Depressive symptoms in mothers following peri-natal and early infant loss in rural

Bangladesh: A population-based study

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Abstract

Purpose: We examined stillbirth and neonatal death as predictors of depressive symptoms in women experiencing these events during the first six months postpartum.

Methods: We performed secondary analyses using data from 41,348 married women ages 13-44, originally collected for the JiVitA-1 study (2001 to 2007) in northwest Bangladesh. Adjusted relative risk ratios were estimated to determine the associations between stillbirth and early infant death and women's risk of reported depressive symptoms (trichotomized 0, 1-2, 3-5) up to six months after the death. Adjusted risk ratios, comparing 0-2 versus 3-5 depressive symptoms, were used in stratified analyses.

Results: Women having fetal/infant deaths had elevated risk of experiencing 1-2 postpartum depressive symptoms (Adj. RRRs between 1.2 and 1.7) and of experiencing 3-5 postpartum depressive symptoms (Adj.RRRs between 1.9 to 3.3), relative to women without a fetal/infant death. Notably, those whose infants died in the early post-neonatal period had over a three-fold risk of 3-5 depressive symptoms (Adj RRR=3.3, 95% CI 2.6-4.3) compared to a two-fold risk for women experiencing a stillbirth (Adj RRR=1.9, 95% CI 1.7-2.1). Following early postneonatal deaths, women with higher levels of education were more likely to suffer 3-5 depressive symptoms (Adj RR=10.6, 95% CI 5.2-21.7, ≥ 10 years of education) compared to women with lower levels of education (Adj RR=2.0, 95% CI 1.6-2.4, no education; Adj RR=2.2, 95% CI 1.6-2.9, 1-9 years of education).

Conclusions: Women's mental health needs should be prioritized in low-resource settings, where these outcomes are relatively common and few mental health services are available.

Keywords: *stillbirth, neonatal death, Bangladesh, depressive symptoms, mental health*

List of Abbreviations and Acronyms

Abbreviation	Description
CI	Confidence intervals
CES-D	Center for Epidemiologic Studies Depression Scale
GLM	Generalized linear models
LAMI	Low- and middle-income
PHQ-9	Patient Health Questionnaire
RRR	Relative Risk Ratio
RR	Relative risk
SD	Standard deviation

Introduction

According to the WHO, major depression is the leading cause of years lived with a disability and the second leading cause of disability-adjusted life years among women of reproductive age in low- and middle-income (LAMI) countries [1]. Given the high burden of depressive symptoms in women in resource-scarce contexts [2, 3], it is important to identify risk factors for depressive symptoms in LAMI countries, where risk factors are not well identified.

Possible risk factors for depression may include stillbirth and neonatal death, both highly traumatic events that can result in profound distress [4]. In Bangladesh, stillbirth and neonatal death are estimated to be 28 and 37 per 1,000 births, respectively [5]. Little is known about depressive symptoms following such adverse experiences in Bangladesh, despite the fact that these rates are over five times higher than in high income countries [6, 7]. Reporting problems, small sample size, hospital-based samples, and limited adjustment for confounders constrain research on pregnancy loss and maternal depression in LAMI countries [8-12]. Composite variables are often used to address lack of power, such that stillbirths are combined with neonatal loss, limiting our understanding of the mental health impact of loss of a live born infant relative to a stillbirth. If identified as important risk factors, care for women experiencing stillbirth and neonatal death could be addressed by government policies (e.g. extending maternity rights to mothers of unborn children, or options to delay women's return to work if formally employed) in order to help mothers cope with such experiences [13]. Knowing the relative impact of different loss experiences may help policymakers or public health interventionists to better focus initiatives on the most affected women.

