INVESTIGATING THE PATTERNS AND DETERMINANTS OF WOMEN'S AGE AT FIRST BIRTH IN BANGLADESH: AN APPLICATION OF QUANTILE REGRESSION MODEL

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Abstract

The birth of a first child is a significant milestone for a woman life as it starts the challenging duties of motherhood. The objective of this study is to investigate the determinants of the age of women at first birth in Bangladesh by using quantile regression model. This research collected data from Bangladesh Demographic and Health Survey (BDHS) conducted in 2017-18. The final dataset of this study consists of 16,711 ever-married women whose aged 15–49 years. Result shows women's current age, education level, employment status, age at first sex (years), mass media exposure, wealth index and partner's higher education have positive effect on the age of women at first birth. Conversely, husband's current age, rural area, outside of the Dhaka division, current contraceptive user and female household head have negative effect. The study findings will help government and policymaker to take the necessary steps for increasing the women's age at first birth.

Keywords: Quantile regression model, Age of women at first birth, Kruskal-Wallis test, Body mass index, Bangladesh.

1. INTRODUCTION

The age of woman at first birth refers to an age when a woman gives birth to her first child. The birth of a first child is a significant milestone for a woman life since it starts the challenging duties of motherhood (Sobhan et al., 2024). This is a life-changing experience for women that can affect their physical, psychological, social, and existential well-being. Its influence can be long-term or short-term, positive or unpleasant, empowering or traumatizing (Aune et al., 2015). Woman's first birth time can determine the number of children she will have and a larger population is the result of positive correlation between an earlier first birth and a higher fertility rate (Gyimah, 2003). Early pregnancy and childbearing have greater social and economic repercussions for a nation. These effects are linked to low birth weight, maternal mortality, reduced productivity and education, and ultimately the transfer of poverty across generations (Gyimah, 2003; WHO, 2011).

Moreover, a number of life threatening diseases like cancer, high blood pressure, diabetes, coronary heart disease, osteoporosis, chronic obstructive pulmonary disease, arthritis and stroke are connected with women's early first birth age (Mueller et al., 2013; Vandenheede et al., 2012). Concurrently, higher age (> 30 years) at first birth are linked with hypertension, miscarriage, breast cancer, chromosomal defects, diabetes mellitus, numerous pregnancies, preterm birth and low birth weight (Sakai et al., 2017; Jacobsson et al., 2004; Valadan et al., 2011). Scholars state that woman's age between 20 to 30 years is the appropriate time to become pregnant (Watson, 2018).

Worldwide, 295,000 women and 2.5 million infants lost their lives in 2017 due to pregnancy-related causes (WHO, 2019). In each year, almost 11% women's first birth occurs at an early age, among them 95% happen in developing countries (WHO, 2014). A study was conducted by using World Fertility Surveys (WFS) and 36 Demographic and Health Surveys (DHS) depicted that probability of death is about 46% higher for under-five children whose mother's ages were under 18 years during birth than children whose mothers were 20-34 years (Rabbi & Kabir, 2013).

In developing countries, more than 40% women give birth at teenage age (<19 years) and pregnancy is the major reason of death for women whose age between 15 to 19 years (Hossain & Majumder, 2019). In addition, the highest rate of maternal deaths is seen in South East Asia region and in every two minutes, women die for pregnancy difficulties (Chowdhury et al., 2020). In Bangladesh, the rate of early pregnancy is about 35% where 90% of these give live birth and 10% are terminated in various ways (Ali et al., 2021).

A previous study has shown that women's education level, current age, and husband's higher education have positive effect on women's age at first birth. In contrast, husband's age, rural area, and smoking status have inverse effect on women's age at first birth (Talukder et al., 2021). A recent study in Bangladesh has found that Dhaka and Sylhet region's women have high age at first birth compared with other region (Sobhan et al., 2024). The age of women at first birth can be mostly described by fecundity factor as well as consciousness of parents (Rabbi & Kabir, 2013). Another study have indicated that women's age at first birth are negatively influenced by Muslim women, currently using contraceptives and early marriage but positively influenced by higher education, employed, high income household and partner's higher education (Ali et al., 2019). All of those studies were carried out their analysis by using multiple linear regression or multiple logistic regression model. Both models give the estimates of covariates based upon the mean of the women's age at first birth and are influenced by outlier (Hossain, 2017). In addition, the effects of covariates can vary across the quantiles of the women's age at first birth.

