Maternal depressive symptoms and infant growth in rural Bangladesh

Maureen M Black, Abdullah H Baqui, K Zaman, Shams El Arifeen, and Robert E Black

ABSTRACT
Background: Depressive disorders are a major source of disability among low-income mothers in developing countries.
Objectives: The objectives were to examine the association of maternal depressive symptoms and infant growth among infants in rural Bangladesh and to examine how the relation is affected by infant irritability and caregiving practices.
Design: Infant growth was measured among 221 infants at 6 and 12 mo. Mothers reported their depressive symptoms and perceptions of their infant’s temperament, and a home observation of caregiving was conducted.
Results: At 6 mo, 18% of infants were stunted (length-for-age < −2 z scores). At 12 mo, 36.9% of infants were stunted; infants of mothers with depressive symptoms had a 2.17 higher odds of being stunted (95% CI: 1.24, 3.81; P = 0.007) than did infants of mothers with few symptoms (45.3% compared with 27.6%). In a multivariate regression analysis, maternal depressive symptoms were associated with 12-mo length-for-age, adjusted for 6-mo length-for-age, maternal education, infant sex, birth order, receipt of iron and zinc, months breastfed, maternal perception of infant temperament, and caregiving observations. Maternal depressive symptoms were not related to 12-mo weight-for-length. The relation between depressive symptoms and infant growth was not moderated by maternal perceptions of infant temperament, but was partially mediated by caregiving.
Conclusions: The finding that infants of mothers with depressive symptoms in Bangladesh experience poor linear growth may extend to other low-income countries with high rates of food insecurity. Interventions to promote growth in infants should include prevention or treatment of maternal depressive disorders and strategies to ensure adequate food security. Am J Clin Nutr 2009;89(suppl):951S–7S.

MATERIAL DEPRESSIVE SYMPTOMS AND INFANT GROWTH IN RURAL BANGLADESH

Maternal depressive disorders are a principal source of disability worldwide, particularly among women in low-income countries (1–3). The societal burden of maternal depressive disorders extends beyond women to the next generation by increasing the risk of problems related to growth and development among infants of depressed mothers (4–6). Infants are particularly vulnerable because they are completely dependent on their caregivers, and their nutritional demands are high to support their rapid growth and development. Not only do infants triple their birth weight by 12 mo of age but they experience rapid brain growth as they acquire specific skills that guide their early development. Infants who experience growth faltering early in life that is severe or prolonged enough to cause stunting (length-for-age < −2 z scores) are at risk of lasting cognitive and academic deficits (7, 8).

Despite the vulnerability that occurs during infancy, the evidence linking maternal depressive symptoms with infant growth is mixed. Studies from India (9–11), Pakistan (12, 13), Vietnam (10), Brazil (14, 15), and Nigeria (16) have shown worse growth among infants of mothers with depressive symptoms than in infants of mothers with few symptoms. In contrast, studies from South Africa (17), Peru (10), Ethiopia (10), and Jamaica (18) have shown no significant differences in infant growth related to maternal depressive symptoms. Comparisons across studies are difficult because the studies varied in design; only 4 of the 13 studies were longitudinal, several studies either did not adjust for potential confounders or had minimal adjustment, and there was limited attention to the potential mechanisms linking maternal depressive symptoms with poor infant growth.

The current investigation was conducted in a low-income, rural community in Bangladesh with relatively high rates of maternal depressive symptoms. In an earlier investigation, we found that depressive symptoms were related to poverty and to social and environmental conditions, such as low education, and that there was synergy between maternal depressive symptoms and mothers’ perceptions of their infant as irritable. When both conditions existed, infants experienced delayed cognitive development from 6 to 12 mo, which was partially explained by a lack of responsive stimulation in the home (19). In the current investigation we examined whether the relations we found between maternal depressive symptoms and infant development extended to infant growth. We tested 3 hypotheses. First, we

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examined whether infants of mothers with depressive symptoms experienced slower growth from 6 to 12 mo than did infants of mothers with few depressive symptoms. Second, we examined whether infants of mothers who reported both depressive symptoms and infant irritability experienced worse growth from 6 to 12 mo than did infants of mothers who reported neither or only one condition. Finally, we examined whether caregiving practices observed in the home mediated the relation between maternal depressive symptoms and infant growth.

