



Feasibility of Iron Ingot use in a Resource-Limited Caribbean community: findings from a survey to guide anemia prevention

David M. Sabio^{1,2,3}, Hannah Connor^{3,4}, Ingrid Japa MD³, Ramona Cordero³, Ryan Close MD, MPH^{3,4,5}, Elizabeth Lowenthal MD, MSCE^{3,4,5}

1. University of Colorado School of Medicine, 2. Colorado School of Public Health 3..Niños Primeros en Salud, Consuelo, Dominican Republic 4. Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania 5. The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania



School of Medicine
UNIVERSITY OF COLORADO
COLORADO SPRINGS BRANCH

Background

- The WHO (World Health Organization) recommends universal iron supplementation for children in areas with a prevalence of iron deficiency anemia >40%.
- Implementation of this recommendation is challenged by cost, logistical barriers, poor palatability and side effects of iron supplements.
- Cooking with a reusable iron ingot can supplement common foods with bioavailable iron and may provide a sustainable and cost-effective approach to iron supplementation.
- At the clinic and study site in Municipio Consuelo, Dominican Republic (DR), we have found from prior studies that the prevalence of anemia among children < 5 years of age exceeds 50%
- Randomized controlled trials (RCTs) in rural Cambodia have shown that use of an iron ingot- the Lucky Iron Fish (LIF) resulted in higher levels of hemoglobin and ferritin.
- Use of the LIF to fortify foods or water requires that the iron ingot be boiled with an acidifying agent.
- Use of the LIF provides iron fortification for multiple people and the ingot is effective for 5 years.

The Lucky Iron Fish



Aim Statement

- To examine the resources and cooking practices of families with young children in a low-income community in the Dominican Republic, in order to determine the feasibility of cooking with an iron ingot for sustainable iron fortification.

Methods

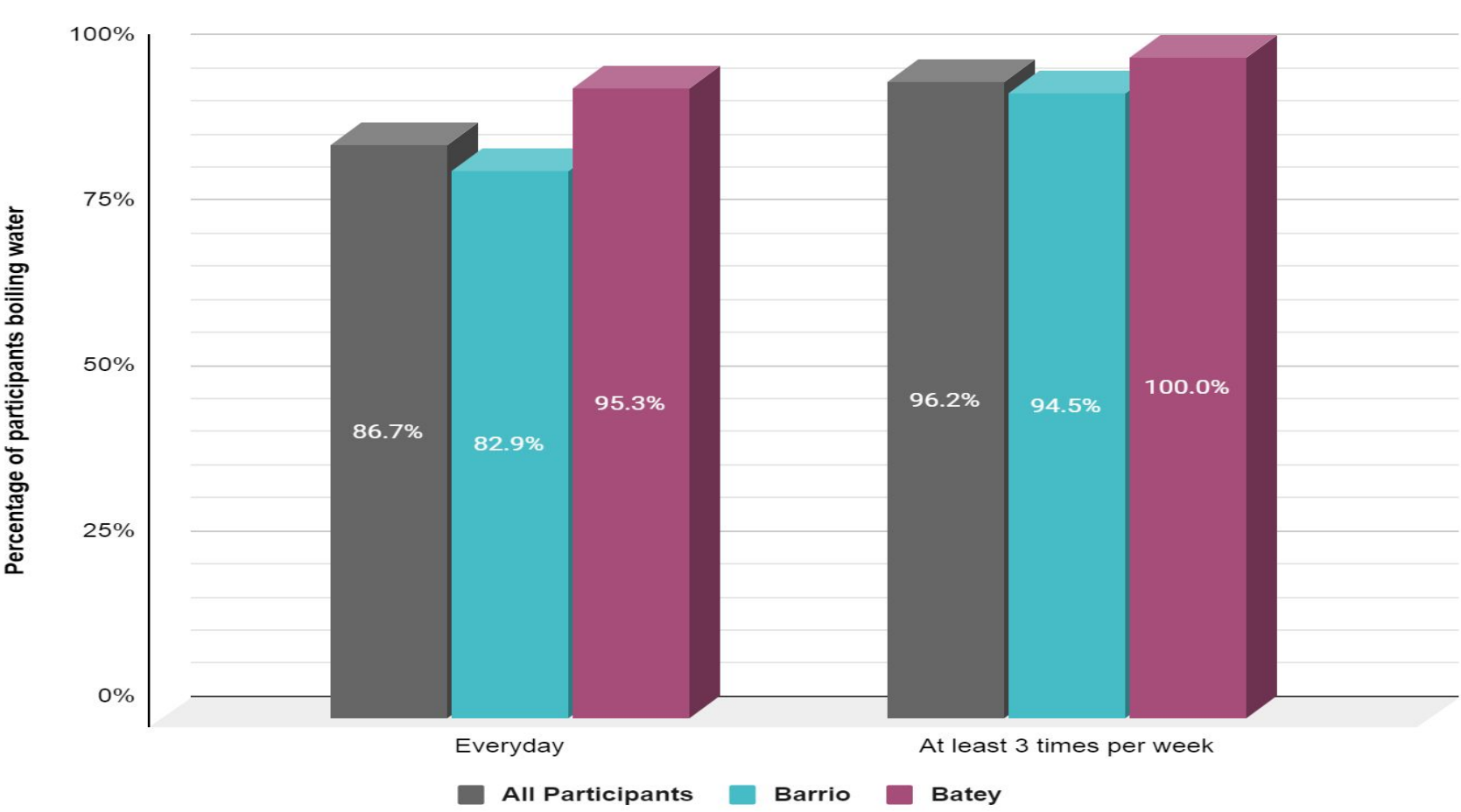
- Our team created a survey to examine household cooking practices and resources with a focus on boiling water, acidifying agents and infant feeding.
- The survey was administered at two clinical sites in Municipio Consuelo, DR, a township with an estimated 30,000 people and a per capita income estimated at US\$2,000 a year (75% less than the national average).
- 210 mothers with infants less than 1 year old participated in the study.
- Surveys were administered orally, in-person and recorded in REDCap mobile, with no personal information collected
- Descriptive analysis was used to identify relationships amongst variables in the data, chi-square analysis was then done to test for independence, and qualitative data was analyzed thematically.
- The study proposal was reviewed and approved by the Children's Hospital of Philadelphia IRB (Institutional Review Board) and in the Dominican Republic, by the Consejo Nacional de Bioética en Salud (CONABIOS).