Quantile regression model is robust to outlier and can estimate the effect of covariate at any percentile of the distribution of women's age at first birth (Stifel & Averett, 2009). Therefore, the main objective of this study is to investigate the patterns and determinants of the age of women at first birth in Bangladesh by using quantile regression model.

2. METHODS AND MATERIALS

Data source and variables

This research considered data from the most recent country representative Bangladesh Demographic and Health Survey (BDHS) conducted in 2017-18. NIPORT, Mitra & Associates, and ICF International conducted this survey. The data comprises 20,127 ever-married women whose aged between15 and 49 years. Afterward deleting the flagged cases and missing values of related variables, the data contains information of 16,711 women. Finally, a weighted sample (16744) is utilized in analysis to make country representative sample. In this paper, age of women at first birth is the response variable, and the explanatory variables are selected by using prior research experience and past studies which are women's current age, educational level, employment status, body mass index (BMI), age at first sex (years), mass media exposure, religion, partner's educational level, occupation, current age, current contraceptive use status, wealth index, place of residence, division and sex of household head.

Quantile Regression

For assessing the association between response variable and explanatory variables, quantile regression (QR) model is applied because it gives estimates for each quantile and shows how the effect of the explanatory variables differ on the entire range of dependent variable. This model is also important as it helps to understand the connection between variables outside of the mean of the data (Oyedapo et al., 2021).

Let, $X_{[p \times q]}$ denotes the matrix of order p (sample size) × q (covariates), α(τ) are the regression parameters at τ[th] quantile level and e is the error term. Then the quantile regression model is given by,

$$Q_\tau(y|X) = X\alpha(\tau) + e$$

Where, Q_τ (y|X) represents the quantile function of the outcome y for a fixed quantile parameter τ in (0,1).

All statistical analyses were performed by using R 4.3.2.

3. RESULTS

Table 1 displays the summary statistics count with percentage as well as 95% confidence interval for the proportions of explanatory variables to describe the dataset. Results show that three-fourth (75.0%) of the women whose ages are less than 18 years started sexual intercourse, among them 31.3% are less than 15 years. The study also depict that more than half of the women (72.4%) are from rural areas, around one-quarters (24.8%) are from Dhaka division, 39% are poor, 16.8% have no education, 50.6% are non-employed, 10.8% are underweight, 90.3% are Muslim, 93.7% are current contraceptive users, 65.2% are mass media exposure and 23.6% are aged 40 years or more. Only 12.4% of the household's head are women. Among the partner, 23.2% receive no education, 32.8%, 29.2% and 14.8% receive primary, secondary and higher education, respectively.

Table 1: Background information of study participants, BDHS 2017-18 (n = 16744 (weighted sample))

