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Measuring perinatal and postpartum quality of life of women and associated factors in semi-urban Bangladesh

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Abstract

Purpose The objective of this study was to measure the health-related quality of life (HRQoL) among pregnant women in the perinatal and postpartum periods and determine influencing factors that predict their HRQoL.

Methods The study was conducted among pregnant women who live in a semi-urban area of Chandpur, Bangladesh. A total of 465 women were recruited. The EuroQoL 5-Dimension 3-Level (EQ-5D-3L) and EuroQoL visual analog scale (EQ-VAS) instruments were used to measure the HRQoL of participants. Two-sample mean test (*t* test) was performed to examine the changes in HRQoL between the perinatal and postnatal periods of the same individuals. Multivariate linear regression was employed to identify the factors influencing HRQoL during the two periods.

Results Overall, the HRQoL scores improved significantly from the perinatal (0.49) to postpartum (0.86) period. Approximately 58% of women experienced *moderate* or *extreme* levels of health problems during the perinatal period regardless of their health status. However, most women had significantly improved health status in the postpartum period. Gestational weight gain and recommended postnatal care were significantly associated with improved HRQoL. Factors that negatively influenced changes in HRQoL included adolescent motherhood, caesarean delivery, inadequate antenatal care consultations and living in a poor household, during both the perinatal and postpartum periods.

Conclusions Overall health status is found to be poor among women during the perinatal period compared with the postpartum period. The study indicates that interventions to address the influencing factors are needed to ensure better quality of life for women both pre- and post-birth. Community-based initiatives, such as awareness building, might address negative factors and subsequently improve health status and reduce adverse health outcomes related to pregnancy and postnatal care.

Keywords EQ-5D-3L · EQ-VAS · Health-related quality of life · Pregnancy · Bangladesh

Introduction

The perinatal and postpartum periods are a time of intense changes among women over the course of their pregnancy [1, 2]. Significantly, this outward change is mainly viewed from a physical functioning standpoint but is also associated with a great deal of mental health upheaval from the perspective of women [3]. These experiences affect women's health-related quality of life (HRQoL), which can then have a significant impact on their overall well-being [4–6]. Recently, HRQoL has attracted greater attention, as it refers to a wider view of the health status of women during their childbearing experience. Even in uneventful pregnancies, reproductive women undergo experiences that may change their capacity to conduct their usual activities, which in turn may affect their overall HRQoL. The additional changes may lead to significant increases in psychological health problems (e.g. psychosis and depression) of an expectant mother in both the perinatal and the postpartum periods [7]. Self-reported health status, including HRQoL, has been integrated into the assessment of health intervention programs [7]. The HRQoL includes different dimensions of health states, such as self-reported functioning and well-being in the physical, psychological and social domains [8]. The concept of HRQoL provides a comprehensive measure that includes mental, physical and social functioning capacity [1]. A review study conducted by Jomeen [9] suggested that HRQoL was a fundamental contributor to an exhaustive measure of health status in the transition to motherhood [9].

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Despite this, very little attention has been paid to estimating HRQoL in expectant mothers.

Some studies have delineated that pregnancy commonly results in poor self-reported HRQoL [8,10, 11]. During pregnancy, women experience reduced social, physical and vitality functioning as well as a greater number of mental health problems than non-pregnant women [10]. There is uncertainty regarding socio-demographic, maternity care, medical and psychosocial factors that may influence women's HRQoL throughout pregnancy [12]. The influence of these factors is magnified during pregnancy [13], yet they have not been featured much in studies about HRQoL among this population. Otchet et al. [12] found Canadian pregnant women experienced significant changes across several dimensions of HRQoL between perinatal and postpartum periods [12]. Another study conducted among Ugandan pregnant women with human immunodeficiency virus (HIV) during the perinatal (36 weeks' gestational age) and postpartum (delivery to 6 weeks) periods [13] showed a strong negative correlation between HRQoL and HIV exposure during the two periods. Symon and Dobb [14] found that HRQoL was significantly lower among Scottish pregnant mothers during the perinatal period compared with the postpartum period [14]. These findings also confirmed that perineal trauma and the number of deliveries were potential contributing predictors of lower postpartum HRQoL. However, these studies have been conducted in different study settings, with different study designs, target populations and study samples. Thus, there is little evidence related to HRQoL among reproductive women, its influencing factors and the extreme changes over the perinatal and postpartum periods for reproductive women in Bangladesh.

The main objectives of this study are twofold: first, to measure HRQoL changes among pregnant women in Bangladesh during the perinatal and postpartum periods; and second, to identify the factors influencing their HRQoL. To achieve the research objectives, the following two research questions (RQs) were posited:

RQ-1: What is the change in quality-of-life among pregnant women over the perinatal and postpartum periods?

RQ-2: What are the significant factors predicting the health status of pregnant women in Bangladesh over an extended period?

Materials and methods

Study setting

The study was conducted in the Chandpur district of the east-central part of Bangladesh which contains eight sub-districts with a population of 94,821 people (49% women). Study participants who sought antenatal and postnatal care services at a government-funded maternal and child welfare centre (MCWC) administered by the Ministry of Health and Family Welfare (MOHFW) of Bangladesh were recruited [15]. In Chandpur district, only one MCWC provides maternal and child healthcare services. Women receive maternal and child healthcare services across different geographical locations in the district (e.g. rural, urban and remote areas). The maternal and child healthcare services provided by the MOHFW are free of cost for all women. Women belonging to any socio-economic and cultural group have access to maternal healthcare at the MCWC. Among the total registered pregnant women at health facilities (including clinics, health centres and hospitals) in the district, 98% received at least one antenatal consultation. However, only 7% women received the recommended four consultations from a qualified medical professional [15]. Maternal healthcare utilisation is lopsided with poor availability and utilisation at most health facilities at the sub-district level or below, and higher utilisation at tertiary and medical teaching hospitals.

Study participants

This study is a sub-study of the project titled 'Introducing Group Prenatal Care in Bangladesh - a Feasibility Study' and therefore all of the participants were recruited based on inclusion criteria of the parent study [16]. The participants were pregnant women aged between 18 and 42 years who met the inclusion criteria: (1) gestational age of 20 weeks or less, (2) without medical complications (e.g. asthma, jaundice, diabetes or heart disease) and (3) willing to participate in the study. Gestational age was measured according to the last menstrual period (LMP) and confirmed through a review of the medical record based on the medical professional's assessment of the LMP. Prior to recruiting the participants, study nurses enrolled women who met the inclusion criteria of the study protocol [16]. The goal of the main study was to introduce a Group Prenatal Care (GPC) model in a healthcare facility in Bangladesh and assess its impact on maternal and neonatal outcomes (e.g. quality of life, preterm birth, caesarean delivery and low birth weight). To find the true impact of GPC on pregnancy outcomes (e.g. preterm birth, stillbirth, abortion, caesarean delivery, low birth weight, postpartum complications), pregnant women with medical complications were excluded from the study at the recruiting stage. For this reason, measuring association between other complications, such as chronic diseases, and the quality of life among pregnant women was beyond the scope of the study. A small number of women ($n = 7$) experienced medical complications and were excluded from the study at the recruiting stage. Participants were recruited over 12 months between May 2015 and May 2016.

Study design and sample size

The study design is a population-based cross-sectional study. Participants were generated from the main GPC intervention study [16], which was related to maternal health education and improving knowledge and awareness of pregnant women. Intervention, design and study procedure were described in detail in the main study. The sample size calculation was explained in detail in the published study protocol [16] using the techniques proposed elsewhere [17, 18]. The sample size calculation was performed according to the main study outcome of interest. To calculate the sample sizes for detecting difference between GPC and standard care groups, the following formula was employed:

$$n = \frac{[Z_\alpha \sqrt{(r+1)\bar{P}\bar{Q}} + Z_\beta \sqrt{(rP_1Q_1 + \bar{P}_2\bar{Q}_2]^2}}{r\delta^2},$$

where

(a) $\delta = |P_2 - P_1|$,
(b) $\bar{P} = \frac{P_1 + rP_2}{r+1}$,
(c) $\bar{Q} = 1 - \bar{P}$,
(d) α, The probability of type I error,
(e) β, The probability of type II error, or (1-power of the test),
(f) P_1, proportion of characteristic present in GPC group,
(g) P_2, proportion of characteristic present in standard care group,
(h) r, ratio of required sample size from two groups ($r = 1$ in this study).

Maternal health indicators were expected to change due to the intervention. Using a percentage of expected change difference in GPC and standard care groups at a 5% error level and 80% power, the estimated sample size for each group was calculated (Table 1). The highest sample size (250) was estimated for breastfeeding rate. Assuming a 15% lost to follow-up, the required sample size was 288 for each group. Therefore, 576 pregnant women (288 GPC group and 288 standard care group) who received maternal healthcare during the course of their pregnancy at MCWC were enrolled randomly in this study. During analysis, 465 samples were included, as this was the number of women who participated in both perinatal and postpartum surveys.

