Impact of Small-Quantity Lipid-Based Nutrient Supplements on Iodine Status

A cluster-randomized trial in young Burkinabe children

Sonja Y Hess
Program in International and Community Nutrition, Department of Nutrition, University of California, Davis, CA, USA

Elizabeth Jimenez Yakes
University of New Mexico, Albuquerque, NM, USA

Souheila Abbeddou
Nutritional and Health-Related Environmental Studies Section, Division of Human Health, Department of Nuclear Sciences and Applications, International Atomic Energy Agency, Vienna, Austria

Strategies to prevent iodine deficiency

Iodine is essential for human health, and particularly for infant and young child development, because of its key role as a structural element of thyroid hormones. Salt iodization is the most cost-effective strategy to prevent iodine deficiency, and its coverage has increased substantially in recent decades.[1] However, in countries with inadequate or unstable coverage of universal salt iodization, other supplementary iodine interventions should be considered for young children and pregnant women while efforts are made to improve the coverage of the salt iodization program.[2] These alternative intervention strategies can include iodine-fortified complementary foods or point-of-use fortificants, such as micronutrient powders (MNP) and small-quantity lipid-based nutrient supplements (SQ-LNS).

The present article summarizes a study published in the British Journal of Nutrition, which aimed to assess the impact of providing SQ-LNS on the iodine status of young Burkinabe children.[3] In Burkina Faso, salt iodization has been mandatory since 2003. The regulations require an iodine content of 50–80 ppm at time of importation and >30 ppm at retail distribution sites.[4] Thus, children in the study were also potentially exposed to iodized salt. At the time of the study, the latest national assessment dated from 2003 indicated that only 34% of households consumed iodized salt with >15 ppm iodine.

> "In countries with inadequate salt iodization, other iodine interventions should be considered"

Methods

This study was an add-on study to the iLiNS-ZINC trial, which was a partially masked, placebo-controlled, cluster-randomized intervention study conducted in 34 communities of the Dandé Health District in southwestern Burkina Faso.[5] Based on selected indicators, 25 communities were assigned to participate in the intervention cohort (IC) and 9 communities were assigned to the non-intervention cohort (NIC). Within the IC, 9-month-old children meeting the inclusion criteria received 20 g SQ-LNS daily containing different amounts of zinc from 9 to 18 months of age.[3] Two of the four intervention groups participated in the iodine assessment: **1)** SQ-LNS without zinc (LNS-ZnO) and **2)** SQ-LNS with 10 mg zinc (LNS-Zn10). Children in all of the intervention groups also received free treatment for diarrhea, malar-

A study participant with her mother receiving a weekly ration of SQ-LNS.

ia and fever, as described in more detail elsewhere.[3] Children in the NIC did not receive SQ-LNS, morbidity surveillance, or any illness treatment during the study period.

At enrollment, children were examined for eligibility to participate in the iLiNS-ZINC trial.[5] In a randomly selected subgroup of eligible children, a venous blood sample and a spot urine sample were collected at baseline and at the end of the study. Children who successfully provided a blood or urine sample at both 9 and 18 months of age were included in the present iodine analysis. Whole blood was preserved on dried blood spots, and plasma was aliquoted. Children's iodine status was assessed based on: urinary iodine (UI), whole blood thyroid-stimulating hormone (TSH) and total thyroxin (T_4), and plasma thyroglobulin (Tg) concentrations. Inadequate iodine status was defined as: UI < 100 µg/L.[6] Normal reference ranges for TSH and T_4 were 0.1–3.7 mU/L and 65–165 nmol/L, respectively. A recommended normal range for Tg assessed in dried blood spots is available only for school-age children (4–40 µg/L), but not for young children.[7] Salt samples (n=106) were collected in the households of randomly selected study participants for assessment of iodine content by iodometric titration.

Results and conclusions

A total of 3,220 children were enrolled in the iLiNS-ZINC trial, and a subset of 284 children provided blood and/or urine samples for the iodine assessment. At enrollment, children were 9.5 ± 0.3 months of age, and all children were still breastfed. Breastfeeding continued to be very common; at 18 months of age, 97% of participating children were still breastfed. In contrast, complementary feeding practices were suboptimal. At nine months of age, only 24% of children had consumed the minimum recommended number of meals during the previous 24 hours, and only 15% met the minimum food group diversity recommended by the World Health Organization.[8] Although there was some improvement by 18 months of age, complementary feeding practices remained suboptimal, with only 60% of children consuming the recommended minimum number of meals, and 27% meeting the minimum food group diversity.