Variable		Count (%)	95% C.I.
Women's current age (years)	<30	7007(41.8)	(41.4-42.9)
	30-39	5790(34.6)	(33.7-35.1)
	40 or more	3947(23.6)	(22.8-24.1)
Women's educational level	No education	2812(16.8)	(16.2-17.3)
	Primary	5512(32.9)	(32.9-34.3)
	Secondary	6621(39.5)	(38.8-40.3)
	Higher	1798(10.7)	(9.7-10.7)
Women's employment status	Non-employment	8476(50.6)	(50.3-51.9)
	Employment	8257(49.4)	(48.1-49.7)
Women's BMI	Underweight (<18.5)	1810(10.8)	(10.6-11.6)
	Normal (18.5–24.9)	9314(55.6)	(55.0-56.5)
	Overweight (≥ 25)	5620(33.6)	(32.5-33.9)
Age at first sex (years)	<15	5424(31.3)	(30.2-31.6)
	15 - 17	7310(43.7)	(43.0-44.5)
	18 and more	4192(25)	(24.6-26.0)
Mass media exposure	No	5828(34.8)	(34.2-35.6)
	Yes	10916(65.2)	(64.4-65.5)
Religion	Non-Muslim	1625(9.7)	(9.0-9.9)
	Muslim	15119(90.3)	(90.1-91)
Partner's educational level	No education	3877(23.2)	(22.6-23.9)
	Primary	5496(32.8)	(32.6-34)
	Secondary	4895(29.2)	(28.7-30.1)
	Higher	2475(14.8)	(13.6-14.7)
Partner's occupation	Unemployed	357(2.1)	(2-2.5)
	Agriculture	4518(27)	(26.4-27.7)
	Service	3103(18.5)	(18.1-19.3)
	Business	3073(18.4)	(17.7-18.9)
	Others	5693(34)	(33-34.4)
Partner's current age	<40	7927(47.3)	(46.8-48.3)
	40 - 49	4743(28.3)	(27.5-28.9)
	50 or more	4073(24.3)	(23.7-25)
Current contraceptive use status	Non-user	1052(6.3)	(6.1-6.8)
	User	15692(93.7)	(93.2-93.9)
Wealth index	Poor	6537(39)	(38.7-40.2)
	Middle	3438(20.5)	(19.8-21)
	Rich	6768(40.4)	(39.4-40.9)
Division	Dhaka	4160(24.8)	(24.2-25.2)
	Chittagong	2993(17.9)	(16.9-18)
	Barisal	942(5.6)	(5.4-6.2)
	Khulna	1959(11.7)	(11.0-12.0)
	Mymensingh	1308(7.8)	(7.2-8.5)
	Rajshahi	2374(14.2)	(14.1-15.1)
	Rangpur	2039(12.2)	(11.6-12.5)
	Sylhet	969(5.8)	(5.5-6.8)
Place of residence	Urban	4627(27.6)	(26.1-27.7)
	Rural	12116(72.4)	(72.3-73.9)
Sex of household head	Male	14666(87.6)	(87.0-88.0)
	Female	2077(12.4)	(12.0-13.0)

The distribution of the age of women at first birth is detected by investigating skewness, box plots, and Kolmogorov-Smirnov tests. Figure 1 and Table 2 display that the response variable is positively skewed and includes outlier observations. Kolmogorov-Smirnov test (test statistic = 0.134, p-value= <0.001) confirms that the data does not follow normal distribution. Thus, non-parametric method and robust regression model are suited for identifying the determinant of the age of women at first birth in Bangladesh. Therefore, for examining bivariate association between response variable and explanatory variable, Kruskal-Wallis test is applied and quantile regression model is chosen to fit the final model.