Some anthropologists posit that in settings of extreme hardship, mothers may be fatalistic and accepting of infant death [14]. On the other hand, in Bangladesh, special care is given to a woman during the forty day lay-in period after delivery of a live baby [15]. Women may

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4 experience distress if this support is not provided after a perinatal death or if they believe the loss
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6 means they have not fulfilled their childbearing role. Multiple stressors such as poverty, loss of a
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8 son or the birth of a girl in South Asian cultures may also precipitate more severe depression if
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10 women are blamed for the death or for the birth of a girl [16].
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14 Our study objective was to examine stillbirth and neonatal death as predictors of
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16 depressive symptoms in women experiencing these events at six months postpartum. We
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18 hypothesized that neonatal deaths result in higher levels of depressive symptoms than stillbirth.
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20 Given strong son preference in Bangladesh [17], we also hypothesized that mothers with neonatal
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22 death of a boy are more likely to experience depressive symptoms than mothers losing a girl.
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24 Finally, because lower education is a risk factor for depression generally [18], is associated with
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26 anxiety following early pregnancy loss [19], and is related to higher fertility and greater
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28 likelihood of infant mortality [20-22], we hypothesized that low education would be associated
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30 with depressive symptoms for mothers experiencing stillbirth and infant death.
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33 34 35 **Material and Methods**

36 37 *Participants and Setting*

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39 We performed a secondary analysis using data from 41,348 married women ages 13-44,
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41 originally collected for the JiVitA-1 study. JiVitA-1 was a cluster randomized, double-masked,
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43 placebo-controlled, community trial. It was originally designed to examine the effect of maternal
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45 vitamin A and beta-carotene supplementation (given to pregnant women in the first 12 weeks of
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47 pregnancy) on maternal mortality in northwest Bangladesh [23].
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51 JiViTA-1 took place in two rural districts of Bangladesh, Gaibandha and Rangpur. These
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53 two contiguous districts, covering 435 sq km, contain 596 villages or small groupings called
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55 ‘sectors’. About 85% of households in the study area lack electricity and most houses are made of
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57 dirt covered with tin roofs. Most men engage in subsistence agriculture, wage labor, or own small
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businesses. About 60% of the women do not work outside the home. At the start of the study, 40% of women were illiterate and 93% had <10 years of education [23]. In the study area, 93.75% deliveries occur at home, 5.74% in a facility and 0.51% en-route to a facility or in an unspecified location (unpublished data).

Procedure

The JiViTA-1 study took place between August 2001 and October 2007. Prior to enrollment, a census of married women of reproductive age residing in the study areas was conducted and enlisted for five-weekly pregnancy surveillance, based on being 13-44 years of age, married and residing with husband, and not menopausal or sterilized. Newly married women were enlisted for surveillance over the course of the trial, based on being registered with the trial within four months of marriage. To identify pregnant women, all eligible women were visited at home every five weeks and asked about their menstrual history. A urine test was used to identify new pregnancies for women reporting amenorrhea in the past 30 days. Women providing oral consent were randomized into three weekly supplement groups: vitamin A, beta-carotene and placebo.

At enrollment, trained interviewers conducted face-to-face interviews with participants to obtain information on demographic variables and maternal health status. Information on birth outcomes, including stillbirths and early infant deaths were collected at three months postpartum. Postpartum depressive symptoms were assessed six months after the event (median 24.7 weeks, mean-29.3 weeks, SD=11.4) and asked about the 'past six months' using a five-item scale developed in the study population.

The Johns Hopkins Bloomberg School of Public Health Institutional Review Board and the Bangladesh Medical Research Council granted ethical approval for the study.

Measures

Maternal postpartum depressive symptoms were assessed referring to the prior six months based on questions modified from the Patient Health Questionnaire (PHQ-9) and the Center for Epidemiologic Studies Depression Scale (CES-D); there were no validated scales for depression in Bangladesh at the time. Items were pilot tested in focus group discussions to identify symptoms from the two scales that were well-understood locally. A professional translator first translated the items from English into Bangla and another independently back translated the items into English. A standard question about suicidal ideation was added. The final, five-item scale included: feeling sad all the time; becoming more forgetful; crying all the time; having thoughts of hurting oneself; and not wanting to bathe or eat for several days (Cronbach alpha=0.72). Women were asked if they experienced any of these symptoms in the last six months. The five depressive symptoms items were summed and categorized into three groups: zero, 1-2, and 3-5 symptoms. While the cutoffs we used served only as a descriptive indicators, our classification for high depressive symptoms was three or more symptoms, which 14% of the sample experienced. This makes it a more stringent cutoff compared to other reported prevalence estimates evaluated on the Edinburgh Scale for Postpartum Depression in rural Bangladesh [24, 25].