The household salt samples (n=106) had a mean iodine content of 37 ppm, ranging from 5–86 ppm. Thirty-seven percent of the samples had an iodine content < 30 ppm, below the minimum level required at the retail level in Burkina Faso. Thus, the majority of households (63%) had adequately iodized salt available.

The iodine status results did not significantly differ between the intervention groups (LNS-ZnO vs. LNS-Zn10), but there were some significant differences between children in the IC versus NIC. Tg concentrations were significantly higher in the NIC at baseline compared to IC (geometric mean (95% confidence interval [CI]): 33.2 (28.8, 37.9) µg/L in NIC versus 27.5 (25.2, 29.9) µg/L in IC (p=0.005)). However, Tg concentrations were no longer significantly different between the cohorts after nine months of study intervention. Because there are no reference values for plasma Tg concentrations in young infants, differences between the cohorts was explored based on the upper and lower 2.5th percentile at 18 months, adjusted for the baseline value. Significantly more children in the NIC (n=5; 6%) had low adjusted Tg (<10.6 µg/L) compared to children in IC (n=1; 0.6%; p=0.006).

Baseline UI concentration did not differ significantly; the geometric mean (95% CI) was 220 (192, 257) µg/L in children in IC and 276 (192, 397) µg/L in children in NIC. After nine months of intervention, the UI concentration was also not significantly different, and only 4% of children in the IC and 5% in the NIC had low UI concentration (p=0.906).

There was no significant difference in TSH or T_4 concentrations between the cohorts at baseline and at endline. Only one child had elevated TSH concentration at baseline, and all children had normal TSH concentrations at the end of the study. The prevalence of low T_4 concentration was low at 9 and 18 months of age in both cohorts. However, there was a marginally significant difference in hypothyroxinemia at 18 months of age (p=0.052). Namely, fewer children (n=2; 1.6%) in the IC had abnormally low T_4 concentrations at the end of the study than in the NIC (n=5; 8.9%).

In summary, although there were some small differences in low T_4 and Tg concentrations between the IC and NIC cohorts after nine months of intervention, the vast majority of all children participating in the study had adequate iodine status and normal thyroid hormone concentrations. These results suggest that these young study participants consumed sufficient amounts of iodine either through breast milk or from iodized salt in family food.

"Study participants consumed sufficient iodine either through breast milk or from iodized salt"

The World Health Organization, the International Council for the Control of Iodine Deficiency Disorders and UNICEF recommend an intake of 90 µg iodine/day for children < 60 months of age.[9] Dietary intake was not quantitatively assessed in the study. However, considering the high frequency of continued breastfeeding reported in the study participants, children could have consumed 80–90 µg iodine per day through breast milk alone, and most were also consuming at least some complementary foods that contained iodized salt.[3] Thus, a provision of 90 µg of iodine in SQ-LNS may have been too high, and could have put some children at risk of usual intakes above the Tolerable Upper Intake Level (UL). The UL is the highest average usual iodine intake that is likely to not pose adverse health risks, and is set at 200 µg iodine per day for children 1–3 years of age.[10,11] Because there is not yet consensus on the appropriate cut-off to indicate elevated UI among young children, we are not able to judge the risk associated with the observed UI levels. However, considering that almost all children in the IC had normal thyroid hormone concentrations, the dietary iodine intakes among IC children did not seem to pose adverse health risks.

In conclusion, a reduction of SQ-LNS iodine content should be considered in settings with similarly successful salt iodization programs and high rates of continued breastfeeding. Assessment of the iodine status of the target population should be considered prior to distributing home fortification products such as SQ-LNS and MNP. Additional research on the impact of SQ-LNS on children's iodine status is needed in countries with lower or unstable coverage of the salt iodization program.

"A reduction in SQ-LNS iodine content should be considered in settings with successful salt iodization programs and high breastfeeding rates"

Correspondence: ***Sonja Hess,***
Program in International and Community Nutrition, Department of Nutrition, University of California, One Shields Avenue, Davis, CA 95616, USA ***Email:*** *syhess@ucdavis.edu*

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