Table 2: Summary statistics of the age of women at 1st birth

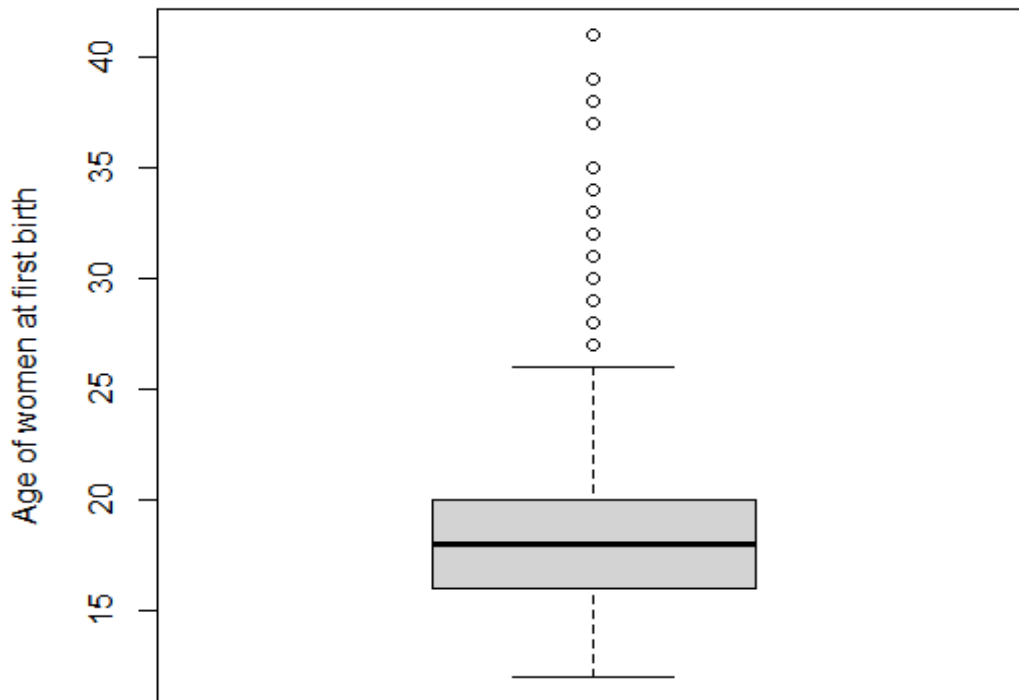| Mean	Standard deviation	Minimum	Maximum	Skewness	Kurtosis	Percentiles					
						10	25	50	75	90	99
18.3	3.16	12	41	1.28	3.15	15	16	18	20	22	29

Figure 1: Box-plot of the age of women at 1st birth

Kruskal-Wallis test's result is shown in table 3 which indicates that median age of women at 1st birth significantly differ with various levels of women's current age (years), educational level, employment status, body mass index (BMI), age at first sex (years), mass media exposure, religion, partner's educational level, occupation, current age (years), current contraceptive use status, wealth index, division, and place of residence.

Table 3: Kruskal-Wallis test

Variables		Chi-square	P-value
Women's current age (years)	<30	23.438	<0.001
	30-39		
	40 or more		
Women's educational level	No education	2208.9	<0.001
	Primary		
	Secondary		
	Higher		
Women's employment status	Non-employment	172.17	<0.001
	Employment		
Women's BMI	Underweight (<18.5)	82.012	<0.001
	Normal (18.5–24.9)		
	Overweight (≥ 25)		
Age at first sex (years)	<15	8637	<0.001
	15 - 17		
	18 and more		
Mass media exposure	No	199.94	<0.001
	Yes		
Religion	Non-Muslim	219.29	<0.001
	Muslim		
Husband's educational level	No education	1501.9	<0.001
	Primary		
	Secondary		
	Higher		
Husband's occupation	Unemployed	387.17	<0.001
	Agriculture		
	Service		
	Business		
	Others		
Husband's current age	<40	17.687	<0.001
	40 - 49		
	50 or more		
Current contraceptive use status	Non-user	100.41	<0.001
	User		
Wealth index	Poor	627.9	<0.001
	Middle		
	Rich		
Division	Dhaka	395.93	<0.001
	Chittagong		
	Barisal		
	Khulna		
	Mymensingh		
	Rajshahi		
	Rangpur		
	Sylhet		
Place of residence	Urban	190.97	<0.001
	Rural		
Sex of household head	Male	2.449	0.118
	Female		

Table 4 clarifies the test results of the significance of running different quantile regression models. As for all hypothesis p value is less than 0.05 which implies that the result rejects the estimated coefficient's equality for different quantiles. Therefore, different quantile regression models are suitable in this analysis.

