 2: Socio-demographic characteristics of respondents

Characteristics	Frequency	Percentage	Characteristics	Frequency	Percentage
Advanced maternal age pregnancy			Proportion who delayed marriage in community		
No	11,682	89.1	Low	6,307	48.1
Yes	1,423	10.9	Medium	2,673	20.4
Reproductive age group			High	4,125	31.5
35-39 years	5,463	41.7	Community level of female higher education		
40-44 years	3,940	30.1	Low	7,029	53.6
45-49 years	3,702	28.2	Medium	1,732	13.2
Marital status			High	4,344	33.2
Not currently married	1,781	13.6	Proportion of female in professional occupation in community		
Currently married	11,324	86.4	Low	7,618	53.1
Exposure to mass media			Medium	849	6.5
Low	4,061	31.0	High	4,638	35.4
Moderate	6,029	46.0	Proportion in commuter marriage in community		
High	3,015	23.0	Low	6,976	53.2
Current contraceptive use			Medium	2,144	16.4
Not using	10,669	81.4	High	3,984	30.4
Using traditional method	794	6.1	Proportion divorced/separated in community		
Using modern method	1,642	12.5	Low	11,100	84.7
Period spent schooling			High	2,005	15.3
Short	8,104	61.8	Type of community		
Moderate	3,510	26.8	Urban	6,162	47.0
Long	1,491	11.4	Rural	6,943	53.0
Remarriage			Geo-political zone		
No	10,973	83.7	North-central	1,748	13.3
Yes	2,132	16.3	North-east	1,835	14.0
Female autonomy			North-west	3,460	26.4
Low	5,130	39.1	South-east	1,798	13.7
Moderate	6,193	47.3	South-south	1,665	12.7
High	1,782	13.6	South-west	2,599	19.8
Income group					
Poorest	2,345	17.9			
Poorer	2,428	18.5			
Middle	2,470	18.9			
Richer	2,767	21.1			
Richest	3,095	23.6			
Total	13,105	100.0	Total	13,105	100.0

Source: Authors' analysis based on 2018 NDHS

Table 3: Bivariate Relationship showing percentage distribution of AMA pregnancy by socio-demographic characteristics

Characteristic	Percent	Coef.	95% CI	Characteristic	Percent	Coef.	95% CI
Reproductive age group				Proportion who delayed marriage in community			
35-39 years ref	15.0	-	-	Low ^{ref}	8.6	-	-
40-44 years	9.6	-0.504**	-0.656, -0.353	Medium	8.4	-0.024	-0.239,0.192
45-49 years	6.1	-1.006**	-1.188, -0.823	High	16.0	0.713**	0.579-0.847
Marital status				Community level of female higher education			
Not currently married ^{ref}	17.0	-	-	Low ^{ref}	9.8	-	-
Currently married	9.9	-0.622**	-0.796, -1.433	Medium	8.8	-0.125	-0.332,0.083
Exposure to mass media				High	13.4	0.354**	0.210-0.499
Low ^{ref}	10.3	-	-	Proportion of female in professional occupation in community			
Moderate	10.6	0.178**	0-109-0.246	Low ^{ref}	9.9	-	-
High	12.2	0.250**	0.204-0.297	Medium	9.3	-0.069	-0.319,0.182
Current contraceptive use				High	12.7	0.286	0.136-0.436
Not using ^{ref}	12.8	-	-	Proportion in commuter marriage in community			
Using traditional method	1.5	-2.267**	-2.288, -1.646	Low ^{ref}	10.9	-	-
Using modern method	2.64	-1.690**	-2.068, -1.312	Medium	10.5	0.845**	0.678-1.013
Period spent schooling				High	11.2	1.247**	1.121-1.374
Short ^{ref}	9.1	-	-	Proportion divorced/separated in community			
Moderate	11.2	0.229*	0.081-0.377	Low ^{ref}	10.9	-	-
Long	19.6	0.886**	0.705-1.067	High	10.8	-0.416**	-0.604,-0.227
Remarriage				Type of community			
No ^{ref}	9.3	-	-	Urban ^{ref}	11.1	-	-
Yes	18.8	0.813**	0.657-0.970	Rural	10.7	0.957**	-1.049,-0.866
Female autonomy				Geo-political zone			
Low ^{ref}	12.7	-	-	North-central ref	9.0	-	-
Moderate	10.2	-0.254*	-0.399,-0.109	Norh-east	11.0	0.227	-0.002,0.455
High	7.8	-0.540**	-0.767,-0.312	North-west	10.4	0.165	-0.043,0.374
Income group				South-east	15.5	0.624**	0.396-0.852
Poorest ^{ref}	2.3	-	-	South-south	12.7	0.389*	0.146-0.633
Poorer	3.1	-0.117	-0.249,0.016	South-west	8.2	-0.099	-0.371,0.171
Middle	10.4	-0.073	-0.276,0.130				
Richer	9.9	-0.133	-0.355,0.090				
Richest	13.5	0.214*	0.021-0.407				

