Duration of Exclusive Breast-Feeding and Infant Iron and Zinc Status in Rural Bangladesh1,2

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Abstract

There is a concern that exclusive breast-feeding (EBF) for 6 mo may lead to iron and zinc deficiency in low-birth weight (LBW) infants. We assessed the association between duration of EBF and infant iron and zinc status in the Maternal and Infant Nutrition Interventions in Matlab trial, Bangladesh, stratified for normal birth weight (NBW) and LBW. Duration of EBF was classified into EBF <4 mo and EBF 4–6 mo based on monthly recalls of foods introduced to the infant. Blood samples collected at 6 mo were analyzed for plasma zinc (n = 1032), plasma ferritin (n = 1040), and hemoglobin (Hb) (n = 791). Infants EBF 4–6 mo had a higher mean plasma zinc concentration (9.9 ± 2.3 μmol/L) than infants EBF <4mo (9.5 ± 2.0 μmol/L) (P < 0.01). This association was apparent in only the NBW strata and was not reflected in a lower prevalence of zinc deficiency. Duration of EBF was not associated with concentration of plasma ferritin, Hb concentration, or prevalence of iron deficiency or anemia in any strata. Regardless of EBF duration, the prevalence of zinc deficiency, iron deficiency, and anemia was high in infants in this population and strategies to prevent deficiency are needed. J. Nutr. 139: 1562–1567, 2009.

Introduction

Exclusive breast-feeding (EBF)6 has numerous beneficial effects on infant health and is the recommended feeding mode for infants during the first 6 mo (1). Up to that age, the mean intake of breast milk is adequate to meet the requirements of energy and protein (2,3). The amount of iron and zinc in breast milk is generally regarded as sufficient to cover the increasing iron and zinc demands of most infants up to 6 mo of age. However, this is not well investigated where stores of iron and zinc may be compromised at birth, e.g. in infants with low birth weight (LBW) who are born with low stores of iron and zinc (4). Even in infants with birth weight >2500 g, there is a higher risk for iron deficiency in the lower end of birth weights (5). Whereas a higher risk for anemia with longer duration of EBF has been reported (6), higher concentrations of hemoglobin (Hb) in EBF infants than in infants receiving complementary foods have also been observed (7).

Iron and zinc are important for growth and normal development of the infant. Iron deficiency in infancy is associated with delayed motor development and neurological damage (8). Adequate zinc status in infancy is crucial for the development of a well-functioning immune system (9). Due to the high prevalence of maternal micronutrient deficiencies, LBW, and diarrheal disease, infants in rural Bangladesh have a high risk for iron and zinc deficiency at 6 mo.

The randomized, community-based trial Maternal and Infant Nutrition Interventions in Matlab, (MINIMat; ISRCTN16581394) in Bangladesh provided an opportunity to assess infant iron and zinc status and breast-feeding practices in a context of high prevalence of maternal malnutrition and LBW. The aim of this analysis was to investigate the relation between duration of EBF and iron and zinc status in infancy.

Methods

Subjects. We used data from the MINIMat trial conducted in Matlab in rural Bangladesh, where community health research workers from the International Centre for Diarrheal Disease Research, Bangladesh (ICDDR,B) visit households monthly to collect health and demographic data. When ICDDR,B staff identified a pregnant woman and a test confirmed the pregnancy, they invited her to participate in the MINIMat study. Women who wanted to participate after being informed about the study gave their written consent. The ethical review board of ICDDR,B, 0022-3166/08 $8.00 © 2009 American Society for Nutrition.


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exclusive breast-feeding and infant iron and zinc
between the EBF duration categories. In our study sample, 94% (982/1041) of the women were interviewed at least 4 times about infant feeding practices and this did not differ between EBF duration categories. All infants in the study were given breast milk and <1% (8/1041) were not breast-feeding at 6 mo. Moreover, 84% (873/1041) had ever been EBF and 7.0% (73/1041) were EBF for 180 d or more.