Table 4: Test the equality of slope at different quantile regression models

Null hypothesis	$F_{(33, 33389)}$	P-value
$Q_{10} = Q_{25}$	12.243	<0.001
$Q_{10} = Q_{50}$	21.822	<0.001
$Q_{10} = Q_{75}$	7.568	<0.001
$Q_{10} = Q_{90}$	40.61	<0.001
$Q_{10} = Q_{99}$	39.077	<0.001
$Q_{25} = Q_{50}$	20.483	<0.001
$Q_{25} = Q_{75}$	6.702	<0.001
$Q_{25} = Q_{90}$	69.235	<0.001
$Q_{25} = Q_{99}$	48.513	<0.001
$Q_{50} = Q_{75}$	4.123	<0.001
$Q_{50} = Q_{90}$	49.593	<0.001
$Q_{50} = Q_{99}$	39.95	<0.001
$Q_{75} = Q_{90}$	1.628	0.013
$Q_{75} = Q_{99}$	10.732	<0.001
$Q_{90} = Q_{99}$	20.139	<0.001

The multiple quantile regression model results are shown in table 5. It is observed from table 5 that women whose current ages 30 - 39 and 40 or more show significant positive increasing coefficients in most quantiles. This mean that age of women at first birth are significantly higher among 30 years or more current age women compared to those current age 29 years or lower. Working women have significant positive coefficient (0.727) than their counterpart at the 99th quantile point, suggesting that women whose are working had more age at first birth than women who are housewife. Also, age at first sex (in years) 15 – 17 and 18 or more exhibit significant positive coefficients through all quantiles.

This indicates that early age of women at first sex are related with first birth at young age. It is also observed from table 5 that at 99th quantile mass media exposed women are 0.236 points higher age at first birth than mass media unexposed women. Moreover, women who are using current contraceptives, the coefficient significantly changes from -1 to -4.579 for the quantile varies from 75th to 99th. This implies that women who are using current contraceptives give first birth at teenage age than women who do not use contraceptive method. Furthermore, women education has an important effect on the conditional women's age at 1st birth. Highly educated women show a significantly positive estimate in all quantiles which indicate that first birth at an early age is lower among women who have higher education compared to their illiterate counterparts. As well as, partner with higher education show 1, 0.983 and 1.421 positive estimate in the 75th, 90th and 99th quantiles respectively. On the other hand, partner's current age have significant inverse impact on women's age at first birth at 90th quantile only.

Table 5: Results of quantile regression model

Variables		$Q_{0.1}$ Estimate (se)	$Q_{0.25}$ Estimate (se)	$Q_{0.5}$ Estimate (se)	$Q_{0.75}$ Estimate (se)	$Q_{0.9}$ Estimate (se)	$Q_{0.99}$ Estimate (se)
Intercept		14.000*** (0.142)	14.000*** (0.088)	16.000*** (0.181)	18.000*** (1.114)	20.182*** (0.440)	26.813*** (1.797)
Women's current age (years)	<30 (Ref)						
	30-39	0.000 (0.088)	0.000 (0.070)	0.000 (0.140)	1.000** (0.305)	1.501*** (0.091)	3.018*** (0.269)
	40 or more	0.000 (0.138)	1.000*** (0.051)	1.000 (0.150)	2.000*** (0.342)	2.817*** (0.127)	5.218*** (0.401)
Women's educational level	No education (Ref)						
	Primary	0.000 (0.061)	0.000 (0.027)	0.000 (0.024)	0.000 (0.207)	0.211** (0.101)	0.985** (0.249)
	Secondary	0.000 (0.070)	0.000 (0.029)	0.000 (0.023)	0.000 (0.262)	0.026 (0.109)	0.541* (0.269)
	Higher	1.000*** (0.106)	1.000*** (0.053)	1.000*** (0.039)	2.000** (0.813)	1.948*** (0.157)	1.008** (0.376)
Women's employment status	Non-employment(Ref)						
	Employment	0.000 (0.042)	0.000 (0.021)	0.000 (0.013)	0.000 (0.174)	0.056 (0.053)	0.727*** (0.132)
Women's BMI	Underweight (<18.5) (Ref)						
	Normal (18.5–24.9)	0.000 (0.061)	0.000 (0.020)	0.000 (0.019)	0.000 (0.262)	-0.002 (0.091)	-0.263 (0.249)
	Overweight (≥ 25)	0.000 (0.066)	0.000 (0.025)	0.000 (0.021)	0.000 (0.285)	0.113 (0.116)	0.140 (0.273)
Age at first sex (years)	<15 (Ref)						
	15 - 17	2.000*** (0.056)	2.000*** (0.025)	2.000*** (0.017)	2.000*** (0.227)	1.696*** (0.083)	1.623*** (0.183)
	18 and more	4.000*** (0.115)	5.000*** (0.026)	5.000*** (0.020)	5.000*** (0.55)	5.554*** (0.101)	5.103*** (0.140)
Mass media exposure	No (Ref)						
	Yes	0.000 (0.048)	0.000 (0.021)	0.000 (0.017)	0.000 (0.186)	0.236*** (0.050)	0.147 (0.188)
Religion	Non-Muslim (Ref)						
	Muslim	0.000 (0.068)	0.000 (0.029)	0.000 (0.029)	0.000 (0.243)	0.016 (0.076)	0.340 (0.180)
Husband's educational level	No education (Ref)						
	Primary	0.000 (0.061)	0.000 (0.021)	0.000 (0.016)	0.000 (0.211)	0.004 (0.066)	0.055 (0.297)
	Secondary	0.000 (0.067)	0.000 (0.024)	0.000 (0.019)	0.000 (0.237)	0.070 (0.084)	0.070 (0.306)
	Higher	0.000 (0.089)	0.000 (0.065)	1.000 (0.051)	1.000** (0.335)	0.983*** (0.104)	1.421*** (0.342)
Husband's occupation	Unemployed (Ref)						
	Agriculture	0.000 (0.134)	0.000 (0.035)	0.000 (0.122)	0.000 (0.867)	0.275 (0.273)	-0.465 (1.681)
	Service	0.000 (0.062)	0.000 (0.040)	0.000 (0.123)	0.000 (0.870)	0.552 (0.289)	-0.276 (1.673)