SUBJECTS AND METHODS

Participants

The participants were a subset from a 6-mo, double-blinded, randomized, controlled trial of micronutrient supplementation conducted among infants in the Matlab field research area of the International Centre for Diarrheal Disease Research, Bangladesh (ICDDR,B) (20, 21). Most villages had limited access to electricity, safe water, and sanitary waste disposal; most houses had 1 or 2 rooms with external water, cooking facilities, and latrines.

Procedures

The procedures were approved by the ethical review boards of the ICDDR,B and the University of Maryland, Baltimore. On the basis of demographic information from a Health and Demographic Surveillance System, potentially eligible infants were identified and informed consent was obtained from parents. Research assistants collected socioeconomic and demographic data and measured the infants’ weight, length, arm circumference, and hemoglobin concentration. Infants were eligible if they were 6 mo of age, were breastfed, were not severely malnourished or anemic (midupper arm circumference ≥110 mm and hemoglobin ≥90.0 g/L), and had no obvious neurological disorders, physical disabilities, or chronic illnesses. A subset of families was selected by inviting every alternate family to participate in a substudy; 43 families refused and 28 families were absent, which left a sample of 346 families (Figure 1). Infants were randomly assigned to a 5-cell micronutrient supplementation trial, and supplements were given weekly by fieldworkers from 6 to 12 mo (20, 21).

Anthropometric data were collected when the infants were 6 and 12 mo of age, and the data were converted to length-for-age and weight-for-length z scores using World Health Organization references (22). At 12 mo, questionnaires on maternal depressive symptoms and infant temperament were administered to mothers orally in Bengali. A trained examiner conducted a 40-min home visit to score the Home Inventory (23). There were 125 families (36%) who did not complete the 12-mo assessment, which left a final sample of 221. Attrition did not vary by supplementation group, sex, maternal education, or anthropometric data.

Measures

Maternal depressive symptoms were measured by using the 20-item Center for Epidemiologic Studies–Depression Scale (CES-D) (24), which addresses 6 aspects of depression: depressed mood, guilt/worthlessness, helplessness/hopelessness, lethargy/fatigue, loss of appetite, and sleep disturbance. Respondents rate the frequency of symptoms from 0 (‘‘rarely or never’’) to 3 (‘‘most or all the time’’). Higher summed scores indicate more symptoms. The clinical cutoff of 16 was used in descriptive analyses, but because the cutoff has not been validated in Bangladesh, we used the CES-D as a continuous variable to test hypotheses. The internal consistency, measured by coefficient alpha, was 0.94.

Maternal perception of infant temperament was measured by adapting items from the Infant Characteristics Questionnaire (25) and the Toddler Behavior Assessment Questionnaire (26) that represented irritability, such as time crying and soothing difficulty. The language was changed to reflect the local environment and education of the mothers. To simplify response choices, the 7-point scales were shortened to 4 points, ranging from 0 “never” to 3 “all the time”. The items were factor analyzed, and one 9-item factor was extracted representing irritability and accounting for 69% of the variance. Scores for the irritability factor were standardized into z scores; low scores reflected high irritability and high scores reflected low irritability, referred to

FIGURE 1. Sample selection. MUAC, midupper arm circumference; Hb, hemoglobin.
throughout the analysis. An early version of the scale administered to mothers of infants in a low-income community in India yielded adequate test-retest reliability ($r = 0.68, P < 0.001$) and internal consistency (coefficient $\alpha = 0.79$) (27). Poverty was defined by household income divided by household size; low scores indicated a higher level of poverty. Breastfeeding duration, based on maternal report, was the months of exclusive breastfeeding. Stimulation and support in the home were measured by using the Home Inventory, an observation scale that has been widely used in international child development research and has shown a strong relation with subsequent intellectual and achievement scores (23, 28). In collaboration with an anthropologist, we adapted and tested the Home Inventory to ensure that items were culturally appropriate. Training and interrater reliability were conducted to ensure agreement.