Health-related quality of life

HRQoL was measured using the EQ-5D-3L instrument and it is a widely used self-report tool in health outcomes research and developed by the EuroQoL Group in 1990 [22]. The EQ-5D-3L is comprised of two sections: EQ-5D-3L descriptive structure and EQ-VAS. A number of studies which have been conducted worldwide on general population health characteristics have used these survey instruments [23]. The tool is available in more than 160 translated versions and more than 25 languages. The translation of this survey instrument (e.g. EQ-5D-3L and EQ-VAS) was undertaken independently from the Europol group [22] and was validated for the Bangladesh population [24–27]. A validation study was conducted to determine whether EQ-5D-3L and EQ-VAS were relevant for this study setting. The EQ-5D-3L tool includes five different health dimensions: mobility, self-care, usual activities, pain or discomfort and anxiety or depression. Each dimension has three levels of severity: level-1 (no problems), level-2 (some problems) and level-3 (extreme problems). The participant was asked to indicate her current self-assessed health state by placing a cross in the box aligned with the accurate statement in each of the dimensions. The EuroQoL group has derived the values of EQ-5D-3L using an algorithm in different country settings, which relates to preference-based responses for the 243 health states constructed for each dimension. The standard preference weights were constructed from the population of the United Kingdom (UK), which is the original study

Table 1 Sample size estimation

Maternal health indicators	Percentage	Percent of expected change	Required sample size with 5% significance level and 80% power	Sample size considering 15% lost to follow-up rate	Total sample
Antenatal care (ANC) [19]	55.0	14	202	232	464
Postnatal care (PNC) [19]	27.0	15	170	196	392
Skilled-birth attendance [19]	31.7	16	158	182	364
Institutional deliveries [19]	28.8	13	227	261	522
Preterm birth [20]	22.3	− 12	164	189	378
Low birth weight [20]	36.0	− 12	245	282	564
Postpartum complications [21]	36.0	− 13	208	239	478
Breastfeeding rate (2–3 months) [19]	71.0	11	250	288	576

population for measuring EQ-5D-3L index scores [23]. For measuring the health status in an identical population, the use of either the UK or other country-specific (e.g. USA, Belgium, Denmark, Finland, New Zealand and Europe) EQ-5D weights as a measure of HRQoL will not significantly change inferences [23, 24]. In the context of Bangladesh, several studies used similar instruments and the UK-based population preference weight in relation to general health status for low-income communities [25], diabetes care [26], chronic energy deficiency [27] and cataract surgery [28]. In this study, we estimated the EQ-5D-3L index scores using the preference weights from the UK-based population [22], as country-specific preference weightings are not available for the Bangladeshi population [23]. The EQ-5D-3L index ranges from − 0.594 to 1.000 with 1.000 indicating 'perfect health' and 0.000 indicating 'death' [22]. However, the negative values (up to − 0.594) of health states signify a worse health status than death. The EQ-VAS shows a self-rating on a 20-cm vertical scale in points with 0 to 100 labelled 'worst imaginable health' and 'best imaginable health state', respectively. Respondents used the EQ-VAS to signify their overall self-related health on the day of the questionnaire. The values of EQ-VAS were converted (divided by 100) to generate a scale of scores ranging from 0 to 1, for consistency with the EQ-5D score. The EQ-VAS also represents the value of HRQoL from pregnant mothers' perspectives.

Survey procedure

The follow-up participant surveys were conducted using structured and semi-structured questionnaires for both perinatal and postpartum surveys. Pre-tested, necessary modification and corrections were performed before conducting the survey. The surveys were conducted with pregnant women in the perinatal (within 2 to 7 days of delivery) and the postpartum periods (42 to 60 days). Data were collected through face-to-face interviews at the delivery place or in their households by trained and experienced female nurses. Socio-demographic variables such as age, age at first marriage, household size, educational background, occupational status, household income and other household-related information (e.g. household assets) were collected once at the time of enrollment. Furthermore, maternal health-related information covering previous pregnancy history, delivery care, newborn care and postnatal care was also collectedin the perinatal and postpartum periods [16]. Self-reported HRQoL information was collected using the EQ-5D-3L and EQ-VAS questionnaires. Written consent was taken from each participant prior to enrolment, while the study objectives were described to participants, and anonymity and confidentiality were confirmed. Trained field research staff performed data management under appropriate supervision.

Study variables

The present study selected potential explanatory predictors based on prior studies, maternal healthcare-related information, existing published quality-of-life literature and available information in the main study dataset [16, 25, 27–32]. Health status as an outcome variable was derived using the EQ-5D instruments. Individual-level factors, such as maternal age, educational background, household size, parity, antenatal care consultations, intake of iron pills, gestational weight gain and mode of delivery and postnatal care-related variables were included in the analyses. Community-level factors, such as household wealth status, were also considered in the study. The current age of the mother was a continuous variable that was classified into four categories (< 19 years, 19 to 25 years, 26 to 30 years or > 30 years). Educational background was defined as no formal education, primary, secondary or higher secondary and higher. The husband's main occupation was categorised as salaried employee, business, farmer, informal sectors worker (e.g. rickshaw pullers, shopkeepers, restaurant workers) and others. Frequency of receiving antenatal care consultation was grouped as inadequate (0 or 1), intermediate (2 or 3) or adequate (4 or 4+) [33]. Intake of iron pills and gestational weight gain at first 6 months of pregnancy period were defined as 1 = "yes" or 0 = "no". Mode of delivery was grouped as normal vaginal delivery, caesarean or episiotomy. Parity was characterised as first birth, 2–3 births or > 3 births. Household size was divided into three groups (< 4 members, 4–5 members or > 5 members). Household wealth status was estimated using asset-based methods and based on the household ownership of durable assets. A wealth index was derived using principal component analysis (PCA) with each asset dichotomised as 1 if present, or 0 otherwise. Cut-off values were used in the earlier study and classified participants into five categorical levels representing wealth quintiles: poorest (Q_1), poorer (Q_2), middle (Q_3), richer (Q_4) and richest (Q_5) [34].

Estimation strategies

Descriptive analyses

The initial descriptive analyses were undertaken to quantify the distribution of participants reporting health problems in each EQ-5D-3L dimension and average EQ-5D index scores and the EQ-VAS score. Two-sample mean test (*t* tests) was performed to measure the average change of HRQoL outcomes in terms of EQ-5D index and EQ-VAS scores in the perinatal and postnatal periods of the same individual since the mean score of EQ-5D index and VAS scores were continuous and quantitative measures. The mean

score of outcome variables was then distributed across the explanatory predictors. The change of health status from the perinatal to postnatal period using mean EQ-5D index and EQ-VAS scores was measured for the same participant across the participant's characteristics.

Test of validity, reliability and responsiveness

Test–retest reliability analysis was performed for the EQ-5D index scores and the EQ-VAS score using the intraclass correlation coefficient (ICC). The present study considered an ICC ≥ 0.7 as large as suggested by Streiner and Norman [35]. In addition, construct validity was checked to ensure the instrument signifies to the original construct [35]. Thus, the EQ-5D index scores and the EQ-VAS score were followed as an approximate normal distribution, and we calculated the correlation coefficient (r) for both outcomes of interest was defined as low for $0.1 \leq |r| < 0.3$, intermediate for $0.3 \leq |r| < 0.5$ and high for $|r| \geq 0.5$ [36]. In terms of responsiveness, this study used the two-sample mean tests (e.g. t test statistic) and estimated the effect size (ES) to investigate the relationship of change of EQ-5D indexes and the EQ-VAS score in the perinatal and postpartum periods. According to Cohen [36], the score of ES was defined as extremely small from ≥ |0.1| to < |0.2|, as small from ≥ |0.2| to < |0.5|, as intermediate from ≥ |0.5| to < |0.8| and as high ≥ |0.8| [36, 37]. The study tested several hypotheses, and a Bonferroni correction was used to measure the level of significance [38]. Two different instruments (e.g. EQ-5D-3L and EQ-VAS) were occupied for examining construct validity, resulting in a corrected significance level of $\alpha = 0.05/2 = 0.025$. The two chronological periods (e.g. perinatal and postpartum) were used for measuring reliability and responsiveness. Thus, the level of significance was defined as $\alpha = 0.05/2 = 0.025$.

Multivariate analysis

Unadjusted and adjusted multiple linear regression models were used to identify the potential factors affecting the HRQoL of mothers separately in both the perinatal and the postpartum periods. In the regression model, the dependent variables (EQ-5D-3L index scores and the EQ-VAS score) were characterised by a continuous variable, which followed an approximately normal distribution. The model was tested for sensitivity by the forward selection procedure (e.g. including and excluding specific variables) with the robust standard error. The predictor variables were included in the adjusted model only if any label of the predictor was significant at ≤ 5% risk level in the unadjusted linear regression model which was used to adjust for the effects of other potential confounders. Insignificant predictors were not included in the adjusted model. The study also looked at interaction effects in the regression models. A number of diagnostics were performed in the regression analyses, such as multicollinearity, heteroscedasticity and specification errors. Multicollinearity was examined using the variance inflation factor test. Heteroscedasticity was examined using the Cook–Weisberg test. Specification errors of the model were detected using the Ramsey RESET test. The statistically significant level was considered a P value of ≤ 0.05. All data analyses were performed using statistical software Stata/SE 13 (StataCorp, College Station, TX, USA).