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	Business	0.000 (0.062)	0.000 (0.041)	0.000 (0.123)	0.000 (0.865)	0.007 (0.271)	-0.844 (1.683)
	Others	0.000 (0.055)	0.000 (0.038)	0.000 (0.122)	0.000 (0.862)	0.287 (0.273)	-0.647 (1.669)
Husband's current age	<40 (Ref)						
	40 - 49	0.000 (0.066)	0.000 (0.05)	0.000 (0.145)	0.000 (0.326)	-0.333*** (0.073)	0.310 (0.211)
	50 or more	0.000 (0.091)	0.000 (0.07)	0.000 (0.143)	-1.000 (0.628)	-0.756*** (0.122)	0.526 (0.326)
Current contraceptive use status	Non-user (Ref)						
	User	0.000 (0.074)	0.000 (0.052)	-1.000*** (0.127)	-2.000*** (0.454)	-2.942*** (0.298)	-4.579*** (0.497)
Wealth index	Poor (Ref)						
	Middle	0.000 (0.054)	0.000 (0.023)	0.000 (0.016)	0.000 (0.234)	0.170** (0.069)	0.204 (0.203)
	Rich	0.000 (0.063)	0.000 (0.025)	0.000 (0.019)	0.000 (0.231)	0.229*** (0.067)	0.038 (0.208)
Division	Dhaka (Ref)						
	Chittagong	0.000 (0.080)	0.000 (0.033)	0.000 (0.045)	-1.000 (0.535)	-0.779*** (0.100)	-1.733*** (0.172)
	Barisal	0.000 (0.075)	0.000 (0.040)	0.000 (0.027)	0.000 (0.375)	-0.180* (0.087)	-0.036 (0.268)
	Khulna	0.000 (0.065)	0.000 (0.027)	0.000 (0.022)	0.000 (0.351)	0.033 (0.127)	-0.318 (0.239)
	Mymensingh	0.000 (0.073)	0.000 (0.032)	0.000 (0.019)	0.000 (0.376)	-0.204 (0.149)	-1.598*** (0.367)
	Rajshahi	0.000 (0.074)	0.000 (0.031)	0.000 (0.022)	0.000 (0.373)	-0.046 (0.104)	-0.725** (0.277)
	Rangpur	0.000 (0.087)	0.000 (0.032)	0.000 (0.029)	0.000 (0.368)	-0.333*** (0.086)	-0.806*** (0.223)
	Sylhet	0.000 (0.08)	0.000 (0.037)	0.000 (0.027)	0.000 (0.296)	0.012 (0.158)	0.022 (0.263)
Place of residence	Urban (Ref)						
	Rural	0.000 (0.047)	0.000 (0.025)	0.000 (0.018)	0.000 (0.180)	-0.279*** (0.063)	-0.141 (0.153)
Sex of household head	Male (Ref)						
	Female	0.000 (0.066)	0.000 (0.025)	0.000 (0.018)	0.000 (0.249)	-0.076 (0.073)	-0.512** (0.175)