Pregnancy outcomes were categorized into four groups: live birth, stillbirth (fetal loss from 28 weeks gestation to delivery), early neonatal death (0-7 days), late neonatal death (8-28 days) and an “early” post-neonatal death (between 29 to 180 days postpartum). Newborn sex was included as a covariate as were demographic variables: maternal age (≤ 19 , 20-29, ≥ 30), parity (zero vs. ≥ 1), maternal education (0, 1-9yrs vs. ≥ 10 yrs), living standard index in quartiles (1st=low, 2nd, 3rd, vs. 4th=high), religion (non-Muslim vs. Muslim) and number of children ages

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4 ≤ 12 in the household (0, 1, ≥ 2). A living standard index was constructed based on Principal
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6 Component Analysis and included household assets (e.g. toilet facilities, beds, radios) [26].
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9 Maternal nutritional status was evaluated with mid-upper arm circumference (<21.5 vs.
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11 ≥ 21.5) and possible anemia in the first trimester (yes, no) defined as symptoms of breathlessness
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13 at rest resulting in an inability to work, and based on the World Health Organization's definition.
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15 Infection in the first trimester (none versus urinary tract infection, gastroenteritis or both) was
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17 used as a proxy for maternal morbidity during pregnancy.
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23 *Statistical Methods* 24

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26 The analytic sample included women with singleton live births and excluded women with
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28 miscarriages and multiple births. Multiparous women were excluded because we did not have data on sex
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30 for previous stillbirths. We first calculated the proportion of women with zero, 1-2 and 3-5 depressive
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32 symptoms by fetal/infant outcome, socio-demographic characteristics and maternal illness during
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34 pregnancy, using chi-square tests to examine bivariate associations. Analyses were performed with
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36 stillbirth and infant death as predictors of depressive symptoms with livebirths that survived past 180 days
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38 as the reference category. Crude and adjusted relative risk ratios and 95% confidence intervals (CI) were
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40 then computed using multinomial logistic regression models, comparing women with 1-2 and 3-5
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42 depressive symptoms after fetal/infant death to those with no symptoms as the reference category.
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46 In adjusted models, covariates were based on statistically significant results from crude
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48 risk ratios ($p \leq 0.05$); they were maternal age, education, parity, household living standard index,
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50 religion, number of children $\leq$ age 12 years in the household, maternal mid- upper arm
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52 circumference in third trimester, symptoms of anemia and infection in the first trimester. All
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54 models were adjusted for geographical cluster and micronutrient supplementation group.
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Because of very few early post neonatal deaths, we were unable to use multinomial logistic regression to compute relative risk ratios between timing of death and depressive symptoms in stratified models. Therefore, in models stratified (separately) by sex, education, micronutrient status and maternal religion, we treated depressive symptoms as a dichotomous outcome variable (low: 0-2 symptoms versus high: 3-5 symptoms). We performed Wald's t-test to determine if there was a significant interaction ($p < 0.05$) between timing of neonatal death and each of these four variables. We computed adjusted risk ratios using generalized linear models (GLM) with a log-link and Poisson distribution, which approximates the relative risk from a binomial distribution. Because the binomial error structure for GLM failed to converge, we assumed a Poisson distribution and adjusted the standard errors and 95% CIs using the Huber-White robust estimator [27].

Results

In all 60,294 women were identified as pregnant through the study's pregnancy surveillance, out of which 628 (1.04%) did not consent or were lost to follow-up. Of the 59,666 women who were enrolled in the study, 2,566 had missing data on depressive symptoms at 6 months postpartum corresponding to 4.3% loss to follow-up (of which 0.6% were refusals). Finally, after exclusion of an additional 15,762 women having multiple births, miscarriages and incomplete birth outcome information, our final analytic sample of was 41,348 women. (See Figure 1).