Ethics approval

The study protocol approval was received from two relevant ethics bodies: the 'Research Review Committee' (RRC) and the 'Ethical Review Committee' (ERC) of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Dhaka, Bangladesh. The research Ethical Approval Number was PR-14119.

Results

Background characteristics

Data from 465 pregnant women were included in the analysis (Table 2). Among the participants, a higher percentage (63%) were young adults (19 to 25 years) followed by those aged 26 to 30 years (20%). Approximately 50% of the mothers were married before they were 21 years of age and 69% of mothers had completed secondary education. Moreover, 33% of the participants' husbands were informal workers (e.g. rickshaw pullers, shopkeepers and restaurant workers) and 47% of the women's households had five or more members. Approximately 59% of mothers received the recommended number (4 or more visits) of antenatal consultations, followed by 34% for intermediate (2 to 3 visits) and only 6% for inadequate (1 visit). The majority (94%) had taken iron pills during pregnancy, and among them 88% gained weight in the 24 gestational weeks of pregnancy. In addition, 57% of women had sought their first postnatal consultation by healthcare providers in the 6-week postpartum period, and 14% had received their second consultation; however, 28% did not receive any postnatal care services.

Distribution of reported health states across the mode of delivery

Figure 1 shows the percentage of self-reported health problems across the model of delivery in the perinatal and postpartum periods. Overall, self-reported health status improved from the perinatal to the postnatal period. Approximately 78% of women who delivered by caesarean reported health problems related to mobility during the perinatal period,

Table 2 Background characteristics of study participants ($N=465$)

Variables	Frequency, *n* (%)	95% CI
Age of mother in years (mean ± SD)	23.44 ± 4.58	(23.02, 23.85)
Age group (years)		
< 19	45 (9.68)	(7.30, 12.73)
19–25	293 (63.01)	(58.51, 67.30)
26–30	93 (20.00)	(16.60, 23.90)
> 30	34 (7.31)	(5.26, 10.07)
Mother educational background		
No education	11 (2.37)	(1.31, 4.23)
Primary education	75 (16.13)	(13.05, 19.77)
Secondary	319 (68.60)	(64.22, 72.67)
Higher secondary and higher	60 (12.90)	(10.14, 16.28)
Husband occupation		
Salaried employee	90 (19.35)	(16.00, 23.22)
Business	133 (28.60)	(24.66, 32.90)
Farmer	11 (2.37)	(1.31, 4.23)
Informal worker	154 (33.12)	(28.97, 37.54)
Others	77 (16.56)	(13.44, 20.23)
Household size		
< 4 Members	63 (13.55)	(10.72, 16.98)
4–5 Members	180 (38.71)	(34.37, 43.24)
> 5 Members (ref)	222 (47.74)	(43.22, 52.30)
Birth order		
1	205 (44.09)	(39.62, 48.65)
2–3	223 (47.96)	(43.43, 52.52)
> 3	37 (7.96)	(5.81, 10.80)
Number of ANC visits		
Inadequate (1)	31 (6.67)	(4.72, 9.34)
Intermediate (2–3)	161 (34.62)	(30.42, 39.08)
Adequate (4 or 4+)	273 (58.71)	(54.16, 63.12)
Iron pill intake		
Yes	441 (94.84)	(92.40, 96.52)
No	24 (5.16)	(3.48, 7.60)
Gestational weight gain (first 6 months)		
Yes	411 (88.39)	(85.13, 91.01)
No	54 (11.61)	(8.99, 14.87)
Postnatal care visits		
None	133 (28.60)	(24.66, 32.90)
1st visit	266 (57.20)	(52.64, 61.65)
2nd or more visits	66 (14.19)	(11.30, 17.68)
Mode of delivery		
Normal vaginal	193 (41.51)	(37.09, 46.06)
Caesarean	171 (36.77)	(32.49, 41.27)
Episiotomy	101 (21.72)	(18.19, 25.72)
Wealth quintile[a]		
Lowest 20%	93 (20.00)	(16.60, 23.90)
2nd	93 (20.00)	(16.60, 23.90)
3rd	93(20.00)	(16.60, 23.90)
4th	99 (21.29)	(17.79, 25.26)
Upper 20%	87 (18.71)	(15.41, 22.53)

[a]Wealth quintile was constructed using principal component analysis for durable household assets

followed by episiotomy (72%) and vaginal (38%) deliveries, which was significantly improved in the postpartum period. Also, among the three levels of mobility, 60% of the women experienced health problems at the perinatal period, whereas in the postpartum period, only 15% of mothers reported health problems. There was a significant improvement in health status between the two periods for 45% of mothers. Overall, approximately 50% of the women reported extreme health problems in their self-care activities, which was also a significant improvement over the postpartum period. This experience was observed more often among mothers who delivered by caesarean (76%) at the perinatal period compared to mothers who delivered by vaginal (32%) or with an episiotomy (52%). However, this improved significantly in the postpartum period. Regarding pain or discomfort, approximately 90% of women who delivered by caesarean or had an episiotomy reported some or extreme problems, which was significantly reduced at the postpartum period to 52% and 42%, respectively. Approximately 80% of women who delivered by caesarean reported some/extreme problems for their usual activities at the perinatal period, but this percentage was significantly lower (12%) in the postpartum period. Similar patterns were observed for anxiety or depression among all women in the perinatal and postnatal periods.

Distribution of quality-of-life (EQ-5D index) scores across pregnant women's characteristics (for RQ-1)

The average EQ-5D index score during the perinatal period was found to be higher for the 26–30 years age group, whereas in the postpartum period, the score was highest in the 19–25 years age group (Table 3). The highest improvement score was for women more than 30 years of age. The average EQ-VAS score value for the postpartum period was higher for mothers more than 30 years and lowest for teenage mothers. In the postpartum period, the average EQ-5D score value was comparatively higher for mothers in the 19–25 years age group and lowest for both the 26–30 and > 30 years age groups. The improvement in the EQ-VAS score was dominated by young adult women. Furthermore, significant improvements in health status were observed among higher educated mothers in the perinatal and postpartum periods. The women who had received an inadequate number of antenatal consultations reported poor health status in the perinatal and postpartum periods. Similarly, women who delivered by caesarean or had an episiotomy experienced poor health status in the perinatal and postnatal periods. Furthermore, women who had taken iron pills or experience gestational weight gain during pregnancy resulted in a higher EQ-5D index score in both periods. A similar pattern of results was also revealed in the EQ-VAS score where the values were similar for both periods. An examination of wealth quintiles exhibited that women who

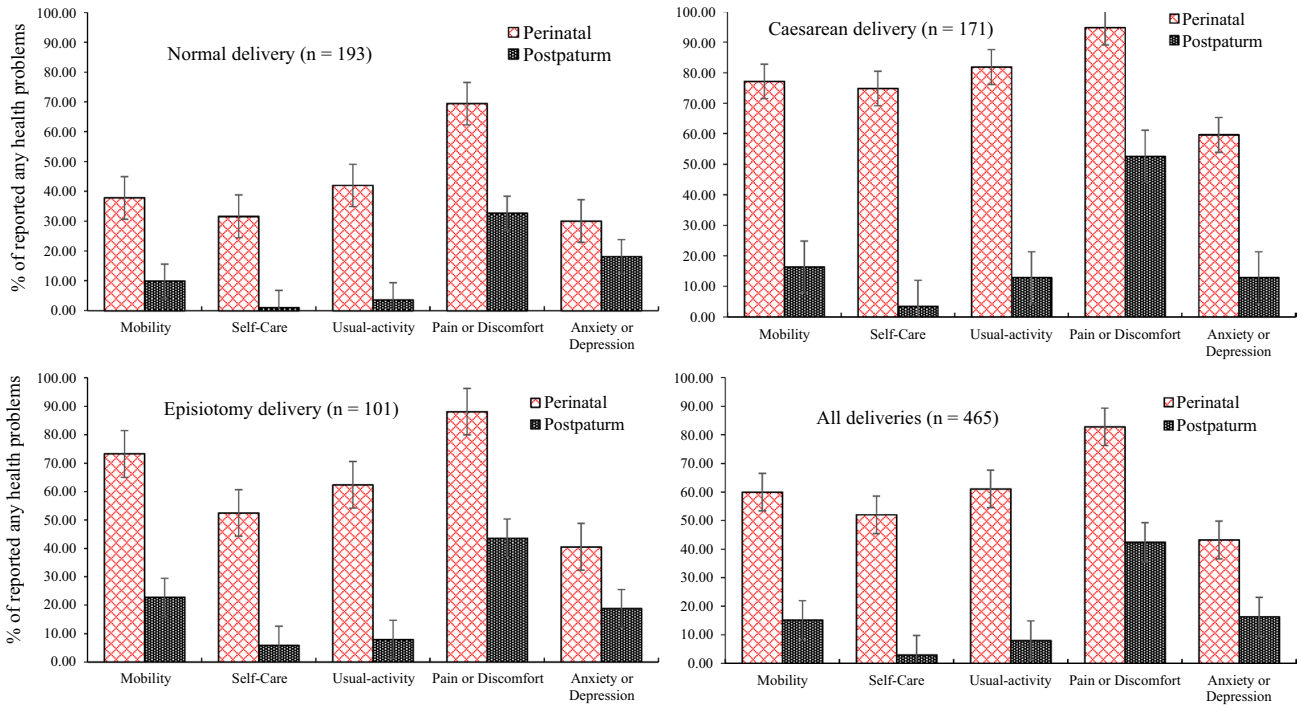

Fig. 1 Distribution of reported moderate or severe health problems of mother by the modes of delivery across health states

lived in disadvantaged socioeconomic households experienced significantly lower health status in both periods compared with the women from the uppermost wealth quintile.