Ref.: Reference category; *** p-value <0.001; ** p-value <0.01; *p-value <0.05.

Moreover, the rural area's women have a significant negative (-0.279) effect on women's age at first birth at 99th quantile only which suggests that rural area's women age at the first birth is significantly lesser compared to urban area's women in that quantile. Additionally, outside of the Dhaka division's women shows significant negative coefficients at upper quartiles suggesting lower women's age at first birth compared to Dhaka division's women. Also, the two categories of the wealth index middle and rich have significantly positive effect on the age of women at first birth on 90th quantile only. This indicates that women from the poor households have a greater possibility of conceiving their first child at an early age than women from the rich households.

Figure 2 represents the effect of some significant covariates on quantiles from 10th, 25th, 50th, 75th, 90th and 99th quantile regression models (black dots) with their 95% confidence interval (gray shaded regions). The ordinary least square regression lines are also shown by solid red lines and associated 95% confidence intervals (dashed red lines). This figure also indicates that the coefficients fluctuate through quantiles.
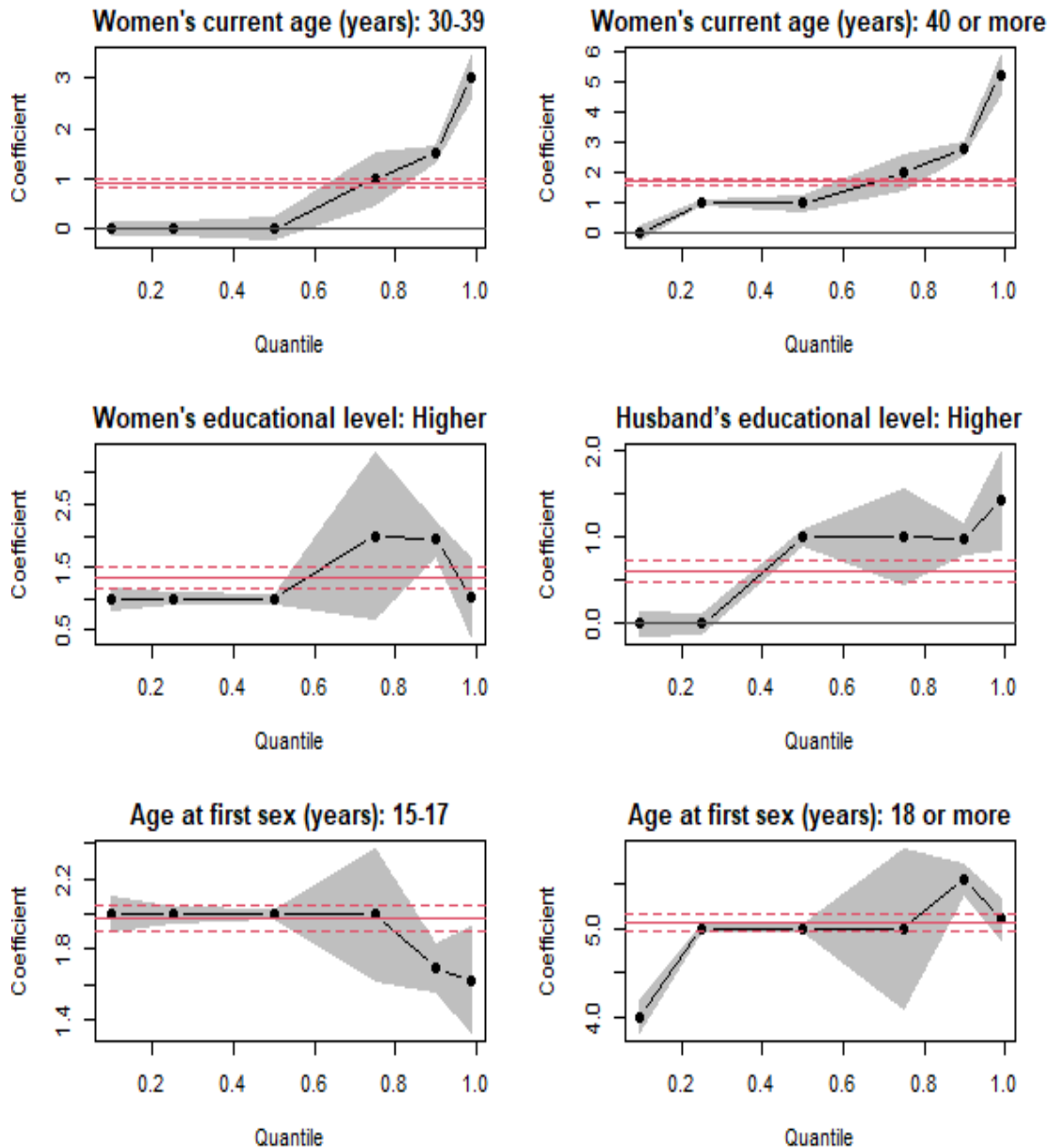

