

Effectiveness of a Lipid-Based Nutrient Supplement Intervention in Bangladesh: Pregnancy and Birth Outcomes

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Research on improving maternal nutrition via provision of nutrient or food supplements during pregnancy has focused mainly on iron and folic acid (IFA), multiple micronutrients, or balanced energy-protein supplementation. However, a new approach being used in the fight against malnutrition is the provision of lipid-based nutrient supplements (LNS), which provide micronutrients and some key macronutrients, including essential fatty acids, for enriching home-based foods for pregnant and lactating women and their children. To evaluate the impact of LNS on the nutritional status of pregnant and lactating women and on the prevention of malnutrition in their children, FANTA, with funding from the Office of Health, Infectious Diseases, and Nutrition in the Bureau for Global Health at the U.S. Agency for International Development, began the Rang Din Nutrition Study in Bangladesh.

The study was designed to evaluate the effectiveness of providing, as part of a community-based program, one formulation of LNS to pregnant and lactating women up to 6 months postpartum and another formulation to their offspring from 6 to 24 months of age to help prevent maternal and child undernutrition during the 1,000 days between pregnancy and a child's second birthday. The hypothesis was that this two-pronged approach would improve indicators of maternal and child health and nutrition among the study participants, compared to the provision of IFA during pregnancy and the first 3 months postpartum.

This brief summarizes the effects of LNS supplementation on pregnancy and birth outcomes, including infant birth size and gestational age; maternal weight gain during pregnancy; complications of pregnancy and childbirth; maternal hemoglobin, iron status, and inflammatory markers; vitamin A status; iodine status; and health care expenditures during pregnancy and childbirth. Long-term impacts of the supplementation on child



Images and instructions from a small-quantity LNS sachet for pregnant and lactating women in Bangladesh.

growth and body composition, food preferences, cognitive development, and pre-academic skills are forthcoming.

Methods

The study, which began in 2011, was conducted in 11 rural unions of the Badarganj and Chirirbandar sub-districts of the northwest region of Bangladesh and was carried out by three partners: LAMB, icddr,b, and the University of California, Davis. LAMB administered the study intervention, including the delivery of nutrition supplements, through its existing Community Health and Development Program. The University of California, Davis and icddr,b jointly evaluated the interventions. The study was designed as a researcher-blind, longitudinal, cluster-randomized effectiveness trial with four arms:

- 1. Comprehensive LNS group:** Women received LNS formulated for pregnant and lactating women (LNS-PL) during pregnancy and the first 6 months postpartum. Their children received LNS formulated for children (LNS-C) from 6 to 24 months of age.

2. **Child-only LNS group:** Women received IFA (one tablet of 60 mg of iron and 400 µg of folic acid) daily during pregnancy and every alternate day during the first 3 months postpartum.¹ Their children received LNS-C from 6 to 24 months of age.
3. **Child-only micronutrient powder group:** Women received IFA daily during pregnancy and every alternate day during the first 3 months postpartum. Their children received micronutrient powder from 6 to 24 months of age.
4. **Control group:** Women received IFA daily during pregnancy and every alternate day during the first 3 months postpartum. Their children received no supplements.

The results summarized in this brief compare women in the comprehensive LNS group with women in the other three groups combined, all of whom received IFA during pregnancy (results for children are forthcoming). The study enrolled 4,011 pregnant women—1,047 in the comprehensive LNS group and 2,964 in the IFA group. Primary data analysis was performed based on “intention-to-treat” (meaning that no women were excluded from the analysis based on adherence to the supplements). Further “per-protocol” analyses were conducted, which were confined to those who reported consuming their assigned supplement at least four times per week, on average, during the pregnancy. A separate exploratory analysis was done to examine the effects of the intervention on children who were born before a 10-week disruption in the supply of LNS-PL, during which women in all study arms received IFA.

Results

At baseline, sociodemographic, anthropometric, and obstetric characteristics of pregnant women were similar between intervention groups. On average, the women were approximately 22 years of age and had about 6 years of education. Mean height was 151 cm, mean body mass index (BMI) was approximately 20 kg/m², about a third of the women were thin (BMI < 18.5 kg/m²), and about 39–42 percent were nulliparous. The mean gestational age at enrollment was 13 weeks in both groups. The percentage of mothers reporting regular consumption during pregnancy (at least four times per week) was 64 percent in the LNS group and 92 percent in the IFA group.