The plasma concentration of zinc was higher in infants EBF for 4–6 mo than in those with a shorter duration of EBF in both the total sample as well as in the strata of NBW infants (Table 2). Analysis with EBF duration as a continuous variable confirmed the small but significant association with infants’ plasma zinc concentration. There was no association between duration of EBF as a continuous or categorical variable and concentrations of plasma ferritin or Hb. In LBW infants, there was no association between EBF duration categories and concentrations of plasma zinc, plasma ferritin, or Hb (Table 2).

Duration of EBF was not associated with the prevalence of zinc or iron deficiencies or anemia (Table 3). We also used the WHO cutoffs to define iron deficiency: plasma ferritin < 12 μg/L and anemia: Hb < 110 g/L. When we applied these cutoffs, 28% of infants were iron deficient and 67% were anemic. Among NBW infants, 23% were iron deficient and 64% were anemic. In the LBW strata, 39% of infants were iron deficient and 77% were anemic. There was no association between duration of EBF and iron deficiency or anemia when these were defined by WHO criteria in any of the strata. Duration of EBF was not associated with concentration of plasma ferritin, Hb concentration, risk for iron deficiency, or risk for anemia.

The positive association between a longer EBF duration and infant zinc status could be due to higher intake of zinc from breast milk than from other foods or reduced morbidity. Zinc intake from breast milk exceeded that from complementary foods in 6- to 8-mo-old infants in Matlab, but the total intake of zinc fell below one-half of the recommended intake for infants of that age (21). The possibility that addition of complementary foods could reduce bioavailability of zinc from breast milk has been investigated (22–24). Studies differ in method and type of foods introduced, making it difficult to draw a general conclusion. Similar to a study in Honduras (25), plasma zinc concentration did not differ between EBF LBW infants and LBW infants receiving complementary foods. Although plasma zinc is often the best available biomarker for studying zinc status in children in low-income countries (26), it is insensitive and the prevalence of zinc deficiency may be even higher than reported here. The fact that we did not observe a reduction in the high rates of zinc deficiency with a longer duration of EBF suggests a limited public health importance of the small increase in plasma zinc associated with a longer duration of EBF.

The outcome of a comparison of iron status of EBF infants with infants who received replacement foods depends on the iron content of these foods. Several studies, although different in design, indicate that a longer duration of EBF or predominant
The lack of agreement between our result and findings from other studies could be due to differences in socioeconomic conditions and infant feeding practices between the different study settings.

Although we had data to determine the external validity of our findings, the generalizability was affected by the fact that this study was part of a maternal micronutrient supplementation trial. There were high rates of refusal of the infant blood samples, but because there were only small differences between women who allowed blood sampling and those who did not, the impact on external validity was probably low. The micronutrient intervention in MINIMAT assured that all women in the study settings.

### Table 2

<table>
<thead>
<tr>
<th>Duration of EBF, mo</th>
<th>Plasma zinc, μmol/L</th>
<th>Plasma ferritin, μg/L</th>
<th>Hb, g/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>(407) 9.5 ± 2.0</td>
<td>(501) 32.0 ± 33</td>
<td>(387) 105 ± 10</td>
</tr>
<tr>
<td>NBW</td>
<td>(350) 9.6 ± 2.0</td>
<td>(351) 34.9 ± 35</td>
<td>(284) 106 ± 10</td>
</tr>
<tr>
<td>LBW</td>
<td>(380) 10.1 ± 2.3</td>
<td>(382) 35.9 ± 32</td>
<td>(300) 107 ± 12</td>
</tr>
</tbody>
</table>

Values are (n) means ± SD. Analyses with univariate general linear model adjusted for allocation of mother to EBF counseling and food and micronutrient interventions.