### Analysis plan

We conducted 3 descriptive analyses before hypothesis testing. First, we used repeated-measures analysis of variance to examine changes from 6 to 12 mo in length-for-age and weight-for-length between infants of mothers who reported depressive symptoms above and below the clinical range (CES-D $> 16$ compared with CES-D $\leq 16$) at 12 mo (Table 1). Second, we conducted a logistic regression analysis to describe rates of stunting at 12 mo. Finally, we conducted a correlation matrix among the variables of interest: maternal depressive symptoms, infant anthropometric data at 6 and 12 mo, Home Inventory score, maternal perception of infant temperament, maternal education, and poverty (Table 2). All analyses were conducted with SPSS version 16.0 (SPSS Inc, Chicago, IL).

To test the first hypothesis that maternal depressive symptoms were related to poor infant growth from 6 to 12 mo, we used multivariate regression analyses to examine length-for-age and weight-for-length z scores at 12 mo, controlling for 6-mo scores and for covariates associated with depressive symptoms or growth, including maternal education, poverty status, infant sex, birth order, receipt of zinc or iron supplements, Home Inventory score, maternal perception of infant temperament, and months breastfed. To test the second hypothesis, that the relation between maternal depressive symptoms and infant growth varies by maternal perception of infant temperament, we reran the regression analysis including the interaction between depressive symptoms and maternal perception of infant temperament. To test the final hypothesis, that the relation between maternal depressive symptoms and infant growth is mediated by the home environment, we conducted a stepwise regression analysis to examine whether the relation between maternal depressive symptoms and infant growth was attenuated by the introduction of the Home Inventory score into the model (29).

### RESULTS

At enrollment the mean ($\pm$ SD) maternal age was 28.1 $\pm$ 5.8 y. Most mothers were married (98.2%), and 48.6% had $< 5$ y of schooling. The mean household size was 6.4, and 72.5% of the children had older siblings. Eighteen percent of the infants were stunted (length-for-age $< -2$ z scores), and more than two-thirds (68%) were mildly anemic (hemoglobin $< 110.0$ g/L).

There were no differences in the infants’ length-for-age or weight-for-length at 6 mo based on their mothers’ depression status at 12 mo (Table 1). The infants’ relative position on both indexes worsened significantly over time. At 12 mo, there was a significant depression-by-time effect on length-for-age, which indicated worse growth for infants of mothers with depressive symptoms (Table 1). By 12 mo, 36.9% of the infants were stunted. Infants of mothers with depressive symptoms had a 2.17 higher odds of being stunted (95% CI: 1.24, 3.81; $P = 0.007$) than did infants of mothers with few symptoms (45.3% compared with 27.6%).

The correlation matrix showed that maternal depressive symptoms were significantly related to length-for-age at 12 mo ($r = -0.13, P = 0.05$), but not to other anthropometric indexes at 6 or 12 mo (Table 2). Both depressive symptoms and length-for-age at 12 mo were related to the Home Inventory score, infant temperament, maternal education, and poverty—all in the expected direction, which indicated better growth for infants in stimulating homes, with easygoing temperaments, with better-educated mothers, and with lower rates of poverty. There were no differences in breastfeeding duration or mother-reported birth size by depressive symptoms. Weight-for-length at 12 mo was positively related to infant temperament, maternal education, and poverty, but not to the Home Inventory score.

The first hypothesis, that maternal depressive symptoms are associated with poor infant growth, was supported for change in length-for-age from 6 to 12 mo. In a multivariate regression analysis adjusting for 6-mo length-for-age, maternal depressive symptoms predicted 12-mo length-for-age (Table 3, model 1).

### TABLE 2

<table>
<thead>
<tr>
<th>Anthropometric data</th>
<th>6 mo</th>
<th>12 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nondepressed $^2$</td>
<td>Depressed $^2$</td>
</tr>
<tr>
<td>Length-for-age $z$ score $^4$</td>
<td>$-1.20 \pm 0.77$</td>
<td>$-1.23 \pm 0.83$</td>
</tr>
<tr>
<td>Weight-for-length $z$ score $^3$</td>
<td>0.06 $\pm$ 0.79</td>
<td>0.06 $\pm$ 0.92</td>
</tr>
</tbody>
</table>

$^1$ There were no significant differences in length-for-age or weight-for-length z scores at 6 mo.

$^2$ Defined as a Center for Epidemiologic Studies–Depression Scale score $< 16$.

$^3$ Defined as a Center for Epidemiologic Studies–Depression Scale score $\geq 16$.