Figure 2: Coefficient plots of significant covariates attained from quantile regression models

4. DISCUSSIONS

The goal of this study is to investigate the determinants of the age of women at first birth in Bangladesh by using quantile regression model since the dataset have outliers and don't follow normal distribution. Results show that husband's education, women's education and employment status have positive effect on women's age at first birth which is consistent with previous study (Hossain & Majumder, 2019). This happens because higher educated women and partner have sufficient awareness about family planning, threat of being pregnant early, and risk of their early child as well as women's health. So, prioritizing education for all can be a good solution to rise the women's age at first birth in Bangladesh. This study identifies the age of women at first birth is positively related with women's age at first sex which is in accordance with previous researches (Dewau et al., 2021; Ida & Albert, 2015).

In addition, mass media exposed women's age at first birth are higher than their counterparts because they have knowledge about consequences of early childbirth. Previous studies also stated same result conducted in Bangladesh (Ali et al., 2019; Sobhan et al. 2024). This research also indicates that women who are using contraceptives currently had more propensity to get their first child at young age which is concur with previous study (Ali et al, 2019). Like past studies (Ali et al., 2019; Sobhan et al., 2024; Hossain & Majumder, 2018), this study also identifies that women from middle and rich families have lower rate of having their first child early compared to women from the poor families.

Furthermore, women who live in rural area give birth early than those who live in urban areas. This finding also consistent with prior research (Hossain & Majumder, 2019; Islam et al., 2017). Also, outside of the Dhaka division's women have lower age at first birth which supporting previous study in Bangladesh (Sobhan et al. 2024). The educational lacking in the rural areas and outside of the Dhaka division could be the reason behind it.

5. CONCLUSIONS

The birth of a first child is a significant milestone in women's life. This study's result shows women's current age, education level, employment status, age at first sex (years), mass media exposure, wealth index and partner's higher education have positive effect on the age of women at first birth. Conversely, husband's current age, rural area, outside of the Dhaka division, current contraceptive user and female household head have negative effect.

This study recommends to give prioritize on education to decrease the incidence of early marriage and to increase the awareness about the threat of being pregnant early. Furthermore, community clinics and health workers can provide information about the risk of early motherhood. Media can be used to increase awareness among people about negative effect of early entry of mothers. The study findings will help government and policymaker to take the necessary steps for increasing the women's age at first birth.

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