### Table 3

<table>
<thead>
<tr>
<th>Duration of EBF, mo</th>
<th>Zinc deficiency¹</th>
<th>Iron deficiency²</th>
<th>Anemia³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%) OR (95% CI)</td>
<td>n (%) OR (95% CI)</td>
<td>n (%) OR (95% CI)</td>
</tr>
<tr>
<td>All</td>
<td>1032</td>
<td>1040</td>
<td>791</td>
</tr>
<tr>
<td>&lt;4</td>
<td>286 (67.7)</td>
<td>1.00</td>
<td>108 (21.6)</td>
</tr>
<tr>
<td>4–6</td>
<td>303 (56.6)</td>
<td>0.97 (0.75, 1.3)</td>
<td>106 (19.7)</td>
</tr>
<tr>
<td>NBW</td>
<td>730</td>
<td>733</td>
<td>584</td>
</tr>
<tr>
<td>&lt;4</td>
<td>194 (55.4)</td>
<td>1.00</td>
<td>66 (18.8)</td>
</tr>
<tr>
<td>4–6</td>
<td>205 (54.2)</td>
<td>0.94 (0.70, 1.3)</td>
<td>54 (14.1)</td>
</tr>
<tr>
<td>LBW</td>
<td>302</td>
<td>307</td>
<td>207</td>
</tr>
<tr>
<td>&lt;4</td>
<td>92 (62.6)</td>
<td>1.00</td>
<td>42 (28.0)</td>
</tr>
<tr>
<td>4–6</td>
<td>97 (62.6)</td>
<td>1.08 (0.65, 1.8)</td>
<td>52 (33.1)</td>
</tr>
</tbody>
</table>

1 Values are (n) means ± SD. Analyses with logistic regression, adjusted for allocation of mother to EBF counseling and food and micronutrient interventions.

2 Plasma zinc < 9.9 μmol/L.

3 Plasma ferritin < 9 μg/L.

4 Hb < 10 g/L.
study were given iron supplements of at least 30 mg iron/d during pregnancy and until 3 mo postpartum. Some women also received zinc. The concentrations of iron and zinc in breast milk are independent of maternal intake or status of iron and zinc (36). Breast milk iron levels can be decreased in severely anemic women (37). Whereas levels of iron and zinc in breast milk are unlikely to be affected by the supplementation, the iron and zinc status of infants at birth is expected to be higher in this population. It is possible that the impact of duration of EBF on iron and zinc status would be different in settings with no or low coverage of prenatal supplementation.

The high rates of anemia, zinc deficiency, and iron deficiency imply that infants in our study population were at high risk for deficiencies even if EBF up to the recommended duration of 6 mo. Introduction of non-breastmilk foods, which are likely to be low in both iron and zinc, before 4–6 mo did not reduce the prevalence of anemia, iron deficiency, and zinc deficiency. We cannot determine from this study whether this would have been different with the introduction of higher quality complementary foods, fortified foods, or supplements before 6 mo of age.

Breast-feeding is widely practiced in Matlab and EBF should be encouraged to 6 mo. However, because duration of EBF explains only a small part of plasma zinc, plasma ferritin, and Hb concentrations at 6 mo, promotion of EBF is not sufficient to reduce the high rates of micronutrient deficiencies. Supplementation targeted at infants at risk is probably needed to reduce the prevalence of deficiencies in this population. It is reported that LBW infants receiving supplements together with EBF have adequate iron status (25) and iron supplements are recommended for all infants in this group (20). There are many unresolved issues concerning supplementation of NBW infants with iron, as there are reports of reduced growth and increased morbidity when iron-replete children are supplemented with iron (38). However, a recent study found no adverse effects of preventive iron supplementation in infancy (39). Zinc supplements reduce mortality (40) and morbidity (41,42) in LBW infants. Whereas there are recommendations for zinc supplementation therapy for diarrhea (43), we are not aware of any general recommendations on zinc supplementation for infants. Besides supplementation, measures to increase iron and zinc status at birth could, together with appropriate infant feeding, prevent deficiency of iron and zinc in infancy.

**Literature Cited**