$^4$ $P = 0.001$ for overall decline from 6 to 12 mo (repeated-measures ANOVA).

$^5$ Mean $\pm$ SD (all such values).

$^6$ Comparison with children of nondepressed mothers at the same time point, $P = 0.001$ (repeated-measures ANOVA).
The association remained significant after the covariates were introduced (Table 3, model 3). Maternal education was the only covariate that was a significant predictor of 12-mo length-for-age.

The first hypothesis was not supported for weight-for-length. In a multivariate regression analysis that adjusted for 6-mo weight-for-length, maternal depressive symptoms did not predict 12-mo weight-for-length (Table 3). When the covariates were introduced, there were no significant predictors beyond weight-for-length at 6 mo.

The second hypothesis, that the relation between maternal depressive symptoms and infant growth is moderated by perceptions of infant temperament, was not supported. The interaction of depression by infant temperament did not account for significant variance in the prediction of either length-for-age or weight-for-length at 12 mo.

The third hypothesis, that the relation between maternal depressive symptoms and infant growth is mediated by the home environment, was partially supported. The first 2 criteria for mediation were met (30): 1) the home environment was related to both maternal depressive symptoms and to 12-mo length-for-age and 2) when the home environment was included in the model, the relation between maternal depressive symptoms and infant growth was attenuated. However, after introduction of the covariates into the model, particularly maternal education, the home environment was not a significant predictor of 12-mo length-for-age.

DISCUSSION

Children of mothers with depressive symptoms experienced poor linear growth from 6 to 12 mo of age. At 6 mo, there were no differences in infant weight or length related to maternal depressive symptoms. However, from 6 to 12 mo, infants of mothers with depressive symptoms experienced linear growth faltering severely or chronically enough to cause stunting. By 12 mo, almost one-half the infants (45%) of mothers with depressive symptoms were stunted, as opposed to just more than one-quarter (27%) of the infants of mothers with few depressive symptoms.

By 12 mo, infants are typically consuming the family diet and learning to self-feed, but they require substantial feeding

| Table 2 |
| Pearson’s correlation coefficients among maternal depressive symptoms, infant anthropometric data at 6 and 12 mo, Home Inventory score, infant temperament, maternal education, and socioeconomic status

<table>
<thead>
<tr>
<th>Maternal depressive symptoms</th>
<th>Length-for-age 6 mo</th>
<th>Length-for-age 12 mo</th>
<th>Weight-for-length 6 mo</th>
<th>Weight-for-length 12 mo</th>
<th>Home Inventory score</th>
<th>Infant temperament</th>
<th>Maternal education</th>
<th>Socioeconomic status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length-for-age at 6 mo</td>
<td>−0.13²</td>
<td>0.79⁴</td>
<td>0.05</td>
<td>0.17³</td>
<td>0.02</td>
<td>0.06</td>
<td>0.54⁴</td>
<td>0.13²</td>
</tr>
<tr>
<td>Length-for-age at 12 mo</td>
<td>−0.05</td>
<td>0.001</td>
<td>0.06</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Weight-for-length at 6 mo</td>
<td>−0.10</td>
<td>0.01</td>
<td>0.02</td>
<td>0.17³</td>
<td>0.001</td>
<td>0.01</td>
<td>0.18⁴</td>
<td>0.19⁴</td>
</tr>
<tr>
<td>Weight-for-length at 12 mo</td>
<td>−0.21⁴</td>
<td>0.20⁴</td>
<td>0.24⁴</td>
<td>0.04</td>
<td>0.05</td>
<td>0.18⁴</td>
<td>0.19⁴</td>
<td>0.10</td>
</tr>
<tr>
<td>Home Inventory score</td>
<td>−0.23⁴</td>
<td>0.05</td>
<td>0.13²</td>
<td>0.10</td>
<td>0.18⁴</td>
<td>0.43³</td>
<td>0.15²</td>
<td>0.41³</td>
</tr>
<tr>
<td>Infant temperament</td>
<td>−0.22⁴</td>
<td>0.19⁴</td>
<td>0.26⁴</td>
<td>0.17</td>
<td>0.17³</td>
<td>0.43³</td>
<td>0.15²</td>
<td>0.41³</td>
</tr>
<tr>
<td>Maternal education</td>
<td>−0.22⁴</td>
<td>0.19⁴</td>
<td>0.26⁴</td>
<td>0.17</td>
<td>0.17³</td>
<td>0.43³</td>
<td>0.15²</td>
<td>0.41³</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>−0.13²</td>
<td>0.26³</td>
<td>0.18⁴</td>
<td>0.02</td>
<td>0.14²</td>
<td>0.36³</td>
<td>0.10</td>
<td>0.41³</td>
</tr>
</tbody>
</table>