In addition, analyses included overall test of reliability, validity and responsiveness of the EQ-5D-3L index score and EQ-VAS scores for the perinatal and postpartum periods. Moderate to large ICCs were observed in terms of the EQ-5D-3L index score and EQ-VAS score in most of the pairwise comparisons (Table 4). Further, both scores exhibited a higher ICC in the postpartum period compared with the perinatal period. Thus, the EQ-5D-3L index and EQ-VAS scores seem to be reliable, in particular in measuring quality of life with pregnant women in both periods. The correlation coefficients were identified as having only a small negative value related to the EQ-5D-3L index score and EQ-VAS score for both periods, which may explain the low construct validity. In terms of responsiveness, the ESs of the EQ-5D-3L index score and EQ-VAS score were shown to be significantly small to medium in scale.

Factors influencing the quality-of-life outcomes among pregnant mothers over the perinatal and postpartum periods (for RQ-2)

The factors influencing quality-of-life (using the EQ-5D index and EQ-VAS) scores across participant's characteristics in the perinatal period (Table 5) and postpartum periods (Table 6) are shown. The Cook–Weisberg diagnostic test shows that heteroscedasticity was not present in themodel. The VIF test shows that there was no multicollinearity problem in the model. Adolescent mothers (< 19 years of age) tended to report the worst quality-of-life outcomes in the perinatal and postpartum periods. Mothers who had received inadequate antenatal consultations reported low quality-of-life scores during both the perinatal and postpartum periods. Similarly, in the postpartum period, mothers who had received a limited number of antenatal consultations (0 or 1) had significantly lower quality-of-life scores compared with mothers who had received the recommended antenatal services (4 or more). Similarly, mothers who had delivered by caesarean section reported significantly poorer health in both the perinatal and postpartum periods. Furthermore, mothers who gained gestational weight in the first 24 gestation weeks experienced significantly improved health compared with mothers who did not gain gestational weight in the perinatal period. Mothers who lived in disadvantaged socioeconomic status households were more likely to report poor quality-of-life scores in both periods. In the postpartum period, women who had received the standard number of postnatal care visits reported significantly better quality-of-life score. Similar findings were also observed regarding the EQ-VAS scores. Being an adolescent mothers, inadequate antenatal and postnatal consultations, as well as living in poor socioeconomic status households were all significantly associated with lower quality-of-life score in both periods. These results were supported by the EQ-VAS scores given

Table 3 Distribution of quality-of-life outcomes (using EQ-5D index and EQ-VAS scores) by characteristics during the perinatal and postnatal periods

Variables	Number of participants (*N*)	EQ-5D index scores			EQ-VAS scores		
		Perinatal period Mean (SD)	Postnatal period Mean (SD)	Changed mean scores (95% CI)[a]	Perinatal period Mean (SD)	Postnatal period Mean (SD)	Changed mean scores (95% CI)[a]
Age of mothers (years)							
< 19	45	0.40 (0.44)	0.70 (0.15)	0.30* (0.20, 0.50)	0.65 (0.20)	0.75 (0.08)	0.10* (0.03, 0.15)
19–25	293	0.49 (0.41)	0.85 (0.23)	0.36* (0.31, 0.41)	0.72 (0.18)	0.87 (0.13)	0.15* (0.12, 0.18)
26–30	93	0.51 (0.38)	0.84 (0.18)	0.33* (0.24, 0.41)	0.72 (0.18)	0.85 (0.13)	0.13* (0.08, 0.18)
> 30	34	0.49 (0.43)	0.89 (0.11)	0.40* (0.25, 0.55)	0.73 (0.16)	0.85 (0.12)	0.12* (0.05, 0.19)
Mother education level							
No formal education	11	0.74 (0.23)	0.92 (0.11)	0.18[§] (0.02, 0.34)	0.71 (0.22)	0.89 (0.10)	0.18* (0.03, 0.33)
Primary education	75	0.51 (0.44)	0.88 (0.14)	0.37* (0.26, 0.48)	0.72 (0.18)	0.88 (0.10)	0.16* (0.11, 0.21)
Secondary education	319	0.49 (0.41)	0.86 (0.22)	0.37* (0.32, 0.42)	0.73 (0.18)	0.87 (0.13)	0.80* (0.77, 0.83)
Higher secondary and higher	60	0.45 (0.40)	0.83 (0.26)	0.38* (0.26, 0.50)	0.69 (0.18)	0.87 (0.12)	0.14[§] (0.12, 0.16)
Husband occupation							
Salaried employee	90	0.53 (0.37)	0.84 (0.24)	0.31* (0.22, 0.40)	0.75 (0.18)	0.87 (0.13)	0.12* (0.07, 0.17)
Business	133	0.49 (0.40)	0.87 (0.21)	0.38* (0.30, 0.46)	0.72 (0.18)	0.88 (0.12)	0.16* (0.12, 0.20)
Farmer	11	0.49 (0.45)	0.84 (0.21)	0.35* (0.27, 0.43)	0.73 (0.15)	0.85 (0.11)	0.12* (0.00, 0.24)
Informal worker	154	0.39 (0.40)	0.93 (0.11)	0.54* (0.28, 0.80)	0.71 (0.19)	0.87 (0.12)	0.16* (0.12, 0.20)
Others	77	0.49 (0.41)	0.88 (0.18)	0.39* (0.29, 0.49)	0.71 (0.18)	0.87 (0.12)	0.16* (0.11, 0.21)
Household size							
< 4 Members	63	0.47 (0.43)	0.88 (0.14)	0.41* (0.30, 0.52)	0.71 (0.19)	0.87 (0.13)	0.16* (0.10, 0.22)
4–5 Members	180	0.50 (0.40)	0.86 (0.21)	0.36* (0.29, 0.43)	0.72 (0.18)	0.88 (0.12)	0.16* (0.13, 0.19)
> 5 Members	222	0.50 (0.42)	0.85 (0.23)	0.35* (0.29, 0.41)	0.73 (0.18)	0.86 (0.13)	0.13* (0.10, 0.16)
Parity							
1	205	0.44 (0.42)	0.86 (0.23)	0.42* (0.35, 0.49)	0.69 (0.19)	0.87 (0.13)	0.18* (0.15, 0.21)
2–3	223	0.55 (0.38)	0.86 (0.20)	0.31* (0.25, 0.37)	0.75 (0.17)	0.87 (0.12)	0.12* (0.09, 0.15)
> 3	37	0.45 (0.49)	0.83 (0.19)	0.38* (0.21, 0.55)	0.71 (0.20)	0.84 (0.09)	0.13* (0.06, 0.20)
Antenatal care visits							
Inadequate (1)	31	0.37 (0.53)	0.80 (0.26)	0.43* (0.26, 0.68)	0.70 (0.22)	0.88 (0.13)	0.18* (0.09, 0.27)
Intermediate (2–3)	161	0.55 (0.37)	0.84 (0.22)	0.29* (0.22, 0.36)	0.74 (0.18)	0.86 (0.13)	0.12* (0.09, 0.15)
Adequate (4 or 4+)	273	0.48 (0.41)	0.87 (0.20)	0.39* (0.34, 0.44)	0.71 (0.18)	0.88 (0.12)	0.17* (0.14, 0.20)
Iron pill intake							
Yes	441	0.49 (0.41)	0.86 (0.21)	0.37* (0.33, 0.41)	0.72 (0.18)	0.87 (0.13)	0.15* (0.13, 0.17)
No	24	0.55 (0.44)	0.88 (0.21)	0.33[§] (0.13, 0.53)	0.74 (0.19)	0.87 (0.11)	0.13* (0.04, 0.22)
Gestational weight gain							
Yes	411	0.48 (0.41)	0.85 (0.21)	0.37* (0.33, 0.41)	0.72 (0.18)	0.87 (0.12)	0.15* (0.13, 0.17)
No	54	0.61 (0.39)	0.89 (0.19)	0.28[§] (0.16, 0.40)	0.72 (0.19)	0.87 (0.12)	0.15[§] (0.09, 0.21)
Mode of delivery							
Normal vaginal	193	0.55 (0.38)	0.90 (0.23)	0.35* (0.25, 0.40)	0.70 (0.38)	0.83 (0.23)	0.13* (0.09, 0.21)
Caesarean	171	0.39 (0.41)	0.79 (0.19)	0.40* (0.31, 0.45)	0.60 (0.41)	0.75 (0.19)	0.15* (0.11, 0.19)
Episiotomy	101	0.40 (0.35)	0.82 (0.27)	0.42[§] (0.35, 0.49)	0.61 (0.35)	0.80 (0.27)	0.19* (0.15, 0.29)
Postnatal care visits							
None	133	0.59 (0.40)	0.93 (0.12)	0.34* (0.27, 0.41)	0.76 (0.18)	0.90 (0.10)	0.14* (0.10, 0.18)
1st visit	266	0.47 (0.41)	0.83 (0.22)	0.36* (0.30, 0.42)	0.71 (0.18)	0.86 (0.13)	0.15* (0.12, 0.18)

