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SHORT COMMUNICATION

Evaluation of iron intake in preschool children in a setting with high anemia burden

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Background: Iron deficiency anemia affects millions of children worldwide. Iron intake assessments can inform targeted interventions.

Methods: This cross-sectional study describes diet and hemoglobin levels of children 1–5 y of age in a resource-limited setting in the Dominican Republic. The study team performed meal observations and measurements, dietary questionnaires, and point-of-care hemoglobin testing.

Results: Iron intake and bioavailability were low, with liberal estimates indicating that not more than 40% of subjects consumed the recommended daily allowance for iron. Forty of 80 children had anemia, with 23% demonstrating moderate or severe anemia.

Conclusions: Poor observed iron intake likely contributes to the high prevalence of anemia in this population.

Keywords: Caribbean, iron bioavailability, pediatric, resource-limited setting

Introduction

Iron deficiency and iron deficiency anemia (IDA) contribute to increased rates of maternal and fetal mortality and neurodevelopmental deficits in children.[1] Globally, anemia affects >30% of the population, with half of cases linked to iron deficiency.[1] In Consuelo, Dominican Republic, the prevalence of anemia among preschool children is particularly high (>50%). The contribution of dietary iron insufficiency to pediatric anemia in this and similar settings is unknown.

Maternal anemia, dependence on iron-poor foods in early childhood, and viral and helminthic infections all contribute to high rates of IDA in preschool-aged children. High-iron diets are needed to counter the effects of low birth iron stores and infectious insults. Iron bioavailability is also an important consideration. The source of the iron and meal composition both impact absorption, with some foods improving and others inhibiting iron absorption.[2] We evaluated dietary iron intake and iron bioavailability in Consuelo in order to determine whether an intervention focused on increasing dietary iron is likely to be of benefit.

Materials and methods

We performed a cross-sectional study to describe the typical diet and iron intake of 80 children 1–5 y of age between June 2016 and January 2017. We aimed to enroll 20–25% of the patients followed in a clinic for children <5 y of age in the poorest barrios of Consuelo. Sampling involved offering inclusion to parents of children presenting for routine clinic visits, supplemented by selection of every third record in alphabetized clinic files, until full accrual was obtained. Children enrolled in a malnutrition program that included provision of dietary supplements were excluded, as were those with a household member already in the study. An in-home assessment for each subject included a 24-h dietary recall questionnaire, observation of preparation of the main meal of the day, measurement of food intake (by weighing food before and after) and a finger-stick hemoglobin test using a HemoCue device (HemoCue, Ängelholm, Sweden). Clinical data, including prior iron supplementation, were collected via chart review.

From the observed meal we calculated raw and bioavailable iron intake. We used methods developed by Monsen and Balintfy[3]

Table 1. Iron intake compared with recommended daily allowance (NIH, USA, 2018).

Age (y)	RDA of iron (mg)	33% of RDA of iron (mg)	iron intake at observed meal (mg), median (IQR)
1–3	7.0	2.1	1.57 (0.69–2.58)
4–5	10.0	3.0	2.01 (0.86–3.91)

and reported by Tseng et al.,[4] based on data from the Food and Agriculture Organization of the United Nations and the WHO, to calculate the bioavailability of heme and nonheme iron. The WHO definitions were used to define anemia: normal, ≥11.0 g/dL; mild, Hb 10.0–10.9 g/dL; moderate, Hb 7.0–9.9 g/dL; severe, Hb <7.0 g/dL.[5] The mean (standard deviation [SD]) is reported for normally distributed data and median (inter-quartile range [IQR]) for nonparametric data. As this study was descriptive and not powered for formal comparisons, statistical associations between iron intake and hemoglobin values are not presented.

Results

The median total iron consumption at the observed meal was 1.66 mg (IQR 0.75–2.67). The total quantity of bioavailable iron consumed was low among all subjects, with a median intake of 0.13 mg (IQR 0.07–0.23). Adjusting for a single-meal observation, one-third of the age-specific recommended daily allowance (RDA) of iron was compared with the iron consumed during the assessment (see Table 1). Only 32 subjects (40%) met the one-third RDA for iron and 12 (15%) reached the threshold of 14% bioavailable iron that should be met by a mixed nonvegetarian diet.

On the dietary recall questionnaire, caregivers reported that 84% of children ate rice one to two times per day and 85% ate another starch one to two times per day. No child ate iron-rich foods daily (meat, beans or green vegetables). Iron inhibitors (phytate-containing starches such as rice and pasta) were consumed by 99% of children, compared with 73% of children who consumed enhancers (fruits, vegetables, animal products). Rice was the most common inhibitor.

The mean Hb was 11.0 g/dL (SD 1.3). Forty of 80 participants (50%) were anemic (Hb <11.0 g/dL). Among anemic subjects, 17 (43%) had moderate anemia and 1 (3%) had severe anemia. Children 12–23 mo of age had the highest prevalence of anemia by age group (19/26 [73%]). Three subjects (4%) had sickle cell disease and 93% of children had received recommended deworming. Of anemic subjects, more than half (23 [57%]) had not been prescribed iron supplementation in the preceding 3 mo.

Discussion

This study was conducted to determine whether an intervention to increase bioavailable iron intake would be likely to impact the high rate of anemia in this population. We found that a low quantity of consumed iron was compounded by poor meal quality (low bioavailability and prevalence of absorption inhibitors). The local diet is iron poor, and given the extent of anemia, the population-level iron intake appears to be inadequate. In this community with low rates of hemoglobinopathies and high rates of deworming, improving meal quality—specifically, increasing heme iron and enhancer intake—is a logical target for improving anemia rates. This work is the first of a multistep process aimed at evaluating IDA and introducing strategies to lower population-level rates of IDA in this vulnerable group.

Authors' contributions: MGD, RMC, SGM and EDL designed the research. MGD, SGM, RC, and IFJ conducted the research.. MGD, RMC and EDL analyzed the data. MGD, RMC, SGM and EDL wrote the manuscript. MGD has primary responsibility for the final content. All authors had access to the data and read and approved the final manuscript.

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Competing interests: None declared.

Ethical approval: This work was approved by the Institutional Review Board at the Children's Hospital of Philadelphia, as well as the Comité de Bioética en Salud (CONABIOS) in Santo Domingo, Dominican Republic. The procedures followed in this study were in accordance with the ethical standards of the Helsinki Declaration of the World Medical Association.

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