³ n = 221. Adjusted for maternal education, infant sex, birth order, receipt of iron and zinc, and months breastfed.
Maternal depressive symptoms and infant growth occurs in the first year of life, when both their dependency and nutritional needs are high. Depressive symptoms were relatively common among rural Bangladeshi mothers of infants. Consistent with previous reports (39–44), mothers with depressive symptoms were the most impoverished in the sample and had multiple environmental risks, including low income and low education levels.

In low-income societies, such as Bangladesh, food insecurity, defined as limited or uncertain availability of enough food for an active and healthy life (45), is high (46, 47). The US Agency for International Development estimates that approximately one-half of Bangladesh’s 140 million inhabitants are below the poverty line and are food-insecure (48). Food insecurity can interfere with feeding practices. For example, one study found that food-secure families in Bangladesh were more likely to provide age-appropriate feeding practices (eg, provide semisolids foods) in the second 6 mo of life than were less food-secure families (49).

In addition to inadequate food, food insecurity has been associated with depressive symptoms in low-income countries such as Tanzania and Ethiopia (50, 51) and in high-income countries such as the United States (52, 53). The situational aspects of the relation between food insecurity and depression were shown in a recent study in which seasonal changes in food insecurity predicted corresponding changes in symptoms of maternal anxiety and depression (51). Seasonal variation in the availability of food is common (46). Indeed, in Bangladesh, rates of low birth weight are highest during seasons when food supplies are limited (55). Thus, maternal depressive symptoms may at least partially reflect the instability that occurs when families do not have enough food to feed their children (51).

Methodologic considerations

Several methodologic issues should be considered when interpreting these data. First, our interpretation suggests that mothers with depressive symptoms at 12 mo experienced mood disorders earlier in their parenting (4). Although data from India (39, 42) and Pakistan (56) have shown stability of maternal depressive symptoms during early parenting, we have no evidence regarding the stability of depressive symptoms among mothers in Bangladesh. Second, although the relation between maternal depressive symptoms and linear growth was significant, the effects were small, which suggests that multiple factors influence early growth. We adjusted for multiple personal and environmental factors, but we did not control for possible differences in maternal health, nutritional status, or life events—factors known to affect mother-child interactions (57) and possibly early growth. Finally, the time sequence of the measurements limited our ability to draw inferences beyond associations. It is plausible that mothers may have reacted to their infants’ poor linear growth with symptoms of depression.

Implications for programs and policy

The relatively high prevalence of depressive symptoms among women in Bangladesh and the poor growth among their infants indicates that the global burden of disease associated with maternal depressive disorders extends to the next generation. These data contribute to the evidence that the association between maternal depressive symptoms and infant growth occurs in the...
context of extreme poverty (58), probably exacerbated by food insecurity (51).

Evidence from the current study in combination with other data linking symptoms of maternal depressive disorders with infant growth and development suggest that a multilevel approach is needed to ensure the health and well-being of infants in low-income countries (1, 59). Families need consistent access to adequate food, thereby reducing the anxiety and depression associated with food insecurity. Women need education, opportunities, and support for their roles as society members and mothers, including screening and treatment of depressive disorders. Infants and young children need integrated programs that include nutrition and early child development. Although successful interventions exist at each level (1, 59), investments have been slow and few integrated programs exist. However, the evidence from existing intervention trials designed to promote early mother-child interaction is encouraging and may serve as a model for interrupting the intergenerational consequences associated with maternal depressive disorders (59). (Other articles in this supplement to the Journal include references 60–65.)

The authors’ responsibilities were as follows—MMB: analyzed the data and drafted the manuscript; AHB: secured the funds, oversaw the entire study, and contributed to the design; KZ and SEA: supervised the data collection; and REB: assisted in securing the funds and contributed to the design. All authors made contributions to the manuscript and approved the final draft.

None of the authors had a conflict of interest.

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