Table 3 (continued)

Variables	Number of participants (*N*)	EQ-5D index scores			EQ-VAS scores		
		Perinatal period Mean (SD)	Postnatal period Mean (SD)	Changed mean scores (95% CI)[a]	Perinatal period Mean (SD)	Postnatal period Mean (SD)	Changed mean scores (95% CI)[a]
2nd or more visits	66	0.43 (0.39)	0.81 (0.26)	0.38[§] (0.27, 0.49)	0.68 (0.16)	0.85 (0.13)	0.17* (0.12, 0.22)
Wealth quintile							
Lowest 20%	93	0.35 (0.39)	0.65 (0.19)	0.30* (0.22, 0.38)	0.60 (0.18)	0.86 (0.12)	0.10[§] (0.08, 0.16)
2nd	93	0.48 (0.42)	0.89 (0.15)	0.41* (0.32, 0.50)	0.70 (0.19)	0.89 (0.10)	0.19[*] (0.15, 0.23)
3rd	93	0.47 (0.45)	0.83 (0.25)	0.36[*] (0.25, 0.47)	0.73 (0.18)	0.86 (0.14)	0.13[§] (0.08, 0.18)
4th	99	0.52 (0.40)	0.83 (0.25)	0.31* (0.22, 0.40)	0.74 (0.18)	0.86 (0.14)	0.12[§] (0.07, 0.17)
Upper 20%	87	0.43 (0.38)	0.86 (0.20)	0.43* (0.34, 0.52)	0.70 (0.18)	0.88 (0.11)	0.18* (0.14, 0.22)
Overall	$N=465$	0.49 (0.41)	0.86 (0.21)	0.36* (0.32, 0.40)	0.72 (0.18)	0.87 (0.12)	0.15 (0.13, 0.17)

*, §Significant at 0.1% and 1% risk level, respectively

[a]Two sample mean test (*t* test) performed

Table 4 Overall test for reliability, validity and responsiveness of EQ-5D-3L index score and EQ-VAS score for both perinatal and postnatal periods

Measure	Overall values	Periods	
		Perinatal values	Postnatal values
EQ-5D-3L index score (mean ± SD)	0.67 ± 0.31	0.49 ± 0.41	0.86 ± 0.21
EQ-VAS score (mean ± SD)	0.79 ± 0.15	0.72 ± 0.18	0.87 ± 0.12
Correlation coefficient			
EQ-5D-3L index score	− 0.23*	− 0.21*	− 0.24*
EQ-VAS score	− 0.25*	− 0.23*	− 0.26*
Intraclass correlation coefficient (ICC)			
EQ-5D-3L index score	0.60[§]	0.45*	0.74*
EQ-VAS score	0.73*	0.56*	0.89*
Effect size (for absolute mean difference)			
EQ-5D-3L index score	0.37*	0.23[§]	0.50*
EQ-VAS score	0.47*	0.30[§]	0.64*
Changed score	0.40*	0.26[§]	0.53*

*, §Significant at 0.1% and 1% risk level, respectively

in Table 6. The present study also examined the interaction effects of health status in relation to RQ-2 by examining: mother educational level verses the frequency of antenatal care in the perinatal model; mode of delivery versus gestational weight gain in the perinatal model and mother educational level versus the frequency of postpartum care in the postpartum period. The results of these interaction effects were excluded because the effects were only significant at a borderline risk level ($P=0.089$).

Discussion

This study examined the HRQoL of pregnant women aged between 18 and 42 years across two time periods (perinatal and postpartum). Overall, the HRQoL of women improved significantly from the perinatal to the postpartum period. However, approximately 58% of mothers experienced some/extreme health problems across all of the health states of EQ-5D (mobility, self-care, usual activities, pain or discomfort and anxiety or depression) in the perinatal period, whereas a significant improvement was found in the postpartum period. Haas et al. [39] support this finding, as they found prior to pregnancy the majority of women reported being in good health, which then persists throughout pregnancy. However, a large number of women experience significant reductions in various aspects of physical and mental health functions, which may continue during the postpartum period. Different factors, such as access to sufficient and healthy food, hygienic living environments and health awareness during the perinatal period, have been significantly correlated with HRQoL outcomes [10, 27, 40, 41]. In the pregnancy period, different levels of symptoms might also be a significant determinant for reduced quality-of-life

Table 5 Factors influencing health-related quality of life in the perinatal period

Variables	EQ-5D index score		EQ-VAS score	
	Model-1	Model-2	Model-3	Model-4
	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)
Age of mothers (years)				
< 19	− 0.10* (− 0.19, − 0.07)	− 0.12* (− 0.21, − 0.07)	− 0.05* (− 0.09, − 0.02)	− 0.05* (− 0.09, − 0.03)
19–25	0.12 (− 0.14, 0.15)	0.11 (− 0.14, 0.16)	0.02 (− 0.07, 0.06)	0.01 (− 0.06, 0.07)
26–30	0.02 (− 0.14, 0.18)	0.12 (− 0.17, 0.16)	− 0.01 (− 0.08, 0.06)	− 0.01 (− 0.08, 0.07)
> 30 (Ref)	Ref	Ref	Ref	Ref
Mother education level				
No formal education	0.29 (0.03, 0.56)	–	0.03 (− 0.09, 0.15)	–
Primary education	0.06 (− 0.08, 0.20)	–	0.03 (− 0.03, 0.09)	–
Secondary	0.04 (− 0.07, 0.15)	–	0.04 (− 0.01, 0.10)	–
Higher secondary and higher (ref)	Ref	–	Ref	–
Husband occupation				
Salaried employee (ref)	Ref	Ref	Ref	–
Business	− 0.04 (− 0.15, 0.07)	− 0.03 (− 0.15, 0.08)	− 0.03 (− 0.08, 0.02)	–
Farmer	− 0.14 (− 0.40, 0.12)	− 0.19 (− 0.45, 0.07)	− 0.02 (− 0.14, 0.09)	–
Informal worker	− 0.09* (− 0.15, − 0.06)	− 0.08§ (− 0.19, − 0.03)	− 0.04 (− 0.09, 0.01)	–
Others	− 0.03 (− 0.16, 0.09)	− 0.01 (− 0.14, 0.12)	− 0.05 (− 0.10, 0.01)	–
Household size				
< 4 Members	− 0.02 (− 0.10, 0.10)	–	− 0.04 (− 0.07, 0.08)	–
4–5 members	0.11 (− 0.05, 0.21)	–	0.06 (− 0.03, 0.12)	–
> 5 Members (ref)	Ref	–	Ref	–
Parity				
1	− 0.01 (− 0.16, 0.13)	–	− 0.02 (− 0.08, 0.04)	–
2–3	0.10 (− 0.05, 0.24)	–	0.04 (− 0.03, 0.10)	–
> 3 (Ref)	Ref	–	Ref	–
Number of ANC visits				
Inadequate (1)	− 0.11* (− 0.17, − 0.04)	− 0.16* (− 0.32, − 0.12)	− 0.11* (− 0.12, − 0.09)	− 0.06* (− 0.08, − 0.04)
Intermediate (2–3)	0.07 (− 0.01, 0.15)	0.05 (− 0.03, 0.14)	0.03 (− 0.01, 0.06)	0.03 (− 0.01, 0.06)
Adequate (4 or 4+) (ref)	Ref	Ref	Ref	Ref
Gestational weight gain				
Yes	0.08* (0.02, 0.10)	0.13* (0.10, 0.17)	0.08* (0.04, 0.11)	0.05* (0.01, 0.14)
No (ref)	Ref	Ref	Ref	Ref
Mode of delivery				
Normal vaginal (ref)	Ref	Ref	Ref	Ref
Caesarean	− 0.12* (− 0.18, − 0.09)	− 0.16* (− 0.28, − 0.10)	− 0.15* (− 0.22, − 0.11)	− 0.16* (− 0.28, − 0.10)
Episiotomy	− 0.09§ (− 0.14, − 0.06)	− 0.10 (− 0.16, 0.12)	− 0.11§ (− 0.18, − 0.08)	− 0.09 (− 0.14, 0.08)
Postnatal care visits				
None (ref)	na	na	na	na
1st visit				
2nd or more visits				
Wealth quintile				
Lowest 20%	− 0.14* (− 0.22, − 0.09)	− 0.17* (− 0.31, − 0.12)	− 0.05* (− 0.08, − 0.02)	− 0.07* (− 0.09, − 0.05)
2nd	0.06 (− 0.06, 0.18)	0.07 (− 0.05, 0.2)	0.01 (− 0.05, 0.06)	0.01 (− 0.04, 0.07)
3rd	0.04 (− 0.08, 0.16)	0.05 (− 0.07, 0.18)	0.03 (− 0.02, 0.08)	0.03 (− 0.02, 0.09)
4th	0.10 (− 0.02, 0.22)	0.18* (0.11, 0.23)	0.04 (− 0.01, 0.09)	0.04 (− 0.01, 0.10)
Upper 20% (ref)	Ref	Ref	Ref	Ref
Constant		0.19* (0.15, 0.25)		0.20* (0.18, 0.22)
Number of observations (*N*)	465	465	465	465

Table 5 (continued)

Variables	EQ-5D index score		EQ-VAS score	
	Model-1	Model-2	Model-3	Model-4
	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)
R-squared (R^2)		0.1837		0.1928
F statistic		1.33*		3.65*
Mean VIF (Max)		2.21 (1.31)		2.11 (1.21)
Breusch–Pagan test		7.42*		2.67*
Ramsey RESET test		1.21*		1.28*

na not applicable, *ref* reference value

*, §Significant at 0.1% and 1% risk level, respectively

[a]Coefficients (β) derived using multiple linear regression analysis

outcomes. Nevertheless, limited social support, as well as the mode of delivery (e.g. caesarean section), may be potential predictors of poor HRQoL outcomes in the postpartum period.