Notes: ref (Reference category), coef. (Coefficient), *p<0.05, **p<0.001

Table 4: Fixed-effects on AMA pregnancy

Characteristic predicting AMA pregnancy	Model 1			Model 2			Model 3		
	AOR	p-value	95% CI	AOR	p-value	95% CI	AOR	p-value	95% CI
Reproductive age group									
35-39 years ^{ref}	1.000	-	-				1.000	-	-
40-44 years	0.602	p<0.001	0.519-0.699				0.592	p<0.001	0.509-0.688
45-49 years	0.298	p<0.001	0.246-0.361				0.290	p<0.001	0.239-0.353
Marital status									
Not currently married ^{ref}	1.000	-	-				1.000	-	-
Currently married	0.702	p<0.001	0.591-0.833				0.828	0.087	0.667-1.028
Exposure to mass media									
Low ^{ref}	1.000	-	-				1.000	-	-
Moderate	0.993	0.926	0.851-1.157				1.019	0.818	0.867-1.198
High	1.307	p<0.001	1.163-1.452				1.794	p<0.001	1.580-2.008
Current contraceptive use									
Not using ^{ref}	1.000	-	-				1.000	-	-
Using traditional method	0.968	0.768	0.781-1.201				0.895	0.357	0.707-1.133
Using modern method	0.894	0.141	0.770-1.038				0.884	0.263	0.712-1.097
Period spent schooling									
Short ^{ref}	1.000	-	-				1.000	-	-
Moderate	1.481	p<0.001	1.256-1.747				1.347	0.002	1.118-1.622
Long	3.107	p<0.001	2.468-3.911				2.680	p<0.001	2.058-3.488
Remarriage									
No ^{ref}	1.000	-	-				1.000	-	-
Yes	2.240	p<0.001	1.896-2.647				2.269	p<0.001	1.915-2.688
Female autonomy									
Low ^{ref}	1.000	-	-				1.000	-	-
Moderate	0.679	p<0.001	0.438-0.919				0.971	0.718	0.825-1.142
High	1.541	p<0.001	1.374-1.728				1.084	0.335	0.914-1.285
Income group									
Poorest ^{ref}	1.000	-	-				1.000	-	-
Poorer	0.811	0.035	0.668-0.986				0.729	0.356	0.279-1.899
Middle	0.970	0.776	0.788-1.194				0.961	0.735	0.765-1.208
Richer	0.895	0.357	0.707-1.133				0.880	0.336	0.679-1.142
Richest	1.220	0.001	1.084-1.374				1.271	0.001	1.098-1.472
Proportion who delayed marriage in community									
Low ^{ref}				1.000	-	-	1.000	-	-
Medium				1.169	0.092	0.975-	1.145	0.166	0.945-

						1.402			1.386
High				2.430	p<0.001	2.015-2.929	2.173	p<0.001	1.777-2.658
Community level of female higher education									
Low ^{ref}				1.000	-	-	1.000	-	-
Medium				0.861	0.173	0.694-1.068	0.823	0.099	0.653-1.038
High				1.475	p<0.001	1.339-1.612	1.247	p<0.001	1.158-1.609
Proportion of female in professional occupation in community									
Low ^{ref}				1.000	-	-	1.000	-	-
Medium				0.816	0.147	0.620-1.074	1.384	p<0.001	1.158-1.609
High				1.614	p<0.001	1.500-1.778	1.981	p<0.001	1.791-2.172
Proportion in commuter marriage in community									
Low ^{ref}				1.000	-	-	1.000	-	-
Medium				1.202	0.087	0.973-1.485	1.060	0.400	0.925-1.215
High				1.515	p<0.001	1.333-1.698	1.952	p<0.001	1.505-2.533
Proportion divorced/separated in community									
Low ^{ref}				1.000	-	-	1.000	-	-
High				0.963	0.671	0.809-1.145	0.914	0.343	0.758-1.101
Type of community									
Urban				1.000	-	-	1.000	-	-
Rural				0.723	p<0.001	0.589-0.857	0.848	p<0.001	0.677-1.019
Geo-political zone									
North-central ^{ref}				1.000	-	-	1.000	-	-
Norh-east				1.436	0.002	1.145-1.801	0.968	0.768	0.781-1.201
North-west				1.443	0.001	1.166-1.787	0.898	0.062	0.803-1.005
South-east				1.328	0.011	1.067-1.651	1.538	p<0.001	1.210-1.953
South-south				0.967	0.774	0.770-1.215	0.906	0.430	0.709-1.157
South-west				0.647	p<0.001	0.508-0.825	1.037	0.667	0.879-1.223

Notes: ref (Reference category), AOR (Adjusted Odds Ratio)

Table 5: Random-effects on AMA pregnancy

Parameter	Empty Model	Model 1	Model 2	Model 3
Community level variance (SE)	1.649 (0.074)	1.563 (0.137)	1.491 (0.142)	1.281 (0.109)
Log likelihood	-4584.1	-4168.6	-4479.6	-4081.0
LR test	$\chi^2=23.8$; p<0.001	$\chi^2=15.9$; p<0.05	$\chi^2=17.1$; p<0.05	$\chi^2=15.2$; p<0.05
ICC (%)	33.4	32.2	31.2	28.0