¹ The World Health Organization and the Government of Bangladesh recommend providing IFA daily for at least 3 months postpartum, but the study provided IFA (60 mg) every alternate day to the control group because the recommended daily allowance for iron during lactation is only 9 mg and the tolerable upper-intake level is 45 mg.

Results from Provision of LNS during Pregnancy

INFANT

Increased mean:

- ⬆ Birth weight
- ⬆ Weight-for-age z-score
- ⬆ Length
- ⬆ Length-for-age z-score
- ⬆ Head circumference

- ⬆ Head circumference-for-age z-score
- ⬆ BMI z-score

Reduced:

- ⬆ Newborn stunting
- ⬆ Small head size
- ⬆ Low BMI at birth

MOTHER

Greater:

- ⬆ Maternal weight gain for multiparous women over 25

No significant effect on:

- ⬆ Duration of gestation
- ⬆ Most maternal outcomes
- ⬆ Pregnancy-related health care expenditures

Lower:

- ⬆ Iron status at 36 weeks gestation

DURATION OF GESTATION

There were no significant main effects of LNS-PL on duration of gestation or preterm delivery. However, subgroup analyses revealed that LNS-PL increased the duration of gestation by 0.5 weeks among women in very food-insecure households, and by 0.3 weeks among women carrying female infants.

BIRTH SIZE

The intention-to-treat results indicated that provision of LNS-PL during pregnancy (compared with IFA) significantly increased mean birth weight, weight-for-age z-score, length, length-for-age z-score (LAZ), head circumference, head circumference-for-age z-score (HCZ), and BMI z-score (BMIZ), and reduced the prevalence of newborn stunting, small head size, and low BMI at birth. Newborn stunting (LAZ < -2) was reduced by 17 percent in the sample as a whole, by 25 percent in per-protocol analyses, and by 31 percent among infants born before the disruption in the LNS-PL supply. The effect on the prevalence of

stunting was greater than would be expected based on the relatively small difference in mean LAZ. This can be explained by the shift in the distribution of LAZ at birth: LNS-PL reduced the proportion of newborns with low LAZ but had much less effect on the mean or upper end of the LAZ distribution. The percentage of newborns with a small head size (HCZ < -2) was reduced by 17 percent in the sample as a whole, by 19 percent in per-protocol analyses, and by 22 percent among infants born before the disruption in supply of LNS-PL. The prevalence of wasting (BMIZ < -2) at birth was reduced by 9 percent in the sample as a whole and by 11 percent in per-protocol analyses (the difference was not significant among infants born before the disruption in supply of LNS-PL).

The study explored whether the magnitude of the effect of LNS-PL on birth size differed depending on several pre-defined, biologically plausible potential effect modifiers. Results showed a greater effect of LNS-PL among women in food-insecure households, with respect to newborn stunting, birth weight, and head circumference (as well as duration of gestation, as mentioned previously). There was also a greater effect of LNS-PL on newborn stunting among mothers who were 14–24 years of age than in older women.

MATERNAL WEIGHT GAIN

In the study group as a whole, there was no significant effect of LNS-PL on maternal weight gain during pregnancy. This is not surprising given that LNS-PL contains only 118 kcal of energy. However, LNS-PL increased maternal weight gain during pregnancy (+34 g/week) among multiparous women over 25 years of age.

COMPLICATIONS OF PREGNANCY AND CHILDBIRTH

There were no differences in average blood pressure at 36 weeks of gestation or proportions of women with pregnancy or childbirth complications between the LNS and IFA groups. LNS-PL did not reduce the prevalence of high blood pressure at 36 weeks (a proxy indicator for pre-eclampsia) but less than 2 percent of study women had high blood pressure at that time point. It is reassuring that there were no significant differences between intervention groups in the percentage of women with prolonged labor, obstructed labor, or cesarean section, given that infants in the LNS group were larger at birth (including increased head circumference and birth weight).