The study findings showed that adolescent motherhood was significantly associated with lower HRQoL compared with other mothers during perinatal and postpartum periods. This finding is consistent with previous studies [42, 43]. These studies found that teenage or early-age mothers experienced comparatively adverse health status during pregnancy as well as the postpartum periods. Factors related to lack of health awareness and knowledge in addition to psychological stress due to their first pregnancy experience may directly or indirectly negatively influence HRQoL. Supporting school-based programs and conducting training in self-development in terms of health, awareness and knowledge hold great promise against early marriage and adolescent pregnancy [44]. It is very difficult to predict if school-based programs, as well as enhanced school performance, would contribute to lower rates of adolescent childbirths. However, authors of a previous systematic review recommend that this is a feasible and effective path towards improvement [45]. The study results show that an adequate ANC consultation was significantly associated with better health status during pregnancy. Pregnant women who received the recommended number of ANC (4 or more) and postnatal care (2 or more) visits reported fewer self-reported health problems in both the perinatal and postpartum periods. Some previous studies found that the utilisation of adequate ANC visits was the most potent factor, which contributed to promoting mothers' perinatal and postpartum health status [46, 47]. Effective and affordable maternal healthcare services might significantly contribute to improving maternal health status [48, 49]. However, this may depend on how well these maternal services are delivered in the community [50] and the availability and affordability of services, such as emergency care [51].

The study found that mothers delivering by caesarean experienced a greater number of health problems and reported significantly adverse health status compared with mothers who had vaginal delivery for both periods. Some studies have found that women who delivered by caesarean had significantly poor health status in terms of physical functioning [52, 53], psychological [52, 54], social [55, 56], pain or discomfort [52, 55, 56] and vitality [55] in comparison with mothers delivering vaginally. The negative impact of a caesarean delivery on mothers' HRQoL may be mediated through surgical complications, postpartum infection [57], a high risk of physical or mental exhaustion, lack of sleep [58] and treatment cost [59]. Further studies aimed at identifying the supporting financial mechanisms for this concern are undoubtedly needed.

Mothers from the lowest socioeconomic households experienced disproportionately lower levels of health status compared with mothers from higher socioeconomic quintiles during both periods. The positive association between health and wealth status has been well established [14]. In general, mothers from the economically disadvantaged households have limited access to health facilities [60] and lack of opportunities to access both mass media and transportation [61, 62], which are crucial during pregnancy. Therefore, social support and community awareness programs in disadvantaged communities including remote-rural areas would assist to improve the quality of life of mothers. Policy makers and health-related authorities should explore and adopt measures for addressing the above issues for the betterment of maternal health.

This study is the first in Bangladesh to examine the health status of pregnant women as well as to determine potential factors influencing their quality-of-life outcomes in the perinatal and postpartum periods. Previous studies measured quality of life by incorporating either the perinatal or postpartum periods, not both. The study findings contribute to the practice of health professionals in maternal healthcare

Table 6 Factors influencing health-related quality of life in the postpartum period

Variables	EQ-5D index score		EQ-VAS score	
	Model-1	Model-2	Model-3	Model-4
	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)
Age of mothers (years)				
< 19	− 0.05* (− 0.07, − 0.03)	− 0.06* (− 0.09, − 0.03)	− 0.06* (− 0.09, − 0.03)	− 0.06* (− 0.09, − 0.04)
19–25	− 0.03 (− 0.11, 0.04)	− 0.08 (− 0.19, − 0.01)	0.03 (− 0.02, 0.07)	0.02 (− 0.03, 0.07)
26–30	− 0.05 (− 0.13, 0.03)	0.06 (− 0.09, 0.09)	0.02 (− 0.05, 0.05)	0.02 (− 0.05, 0.05)
> 30 (Ref)	Ref	Ref	Ref	Ref
Mother education level				
No formal education	0.10 (− 0.04, 0.23)	–	0.02 (− 0.06, 0.10)	–
Primary education	0.05 (− 0.02, 0.12)	–	0.02 (− 0.03, 0.06)	–
Secondary	0.03 (− 0.03, 0.09)	–	0.05 (− 0.03, 0.08)	–
Higher secondary and higher (ref)	Ref	–	Ref	–
Husband occupation				
Salaried employee (ref)	Ref		Ref	–
Business	0.02 (− 0.03, 0.08)	–	0.01 (− 0.03, 0.04)	–
Farmer	0.08 (− 0.05, 0.22)	–	− 0.02 (− 0.10, 0.06)	–
Informal worker	0.03 (− 0.05, 0.06)	–	− 0.01 (− 0.04, 0.03)	–
Others	0.04 (− 0.03, 0.10)	–	− 0.01 (− 0.04, 0.04)	–
Household size				
< 4 Members	− 0.01 (− 0.16, 0.13)	–	− 0.02 (− 0.08, 0.04)	–
4–5 Members	0.10 (− 0.05, 0.24)	–	0.04 (− 0.03, 0.10)	–
> 5 Members (ref)	Ref	–	Ref	–
Parity				
1	0.04 (− 0.04, 0.11)	–	0.05 (− 0.01, 0.08)	–
2–3	0.03 (− 0.04,0.11)	–	0.03 (− 0.10, 0.07)	–
> 3 (Ref)	Ref	–	Ref	–
Number of ANC visits				
Inadequate (1)	− 0.08* (− 0.11, − 0.04)	− 0.07* (− 0.10, − 0.03)	− 0.08* (− 0.12, − 0.03)	− 0.07* (− 0.12, − 0.04)
Intermediate (2–3)	− 0.03 (− 0.08, 0.01)	− 0.05 (− 0.10, − 0.01)	− 0.02 (0.01, − 1.52)	− 0.02 (− 0.04, 0.01)
Adequate (4 or 4+) (ref)	Ref	Ref	Ref	Ref
Gestational weight gain				
Yes	0.04* (0.02, 0.06)	0.04* (0.02, 0.07)	0.12* (0.08, 0.16)	0.01 (− 0.03, 0.04)
No (ref)	Ref	Ref	Ref	Ref
Mode of delivery				
Normal vaginal (ref)	Ref	Ref	Ref	Ref
Caesarean	− 0.10* (− 0.15, − 0.08)	− 0.13* (− 0.20, − 0.09)	− 0.17* (− 0.24, − 0.12)	− 0.16* (− 0.28, − 0.10)
Episiotomy	0.06[§] (0.02, 0.08)	0.05 (− 0.03, 0.12)	0.08[§] (0.03, 0.12)	0.04 (− 0.01, 0.07)
Postnatal care visits				
None (ref)	0.03 (− 0.03, 0.08)	0.03 (− 0.02, 0.09)	0.02 (− 0.01, 0.05)	0.02 (− 0.01, 0.06)
1st visit	0.13* (0.07, 0.19)	0.14* (0.08, 0.20)	0.05* (0.01, 0.09)	0.06[§] (0.02, 0.09)
2nd or more visits	0.03 (− 0.03, 0.08)	0.03 (− 0.02, 0.09)	0.02 (− 0.01, 0.05)	0.02 (− 0.01, 0.06)
Wealth quintile				
Lowest 20%	− 0.06* (− 0.09, − 0.03)	− 0.08* (− 0.10, − 0.06)	− 0.05* (− 0.08, − 0.02)	− 0.07[§] (− 0.09, − 0.02)
2nd	0.03 (− 0.03, 0.10)	0.03 (− 0.03, 0.09)	0.01 (− 0.03, 0.05)	0.01 (− 0.03, 0.05)
3rd	− 0.02 (− 0.08, 0.04)	− 0.03 (− 0.09, 0.03)	− 0.02 (− 0.06, 0.01)	− 0.02 (− 0.06, 0.01)
4th	0.06* (0.02, 0.09)	0.03* (0.01, 0.05)	0.04 (0.02, 0.08)	− 0.02 (− 0.06, 0.02)
Upper 20% (ref)	Ref	Ref	Ref	Ref
Constant		0.12* (0.80, 0.20)		0.10* (0.08, 0.18)
Number of observations (*N*)	465	465	465	465

Table 6 (continued)

Variables	EQ-5D index score		EQ-VAS score	
	Model-1	Model-2	Model-3	Model-4
	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)	Unadjusted β^a (95% CI)	Adjusted β^a (95% CI)
R-squared (R^2)		0.2119		0.2565
F statistic		3.38*		1.43*
Mean VIF (Max)		2.21 (1.98)		2.13 (1.21)
Breusch–Pagan test		86.25*		22.59*
Ramsey RESET test		1.78*		1.04*

na not applicable, *ref* reference value

*, §Significant at 0.1% and 1% risk level, respectively

[a]Coefficients (β) derived using multiple linear regression analysis

services, including antenatal, postnatal, as well as obstetrics. Expanding the participation of perinatal and postpartum mothers in the modes of their healthcare may improve the quality of their healthcare and improvement in their QoL outcomes. Determinants of HRQoL among perinatal and postpartum women in this study are similar to findings of earlier research. Therefore, findings from this study are instructive for designing appropriate and efficient health promotion programs or interventions that permit women to sustain better health for themselves and their newborn babies.