The respective percentages of women experiencing a stillbirth, early neonatal, late neonatal and early post-neonatal death (29-180 days) were 5% (N=1914), 4% (N=1550), 1% (N=413), and 1 percent (N=391). The proportions of women reporting zero, 1-2 and 3-5 depressive symptoms were 49.0% (N=20,262), 37.2% (N=15,394) and 13.8% (5,692),

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4 respectively. There was a noticeably higher prevalence of women with depressive symptoms
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6 who experienced a stillbirth or early infant death (0-180 days) than among women with livebirths
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8 (Table 1). Newborn sex and trial status were not related to depressive symptoms.
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11 Women who experienced fetal/infant deaths compared to those who did not experience
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13 these losses, had between 1.2 and 1.7 higher risks of 1 to 2 postpartum depressive symptoms and
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15 between 1.9 and 3.3 higher risks of 3 to 5 postpartum depressive symptoms, relative to women
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17 without fetal/infant deaths (Table 2). Mothers of infants who died in the early post-neonatal
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19 period (Adj RRR=3.33, 95% CI 2.55-4.32) compared to women experiencing stillbirths (Adj
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21 RRR=1.88, 95% CI 1.66-2.13) had somewhat higher risk of experiencing 3 to 5 depressive
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23 symptoms, relative to women with livebirths that survived until 180 days postpartum (Table 2).
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29 Based on stratified models and interaction terms, we found no significant interaction for
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31 the sex of the child with perinatal or infant death (Wald's t-test, $p=0.23$), micronutrient
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33 supplementation ($p=0.72$) and maternal religious affiliation ($p=0.28$) (data not shown). We
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35 observed, however, a significant interaction of maternal education with late neonatal and early
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37 post-neonatal deaths (Wald's t-test, $p<0.001$) based on adjusted analyses stratified by maternal
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39 education (Table 3). Women with ≥ 10 years of education who experienced a late neonatal death,
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41 had a four-fold elevated risk of depressive symptoms (RR=4.02, 95% CI 1.94-8.10), while the
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43 risk of symptoms among women with no education was modestly increased and marginally
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45 statistically significant (RR=1.30, 95% CI 0.98-1.72). Similarly, early post-neonatal deaths were
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47 associated with an eleven-fold risk of depressive symptoms for women with ≥ 10 years of
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49 education (Adj RR=10.59, 95% CI 5.16-21.74), also higher than the two-fold risk observed in
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51 women with no education (RR=1.98, 95% CI 1.63-2.41). Moreover, among women with ≥ 10
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53 years of education, the eleven-fold risk of depressive symptoms associated with early post-
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55 neonatal death was greater than that of women experiencing stillbirth and early neonatal death
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(Adj RR=2.08, 95% CI 1.41-3.07; Adj RR=1.86, 95% CI 1.15-3.01, respectively). No differences in depressive symptoms by maternal education were noted for women who experienced stillbirths and early neonatal deaths.

Discussion

Our study shows an elevated likelihood of depressive symptoms during the six months following a stillbirth or infant death in the first 180 days after birth among women in rural Bangladesh. These findings are important, as the impact of depressive symptoms in this population may be particularly pronounced given the dearth of mental health care services in rural low-resource settings [28], such as our study setting.

Our results suggested a higher magnitude of depressive symptom risk with longer time before the death, when comparing stillbirths to infants dying in the first 7 days and to infants dying in the period from 30 to 180 days postpartum. A three-fold increased risk of high depressive symptoms was found for women experiencing an early post-neonatal infant death between one to three months after the delivery after adjusting for important confounders, relative to women not experiencing fetal/infant death. Prior research suggests that longer time with the child may confer a higher risk of depressive symptoms; for example, Nigerian women with late pregnancy loss were more likely to have depressive symptoms than those with a fetal loss early in pregnancy [8].