MATERNAL HEMOGLOBIN, IRON STATUS, AND INFLAMMATORY MARKERS

There were no differences in hemoglobin levels or risk of low or high hemoglobin at 36 weeks of gestation between those who received LNS-PL and those who received IFA. However, women in the LNS group had lower iron status and higher risk of iron deficiency and iron deficiency anemia at 36 weeks, compared to women in the IFA group. Nevertheless, iron deficiency anemia was relatively uncommon in both groups (10–15 percent). The difference in iron status between groups was not surprising, given the much larger dose of iron in the IFA group (60 mg/day versus 20 mg/day). It is possible that the amount of iron in LNS-PL was too low. However, it is not clear whether the difference in maternal iron deficiency anemia at 36 weeks observed in the LNS group would have negative functional consequences, given that there is debate about the most appropriate cutoffs to use for both hemoglobin and markers of iron status during pregnancy and given that birth outcomes were better in the LNS group despite lower maternal iron status at 36 weeks of gestation. There were no significant differences between groups regarding inflammatory markers.

VITAMIN A STATUS

With regard to vitamin A status, average retinol-binding protein (RBP) concentration and prevalence of low RBP (< 1.17 $\mu\text{mol/L}$) at 36 weeks of gestation did not differ significantly between women who received LNS-PL and those who received IFA. The prevalence of low RBP (23.4 percent in the LNS group and 27.5 percent in the IFA group) was relatively low compared to previous studies. Dietary recall data revealed that a large proportion of women in this study population had consumed fish, meat, dairy products, and green leafy vegetables during the week prior to data collection. These foods are good sources of vitamin A and beta-carotene, so the lack of significant differences in vitamin A status between the LNS and IFA groups may be explained by the relatively high consumption of foods containing vitamin A and low prevalence of vitamin A deficiency at baseline.

IODINE STATUS

Surprisingly, there were no significant differences in average urinary iodine concentration (UIC) at 36 weeks of gestation between those who received LNS-PL and those who received IFA, although the women in the LNS group tended to have a lower prevalence of

low UIC when the lowest cutoff of less than 50 µg/L was used. The prevalence of iodine deficiency (UIC <150 µg/L) was very high at 36 weeks of gestation. It is unclear why daily supplementation of 250 µg of iodine via LNS-PL did not appear to adequately protect pregnant women in the study area from iodine deficiency. One possibility is that the iodine in LNS was indeed taken up but was stored in the thyroid gland (due to the high prevalence of iodine deficiency) instead of being excreted in urine, which would imply that UIC is not an adequate marker of iodine status in this situation.

HEALTH CARE EXPENDITURES

Provision of LNS-PL did not change pregnancy-related health care expenditures during late pregnancy or childbirth or during the 42-day postpartum period when compared with the provision of IFA, nor did it affect antenatal and postnatal care-seeking decisions during pregnancy or in the first 6 weeks postpartum. Provision of LNS-PL

To our knowledge, this is the first study to report an effect of a prenatal nutrient or food supplement containing multiple micronutrients on the prevalence of newborn stunting. Because this was an effectiveness study conducted in the context of an operating community health program, the findings should be relevant to other programs serving similar populations.

was associated with a greater likelihood of seeking hospital care, but this effect was based on very few women who sought hospital care during the study period, some several times.

Conclusions

LNS-PL supplementation during pregnancy reduced prevalence of newborn stunting, low BMI, and small head size in the study population. These effects occurred without a significant impact on duration of gestation, suggesting that LNS-PL reduces fetal growth restriction but not preterm delivery. As a whole, the study women were at high risk for fetal growth restriction, given that about a third of them had low BMI and 39 percent were under 20 years of age. Reduction of newborn stunting by LNS-PL was most evident among younger women and those residing in households experiencing food insecurity.

There was little effect on the other outcomes explored, with the exception of the following differences in the LNS group when compared with the IFA group: (1) greater maternal weight gain during pregnancy among multiparous women over 25 years of age, (2) lower iron status and higher risk of iron deficiency and iron deficiency anemia at 36 weeks of gestation, and (3) a trend toward a lower prevalence of low UIC at 36 weeks of gestation, when the lowest cutoff of UIC (< 50 µg/L) was used. Additional research on the optimal composition of LNS-PL for reducing maternal micronutrient deficiencies, while still promoting fetal growth, is needed.



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