The present study has several limitations. Measuring quality of life is widely perceived to have substantial potential as an endpoint in health outcomes research; however, results are partially dependent upon study methods and outcome variables of interest [63]. The participants of the present study were derived from the protocol "Introducing a Group Prenatal Care Model in Bangladesh" [16], wherein quality of life of women during the course of pregnancy might change for independent study designs as well as application of survey instruments. For this study, data were gathered from mothers in the perinatal and postnatal periods. The length of survey periods might introduce uncontrolled bias [52], as changes in quality of life are not instantaneous and might emerge only after time, which was not captured in this study. Due to funding restrictions the current study was conducted in a publicly operated MCWC and only mothers who came to this health facility were included. Therefore, we were unable to consider pregnant women who received maternal care from the other health facilities (e.g. private clinics, community clinics, secondary or tertiary hospitals). Further, this study did not consider woman who had no access to healthcare facilities at all. The present study could not confirm the impact on quality of life as a result of the intervention due to a paucity of clinical evidence and the study design (e.g. clinical study, randomised control trial). The results indicated a strong association with levels of education as well as demographic and socio-cultural indicators, which may not be relevant in other parts of the country. However, the language, culture and social norms of many Bangladeshi mothers are relatively homogeneous. Finally, the cross-sectional nature of this study does not permit to the drawing of inferences in terms of causal–effect associations. In this context, longitudinal studies are required to precisely investigate which factors may affect perinatal and postpartum women's health.Further research is needed into women's preferences for maternal healthcare services [64] and their experiences within the Bangladesh maternity system. Further, an exploration of maternity healthcare changes designed to reduce or modify controllable parameters that are associated with adverse outcomes is also urgently needed.

Conclusions

Overall, the self-reported health status of pregnant mothers improved from the perinatal to the postnatal period. Approximately half of the mothers claimed some/extreme health problems across all of the measured aspects (mobility, self-care, usual activities, pain or discomfort and anxiety or depression) in the perinatal period. By contrast, a significant improvement of health status was observed in the postnatal period. Findings of this study would be helpful for policymakers to design new health interventions to address some of the contributing factors to poor health for mothers in Bangladesh. This might include promoting adequate access to quality pre-delivery care and exercise during pregnancy. These initiatives might directly or indirectly influence better health status for mothers during the course of their pregnancy.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Emmanuel, E. N., & Sun, J. (2014). Health related quality of life across the perinatal period among Australian women. *Journal of Clinical Nursing, 23*(11–12), 1611–1619.
2. Torkan, B., Parsay, S., Lamyian, M., Kazemnejad, A., & Montazeri, A. (2009). Postnatal quality of life in women after normal vaginal delivery and caesarean section. *BMC Pregnancy and Childbirth, 9*(4), 1–7. https://doi.org/10.1186/1471-2393-9-4.
3. Hwang, S. S., Smith, V. C., McCormick, M. C., & Barfield, W. D. (2012). The association between maternal oral health experiences and risk of preterm birth in 10 states, Pregnancy Risk Assessment Monitoring System, 2004–2006. *Maternal and Child Health Journal, 16*(8), 1688–1695.
4. Tsai, S., Lee, P., Lin, J., & Lee, C. (2016). Cross-sectional and longitudinal associations between sleep and health-related quality of life in pregnant women: A prospective observational study. *International Journal of Nursing Studies, 56,* 45–53.
5. Semasaka, J. P. S., Krantz, G., Nzayirambaho, M., Munyanshongore, C., Edvardsson, K., & Mogren, I. (2016). Self-reported pregnancy-related health problems and self-rated health status in Rwandan women postpartum: A population-based cross-sectional study. *BMC Pregnancy and Childbirth, 16*(1), 1–17.
6. Sam, K., & Leung, W. K. (2017). Oral health-related quality of life and periodontal status. *Maternal and Child Health Journal, 34*(2), 114–122.
7. Schytt, E., Lindmark, G., & Waldenstro, U. (2005). Physical symptoms after childbirth: Prevalence and associations with self-rated health. *BJOG: An International Journal of Obstetrics and Gynaecology, 112*(2), 210–217.
8. Symon, A. (2003). A review of mothers' prenatal and postnatal quality of life. *Health and Quality of Life Outcomes, 1*(38), 1–8.
9. Jomeen, J. (2004). The importance of assessing psychological status during pregnancy, childbirth and the postnatal period as a multidimensional construct: A literature review. *Clinical Effectiveness in Nursing, 8*(3–4), 143–155.
10. Sahrakorpi, N., Koivusalo, S. B., & Eriksson, J. G. (2017). Perceived financial satisfaction, health related quality of life and depressive symptoms in early pregnancy. *Maternal and Child Health Journal, 21*(7), 1493–1499.
11. Castro, R. T. A., Anderman, C. P., Glover, V., Connor, T. G. O., Ehlert, U., & Kammerer, M. (2017). Associated symptoms of depression: Patterns of change during pregnancy. *Archives of Women's Mental Health, 20*(1), 123–128.
12. Otchet, F., Carey, M. S., & Adam, L. (1999). General health and psychological symptom status in pregnancy and the puerperium: What is normal? *Obstetrics and Gynecology, 94*(6), 935–941.
13. Nuwagaba-biribonwoha, H., Mayon-White, R. T., Okong, P., Carperter, L. M., & Jenkinson, C. (2006). The impact of HIV on maternal quality of life in Uganda. *AIDS Care, 18*(6), 614–620. https://doi.org/10.1080/09540120500359298.
14. Symon, A., & Dobb, B. (2011). Maternal quality of life assessment: The feasibility of antenatal postnatal follow-up using the Mother-Generated Index. *Journal of Reproductive and Infant Psychology, 29*(2), 183–194. https://doi.org/10.1080/02646838.2010.513049.
15. Ministry of Health and Family Welfare, MoHFW. (2014). *Health Bulletin: Chadpur (Sadar) Upazalia Health Office*. Dhaka: Directorate General of Health Services (DGHS).
16. Sultana, M., Mahumud, R. A., Ali, N., Ahmed, S., Islam, Z., Khan, J. A. M., et al. (2017). The effectiveness of introducing Group Prenatal Care (GPC) in selected health facilities in a district of Bangladesh: Study protocol. *BMC Pregnancy and Childbirth, 17*(48), 1–7.
17. Casagrande, J. T., Pike, M. C., & Smith, P. G. (1978). An improved approximate formula for calculating sample sizes for comparing two binomial distributions. *Biometrics, 34,*483–486.
18. Ury, H. K., & Fleiss, J. L. (1980). On approximate sample sizes for comparing two independent proportions with the use of Yates' correction. *Biometrics, 36,* 343–346.
19. National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. (2013). *Bangladesh demographic and health survey 2011*. Dhaka and Calverton, MD: NIPORT, Mitra and Associates, and ICF International.
20. Shah, R., Mullany, L. C., Darmstadt, G. L., Mannan, I., Rahman, S. M., et al. (2014). Incidence and risk factors of preterm birth in a rural Bangladeshi cohort. *BMC Pediatrics*. https://doi.org/10.1186/1471-2431-14-112.
21. Fronczak, N., Antelman, G., Moran, C., & Baqui, A. H. (2005). Delivery-related complications and early postpartum morbidity in Dhaka, Bangladesh. *International Journal of Gynecology and Obstetrics, 91,* 271–278.
22. The EuroQoL Group. (1990). EuroQoL—A new facility for the measurement of health-related quality of life. *Health Policy, 16*(3), 199–208.
23. Szende, A., Janssen, B., & Cabases, J. (Eds.). (2014). *Self-reported population health: An international perspective based on EQ-5D*. Dordrecht: Springer.
24. Huang, I. C., Willke, R. J., Atkinson, M. J., Lenderking, W. R., Frangakis, C., & Wu, A. W. (2007). US and UK versions of the EQ-5D preference weights: Does choice of preference weights make a difference? *Quality of Life Research, 16*(6), 1065–1072.
25. Sultana, M., Sarker, A. R., Mahumud, R. A., Ahmed, S., Ahmed, W., Chakrovorty, S., et al. (2016). Inequalities in health status from EQ-5D findings: A cross-sectional study in low-income communities of Bangladesh. *International Journal Health Policy and Management, 5*(5), 301–308.
26. Safita, N., Islam, S. M. S., Chow, C. K., Niessen, L., Lechner, A., Holle, R., et al. (2016). The impact of type 2 diabetes on health related quality of life in Bangladesh: Results from a matched study comparing treated cases with non-diabetic controls. *Health and Quality of Life Outcomes, 14*(129), 1–9.
27. Shaheen, R., & Lindholm, L. (2006). Quality of life among pregnant women with chronic energy deficiency in rural Bangladesh. *Health Policy, 78*(2–3), 128–134.