A strength of our study was the use of data from a very large cohort including prospectively collected information and surveillance of women throughout pregnancy until six months postpartum, unusual in rural, resource-scarce settings. Due to limited power, it has not been possible for many studies to investigate the separate effects of experiencing a stillbirth or infant death or to study effect modification, both of which we examined in our study. A study limitation was the lack of a validated instrument for measuring depressive symptoms in

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4 Bangladesh at the time of data collection, making it unknown how our cutoff might predict a
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6 depression diagnosis. Nonetheless, the depressive symptoms included in our measure were based
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8 on standard items (e.g. crying all the time, suicidal ideation), and likely reflect depressive
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10 symptomatology on a continuum. Lack of a single validated instrument across studies may also
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12 be one possible explanation for the differences we found relative to other studies in the region,
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14 such as in Matlab. An alternative explanation may be attributable to the small number of women
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16 who experienced a perinatal death in the Matlab studies, and the smaller sample size in general.
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18 We would have liked to compare women with chronic high levels of depressive symptoms versus
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20 depressive symptoms occurring first during pregnancy. However that was not possible, due to our
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22 lack of data on depressive symptoms before pregnancy. Further, we were unable to control for
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24 social support as a potential confounding variable, due to lack of information on support. Finally,
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26 our generalizability is limited to Bangladeshi women who are married, have singleton births, and
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28 live in rural areas.
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36 The observed association between perinatal or infant death and subsequent depressive
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38 symptoms extends prior research in Bangladesh and other developing countries. Gausia et al.
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40 reported a relation between perinatal death and postnatal depression at six to eight weeks follow-
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42 up in the rural sub-district of Matlab [9]; they reported a fourteen-fold higher odds of depressive
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44 symptoms for women with a perinatal death, but the estimate was based on only ten perinatal
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46 deaths [9]. In a later study in Matlab, the same investigators interviewed women experiencing
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48 perinatal deaths (stillbirths and neonatal deaths up to seven days postpartum) and a control group,
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50 assessing depressive symptoms at six months after the loss or birth [10]. No significant
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52 differences between groups were found at six months postpartum [10]. The latter findings for
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54 depressive symptoms among women in Matlab at six months contrast with our findings of an
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56 elevated risk of depressive symptoms during the six months postpartum. Researchers also found
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4 that women experiencing pregnancy loss or perinatal death were at increased risk of depression
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6 measured at three and six months postpartum in two Nigerian studies, respectively [8, 12]. In
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8 Benin, women from tertiary hospitals who experienced a perinatal death reported moderate to
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10 severe depressive symptoms when surveyed four weeks after the death [11].
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14 The sex of the deceased fetus or infants was not related to risk of depressive symptoms in
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16 our study. Although loss at any point predicted elevated symptoms, the risk among women with
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18 higher education was particularly elevated compared to women with lower educational levels
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20 following a late neonatal death. Given that women in the region with higher educational status
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22 tend to desire fewer children and have lower fertility rates [29], economic theory posits a
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24 quantity-quality tradeoff of having a child suggesting that women with higher education may be
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26 more depressed if they experience neonatal loss [30]; that is, if more highly educated women tend
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28 to have fewer children because of the opportunity cost of giving birth, they may invest more in
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30 each child given a smaller family size [31].
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35 Anthropological theory provides a possible explanation for fewer depressive symptoms
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37 among women with lower education levels following a post-neonatal loss. It has been proposed
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39 in low-resource settings with high child mortality and high fertility that grief may be reduced and
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41 anthropomorphisation may not take place until it is clear that the infant is likely to survive [32].
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43 Given that Bangladeshi women with lower education may experience more neonatal and post-
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45 neonatal deaths [33], this phenomenon, if present in Bangladesh, may be more common among
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47 women with less education.
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52 Our results showed increased risk of depressive symptoms following the death of a fetus
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54 and infant, which has significant implications for mental healthcare needs in this setting. Based
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56 on research from developed countries, there may be even longer-term mental health
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58 consequences resulting from these adverse events for mothers, including increased risk of
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hospitalization for psychiatric disorders five years or more following the death [34]. Depressive symptoms are known to be related to sub-optimal caregiving [35], which could affect children from prior and subsequent pregnancies.

Conclusions

Our results suggest that rural Bangladeshi women experiencing stillbirth and neonatal death, and in particular more educated women in this setting, could benefit from mental health initiatives. Despite challenges in mental health service delivery in resource-scarce countries [36], a pooled analysis of 13 trials from LAMI countries on interventions to improve mental health of women in the perinatal period indicated that they were effective overall in reducing depression within the first year postpartum [37]. Positive results of these studies, conducted by non-specialist and community workers, point to possible delivery of psychological interventions by personnel without specific mental health training [37]. Mental health needs of women experiencing stillbirth or death of an infant need to be prioritized along with other perinatal mental health interventions in such low-resource rural settings.