28. Polack, S., Eusebio, C., Mathenge, W., Wadud, Z., Mamunur, A. K. M., et al. (2010). The impact of cataract surgery on health related quality of life in Kenya, the Philippines, and Bangladesh. *Ophthalmic Epidemiology, 17*(6), 387–399.
29. Oviedo-Caro, M. A., Bueno-Antequera, J., & Munguía-Izquierdo, D. (2018). Explanatory factors and levels of health-related quality of life among healthy pregnant women at mid pregnancy: A cross sectional study of The PregnActive Project. *Journal of Advance Nursing, 74,* 2766–2776.
30. Lagadec, N., Steinecker, M., Kapassi, A., Magnier, A. M., Chastang, J., Robert, S., et al. (2018). Factors influencing the quality of life of pregnant women: A systematic review. *BMC Pregnancy and Childbirth, 18*(455), 1–14.
31. Moafi, F., Kazemi, F., Siboni, F. S., & Alimoradi, Z. (2018). The relationship between food security and quality of life among pregnant women. *BMC Pregnancy and Childbirth, 18*(319), 1–9.
32. Calou, C. G. P., de Oliveira, M. F., Carvalho, F. H. C., Soares, P. R. A. L., Bezerra, R. A., de Lima, S. K. M., et al. (2018). Maternal predictors related to quality of life in pregnant women in the Northeast of Brazil. *Health and Quality of Life Outcomes, 16*(109), 1–10.
33. Mahumud, R. A., Sultana, M., & Sarker, A. R. (2017). Distribution and determinants of low birth weight in developing countries. *Journal of Preventive Medicine and Public Health, 50*(1), 18–28.
34. Rutstein, S. O. (2015). *Steps to constructing the new DHS Wealth Index*. Rockville, MD: ICF International.
35. Streiner, D. L., & Norman, G. R. (2008). *Health measurement scales: A practical guide to their development and use* (4th ed.). Oxford: Oxford University Press.
36. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: L. Erlbaum Associates.
37. Whynes, D. K., McCahon, R. A., Ravenscroft, A., Hodgkinson, V., Evley, R., & Hardman, J. G. (2013). Responsiveness of the EQ-5D health-related quality-of-life instrument in assessing low back pain. *Value in Health, 16,* 124–132.
38. Bonferroni, C. E. (1936). Teoria statistica delle classi e calcolo delle probabilità. *Pubblicazioni del R Istituto Superiore di Scienze Economiche e Commerciali di Firenze, 8,* 3–62.
39. Haas, J. S., Jackso, R. A., Fuentes-Afflick, E., Stewart, A. L., Dean, M. L., Brawarsky, P., et al. (2004). Changes in the health status of women during and after pregnancy. *Journal of General Internal Medicine, 20*(1), 45–51.
40. Sakthong, P., Charoenvisuthiwongs, R., & Shabunthom, R. (2008). A comparison of EQ-5D index scores using the UK, US, and Japan preference weights in a Thai sample with type 2 diabetes. *Health and Quality of Life Outcomes, 6*(71), 1–9.
41. Madjdian, D. S., & Bras, H. A. J. (2016). Family, gender, and women's nutritional status: A comparison between two Himalayan communities in Nepal. *Economic History of Developing Regions, 31*(1), 1–30.
42. Vinnerljung, B., Hjern, A., & Bra, L. (2016). Child welfare clients have higher risks for teenage childbirths: Which are the major confounders? *European Journal of Public Health, 26*(4), 592–597.
43. Carson, A., Chabot, C., Greyson, D., Shannon, K., Duff, P., & Shoveller, J. (2016). A narrative analysis of the birth stories of early-age mothers. *Sociology of Health and Illness, 39*(6), 1–16.
44. Pearsa, K. C., Fishera, P. A., Kima, H. K., Brucea, J., Healey, C. V., & Yoerger, K. (2013). Immediate effects of a school readiness intervention for children in foster care. *Early Education and Development, 24*(6), 771–791. https://doi.org/10.1080/10409289.2013.736037.immediate.
45. Harden, A., Brunton, G., Fletcher, A., & Oakley, A. (2009). Teenage pregnancy and social disadvantage: Systematic review integrating controlled trials and qualitative studies. *British Medical Journal, 339,* 1182–1185. https://doi.org/10.1136/bmj.b4254.
46. Hitimana, R., Lindholm, L., Krantz, G., Nzayirambaho, M., Condo, J., Semasaka, J. P. S., et al. (2018). Health-related quality of life determinants among Rwandan women after delivery: Does antenatal care utilization matter? A cross-sectional study. *Journal of Health, Population and Nutrition, 37*(1), 1–10.
47. Hitimana, R., Lindholm, L., Krantz, G., Nzayirambaho, M., Sengoma, J. S., Condo, J., et al. (2017). Health related quality of life determinants for Rwandan women after delivery: Regis Hitimana. *European Journal of Public Health, 27*(3), ckx186.101.
48. Carroli, G., Rooney, C., & Villar, J. (2001). How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. *Paediatric and Perinatal Epidemiology, 15*(Suppl 1), 1–42.
49. Conway, K. S., & Kutinova, A. (2006). Maternal health: Does prenatal care make a difference? *Health Economics, 15*(5), 461–488.
50. Oyerinde, K. (2013). Community medicine and health education can antenatal care result in significant maternal mortality reduction in developing countries? *Journal of Community Medicine and Health Education, 3,* 2–3.
51. Acharya, S. (1995). How effective is antenatal care to promote maternal and neonatal health? *International Journal of Gynecology and Obstetrics, 50,* S35–S42.
52. Sadat, Z., Taebi, M., Saberi, F., & Kalarhoudi, M. A. (2013). The relationship between mode of delivery and postpartum physical and mental health related quality of life. *Iranian Journal of Nursing and Midwifery Research, 18,* 499–504.
53. Baghirzada, L., Downey, K. N., & Macarthur, A. J. (2013). Assessment of quality of life indicators in the postpartum period. *International Journal of Obstetric Anesthesia, 22,* 209–216.
54. Jansen, A. J. G., Essink-Bot, M., Duvekot, J. J., & Van Rhenen, D. J. (2007). Psychometric evaluation of health-related quality of life measures in women after different types of delivery. *Journal of Psychosomatic Research, 63,* 275–281.
55. Kavosi, Z., Keshtkaran, A., Setoodehzadeh, F., Kasraeian, M., & Khammarnia, M. E. (2015). A comparison of mothers' quality of life after normal vaginal, cesarean, and water birth deliveries. *International Journal of Community Based Nursing and Midwifery, 3,* 198–204.
56. Petrou, S., & Kim, S. W. (2017). Mode of delivery and long-term health-related quality-of-life outcomes: A prospective population-based study. *Birth, 44,* 110–119.
57. Villar, J., Carroli, G., Zavaleta, N., Donner, A., Wojdyla, D., Faundes, A., et al. (2007). Maternal and neonatal individual risks and benefits associated with caesarean delivery: Multicentre prospective study. *British Medical Journal, 335,* 1–11.
58. Thompson, J. F., Roberts, C. L., Currie, M., & Ellwood, D. A. (2002). Prevalence and persistence of health problems after childbirth: Associations with parity and method of birth. *Birth, 29,* 83–94.
59. Petroul, S., & Khan, K. (2013). An overview of the health economic implications of elective caesarean section. *Applied Health Economics and Health Policy, 11,* 561–576.
60. Mcleish, J., & Redshaw, M. (2018). Maternity experiences of mothers with multiple disadvantages in England: A qualitative study. *Women and Birth. Australian College of Midwives*. https://doi.org/10.1016/j.wombi.2018.05.009.
61. Kusuma, Y. S., Kumari, R., & Kaushal, S. (2013). Migration and access to maternal healthcare: Determinants of adequate antenatal care and institutional delivery among socio-economically disadvantaged migrants in Delhi, India. *Tropical Medicine and International Health, 18,* 1202–1210.

62. Bostock, L. (2001). Pathways of disadvantage? Walking as a mode of transport among low-income mothers. *Health and Social Care in the Community, 9,* 11–18.
63. Testa, M. A., & Nackley, J. F. (1994). Methods for quality-of-life studies. *Annual Review of Public Health, 15,* 535–559.
64. Mahumud, R. A., Alamgir, N. I., Hossain, M. T., Baruwa, E., Sultana, M., Gow, J., et al. (2019). Women's preferences for maternal healthcare services in Bangladesh: Evidence from a discrete choice experiment. *Journal of Clinical Medicine, 8*(2), 1–21.

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