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Table 1. Descriptive characteristics: Pregnancy outcome, socio-demographic characteristics, maternal postpartum illness and postpartum depression at six months

Variable	Number of Depressive Symptoms				p-value
	Zero	1 to 2	3 to 5		
	Total, n (%)	n (%)	n (%)	n (%)	
Pregnancy outcome variables					
Live birth	37,080 (89.68)	18,632 (50.25)	13,679 (36.89)	4,769 (12.86)	<0.001
Stillbirth (28 weeks gestation to delivery)	1,914 (4.63)	812 (42.42)	715 (37.36)	387 (20.22)	
Early neonatal death (0-7 days)	1,550 (3.75)	543 (35.03)	664 (42.84)	343 (22.13)	
Late neonatal death (8-28 days)	413 (1.00)	150 (36.32)	181 (43.83)	82 (19.85)	
Early post neonatal death (29-180 days)	391 (0.95)	125 (31.97)	55 (39.64)	111 (28.39)	
Maternal age (yrs)					
≤ 19	21,294 (51.53)	11,064 (51.96)	7,709 (36.20)	2,521 (11.84)	<0.001
20-29	16,580 (40.12)	7,817 (47.15)	6,306 (38.03)	2,457 (14.82)	
≥ 30	3,451 (8.35)	1,371 (39.73)	1,369 (39.67)	711 (20.60)	
Parity					
Zero	16,477 (39.88)	8,808 (53.46)	5,776 (35.05)	1,893 (11.49)	<0.001
≥ 1	24,835 (60.12)	11,436 (46.05)	9,605 (38.68)	3,794 (15.28)	
Maternal education (yrs)					
No education	19,919 (48.21)	9,218 (46.28)	7,547 (37.89)	3,154 (15.83)	<0.001
1-9	18,359 (44.44)	9,316 (50.74)	6,784 (36.95)	2,259 (12.30)	
≥10	3,038 (7.35)	1,712 (56.35)	1,052 (34.63)	274 (9.02)	
Living standard index					
1st quartile (poor)	10,595 (25.64)	4,918 (46.42)	3,933 (37.12)	1,744 (16.46)	<0.001
2 nd	10,500 (25.41)	4,959 (47.23)	4,023 (38.31)	1,518 (14.46)	

1						
2	3 rd	10,088 (24.42)	4,980 (49.37)	3,812 (37.79)	1,296 (12.85)	
3						
4	4th quartile (rich)	10,134 (24.53)	5,390 (53.19)	3,615 (35.67)	1,129 (11.14)	
5						
6	Religion					
7						
8	Non-Muslim	3,347 (8.10)	1,791 (53.51)	1,155 (34.51)	401 (11.98)	0.002
9						
10	Muslim	37,970 (91.90)	18,456 (48.61)	14,228 (37.47)	5,286 (13.92)	
11						
12	Number of children (0-12yrs) in household					
13						
14	Zero	13,084 (31.72)	6,877 (52.56)	4,607 (35.21)	1,600 (12.23)	<0.001
15						
16	One	15,227 (36.83)	7,605 (49.94)	5,653 (37.12)	1,969 (12.93)	
17						
18	Two or more	13,006 (31.45)	5,765 (44.33)	5,123 (39.39)	2,118 (16.28)	
19						
20	Mid-upper arm circumference (cm)†					
21						
22	< 21.5	11,817 (28.74)	5,648 (47.80)	4,408 (37.30)	1,761 (14.90)	<0.001
23						
24	≥ 21.5	29,302 (71.26)	14,516 (49.54)	10,890 (37.16)	3,896 (13.30)	
25						
26	Anemia†					
27						
28	No	26,739 (64.96)	13,879 (51.91)	9,732 (36.40)	3,128 (11.70)	<0.001
29						
30	Yes	14,426 (35.04)	6,301 (43.68)	5,590 (38.75)	2,535 (17.57)	
31						
32	Infections† (urinary tract infection and					
33	gastroenteritis)					
34						
35						
36	None	36,669 (88.68)	18,299 (49.90)	13,591 (37.06)	4,779 (13.03)	<0.001
37						
38	At least one or both	4,679 (11.32)	1,963 (41.95)	1,803 (38.53)	913 (19.51)	
39						
40	Sex of the child					
41						
42	Male	20,061 (50.87)	9,852 (49.11)	7,495 (37.36)	2,714 (13.53)	0.65
43						
44	Female	19,373 (49.13)	9,598 (49.54)	7,184 (37.08)	2,591 (13.37)	
45						
46	Vitamin Supplementation Group					
47						
48	Beta Carotene	13,863 (33.53)	6,766 (48.81)	5,229 (37.72)	1,868 (13.47)	0.42
49						
50	Vitamin A	13,704 (33.33)	6,798 (49.33)	5,054 (36.67)	1,929 (14.00)	
51						
52	Placebo	13,781 (33.33)	6,698 (48.88)	5,111 (37.30)	1,895 (13.83)	
53						
54						

55 Measured in the first trimester of pregnancy

56 Although the total sample size varied due to some missing observations on some of the variables, the total sample size with no missing information was
57 N=41,348, i.e. 20,262 reported no symptoms; 15,394 1-2 symptoms; and 5,692 reported 3-5 depressive symptoms.

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Table 2. Crude and adjusted relative risk of postpartum depression at six months after birth: Pregnancy outcome, socio-demographic and infant risk factors

	Crude Relative Risk Ratio ^a		Adjusted Relative Risk Ratio ^{a,b}	
	(95% CI)		(95% CI)	
	1-2 symptoms	3-5 symptoms	1-2 symptoms	3-5 symptoms
Pregnancy outcome variables				
Live birth	1.00	1.00	1.00	1.00
Stillbirth (28 weeks gestation to delivery)	1.19 (1.08-1.33)	1.86 (1.64-2.11)	1.22 (1.09-1.35)	1.88 (1.66-2.13)
Early neonatal death (0-7 days)	1.66 (1.48-1.86)	2.47 (2.15-2.84)	1.73 (1.52-1.95)	2.64 (2.29-3.04)
Late neonatal death (8-28 days)	1.64 (1.32-2.04)	2.14 (1.63-2.80)	1.66 (1.33-2.07)	2.14 (1.63-2.83)
Early post neonatal death (29-180 days)	1.69 (1.33-2.14)	3.47 (2.68-4.49)	1.67 (1.32-2.12)	3.33 (2.55-4.32)
Maternal age (yrs)				
≤ 19	1.00	1.00		
20-29	1.16 (1.11-1.21)	1.38 (1.30-1.47)	1.06 (1.00-1.12)	1.16 (1.07-1.26)
≥ 30	1.43 (1.32-1.55)	2.28 (2.06-2.51)	1.25 (1.14-1.37)	1.69 (1.48- 1.88)
Parity				
Zero	1.00	1.00	1.00	1.00
≥ 1	1.11 (1.09-1.12)	1.17 (1.14-1.19)	1.17 (1.08-1.25)	1.17 (1.06-1.31)
Maternal education (yrs)				
No education	0.88 (0.85-0.93)	0.71 (0.67-0.75)	1.15 (1.04-1.26)	0.91 (0.84-0.97)
0-9	0.75 (0.69-0.82)	0.47 (0.41-0.53)	1.14 (1.04-1.24)	0.65 (0.55-0.75)
≥10	1.00	1.00	1.00	1.00
Living standard index				
1st quartile (poor)	1.01 (0.96-1.07)	0.86 (0.80-0.93)	1.06 (0.99-1.13)	0.89 (0.82-0.96)
2 nd	0.96 (0.90-1.02)	0.73 (0.68-0.80)	1.10 (1.02-1.17)	0.81 (0.74-0.88)
3 rd	0.84 (0.79-0.89)	0.60 (0.54-0.64)	1.06 (0.99-1.13)	0.76 (0.68-0.84)
4th quartile (rich)	1.00	1.00	1.00	1.00

Religion

Muslim	1.00	1.00	1.00	1.00
Non-Muslim	0.84 (0.77-0.90)	0.78 (0.70-0.87)	0.85 (0.79-0.92)	0.81 (0.72-0.91)
Number of children (0-12yrs) in household				
Zero	1.00	1.00	1.00	1.00
One	1.11 (1.05-1.17)	1.11 (1.03-1.20)	0.98 (0.93-1.05)	0.90 (0.82-1.00)
Two or more	1.33 (1.26-1.40)	1.60 (1.47-1.70)	1.13 (1.06-1.22)	1.13 (1.02-1.26)
Mid-upper arm circumference^b (cm)				
< 21.5	0.96 (0.92-1.01)	0.86 (0.81-0.92)	1.01 (0.96-1.06)	0.97 (0.911-1.04)
≥ 21.5	1.00	1.00	1.00	1.00
Anemia^c				
No	1.00	1.00	1.00	1.00
Yes	1.27 (1.21-1.32)	1.79 (1.68-1.90)	1.207 (1.15-1.26)	1.59 (1.50-1.69)
Infections (urinary tract infection and gastroenteritis)^b				
None	1.00	1.00	1.00	1.00
At least one or both	1.24 (1.16-1.32)	1.78 (1.64-1.94)	1.17 (1.10-1.25)	1.59 (1.46-1.74)
Sex of the child				
Male	0.98 (0.94-1.03)	0.98 (0.92-1.04)	--	--
Female	1.00	1.00	--	--
Vitamin Supplementation Group				
Beta Carotene	0.96 (0.91-1.02)	0.97 (0.91-1.03)	0.96 (0.911-1.02)	1.02 (0.95-1.10)
Vitamin A	0.99 (0.93-1.05)	0.99 (0.93-1.05)	0.98 (0.93-1.04)	1.02 (0.94-1.09)
Placebo	1.00	1.00	1.00	1.00

^a Women with no symptoms of depression was the reference group

^b Analyses adjust for maternal age, parity, maternal education, living standard index, religion, number of children (0-12yrs) in the household, mid upper arm circumference at third trimester, anemia during pregnancy, infection, vitamin supplementation group, and village cluster. Given child sex was not significant in bivariate analyses and did not have data on sex for stillbirths, it is not included in the multivariate analyses. In the adjusted model the total sample size was N=41,087. The number of missing values per variable was as follows: maternal age=23, maternal education =32, religion=31, living standard index=31, number of children (0-12) in household =31, and maternal upper arm circumference=229.

^c Measured in the first trimester of pregnancy.

Table 3: Adjusted associations between neonatal death and high postpartum depressive symptoms at 6 months among Bangladeshi women with single births, stratified by maternal educational status.

Pregnancy outcome	Years of education		
	Zero	1-9	≥10
	Relative Risk	Relative Risk	Relative Risk
	(95% CI)	(95% CI)	(95% CI)
	of high depressive symptoms	of high depressive symptoms	of high depressive symptoms
Live birth	1.00	1.00	1.00
Stillbirth (28 weeks gestation to delivery)	1.49 (1.33-1.69)	1.60 (1.37-1.87)	2.08 (1.41-3.07)
Early neonatal death (0-7 days)	1.57 (1.36-1.80)	2.02 (1.76-2.33)	1.86 (1.15-3.01)
Late neonatal death (8-28 days)	1.30 (0.98-1.72)	1.76 (1.31-2.37)	4.02 (1.94-8.10)
Early post neonatal death (29-180 days)	1.98 (1.63-2.41)	2.20 (1.64-2.94)	10.59 (5.16-21.74)

Analyses are adjust for maternal age, parity, living standard index, religion, number of children (0-12 yrs) in the household, mid upper arm circumference at third trimester, anemia during pregnancy, infection, vitamin supplementation group, and village cluster. The p-value for the interaction is <0.0001. The total sample size for this analysis was 41,087, corresponding to 19,799, 18,265, and 3,023 participants with zero, 1-9, and ≥ 10 years of education, respectively. Risk of high depressive symptoms (3-5 symptoms) we assessed in relation to the reference group of low symptoms (0-2).

Figure 1. Study Flow Diagram