Results

Participants (n=210)

	All Participants (Barrios + Bateyes) (N=210)	Barrio (N=146)	Batey (N=64)	p-value*
Creole speaking*	64 (30.5%) 95%CI 24.3-37.2%	27 (18.5%) 95%CI 12.6-25.8%	37 (57.8%) 95%CI 44.8-70.1%	<.00001
High school or beyond	145 (69.0%) 95%CI 62.3-75.2%	109 (74.7%) 95%CI 66.8-81.5%	36 (56.3%) 95%CI 43.3-68.8%	0.008
Communal water faucet used for cooking	46 (21.9%) 95%CI 16.5-28.1%	21 (14.4%) 95%CI 9.1-21.1%	25 (39.1%) 95%CI 27.1-52.1%	<0.0001
Electricity <50% of the time	120 (57.1%) 95%CI 50.2-63.9%	92 (63.0%) 95%CI 54.6-70.8%	33 (51.6%) 95%CI 38.7-64.3%	0.12
Generator in house for electricity	52 (24.8%) 95%CI 19.1-31.2%	44 (30.1%) 95%CI 22.8-38.3%	9 (14.1%) 95%CI 6.6-25.0%	0.01
Participant (mother) younger than 20yo	39 (18.6%) 95%CI 13.6-24.5%	20 (13.7%) 95%CI 8.9-20.4%	19 (29.7%) 95%CI 18.9-42.4%	0.006
Four or more kids living in home	41 (19.5%) 95%CI 14.4-25.5%	19 (13.0%) 95%CI 8.0-19.6%	22 (34.4%) 95%CI 22.9-47.3%	0.0003
Boils water with firewood	31 (14.8%) 95%CI 10.3-20.3%	11 (7.5%) 95%CI 3.8-13.1%	20 (31.3%) 95%CI 20.2-44.1%	<.00001
Boils water and stores it to drink later	29 (13.8%) 95%CI 9.4-19.2%	13 (8.9%) 95%CI 4.6-14.7%	16 (25%) 95%CI 15.0-37.4%	0.002

Frequency of boiling water for cooking



Discussion

- The burden of iron deficiency anemia primarily weighs upon countries and subpopulations living with limited resources in less developed areas, and this is both a downstream effect and perpetuator of global inequities.
- The vast majority (96.2%) of the 210 participants boil water at least 3 times per week, and 86.27% boil water daily for cooking, and nearly all (99.0%) have year-round access to an edible acidifying agent- but less than 40% cook with an acidifying agent three times per week.
- The feasibility of LIF use is supported by frequency of boiling water boiling and access to acidifying agents. However, changes in cooking practices need to be further explored for it to be considered a sustainable source of iron fortification in this context.

Next steps

- To evaluate the possible uptake of recipes using acidifying agents for LIF use in the community.
- To examine other locales with high prevalence of iron deficiency anemia to identify further differences and similarities in potential interventional approach.
- To assess alternative dosing strategies of different acidifying agents and potential enhancers or inhibitors of iron bioavailability with the LIF in laboratory settings.
- To examine adherence of LIF use in ongoing RCT and evaluate potential barriers.

Municipio Consuelo



References

1. McLean, Erin, Mary Cogswell, Ines Egli, Daniel Wotiyila, and Bruno de Benoist. "Worldwide Prevalence of Anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993–2005." *Public Health Nutrition* 12, no. 4 (April 2009): 444–54. <https://doi.org/10.1017/S1368880009002401>.
2. McKee, Steven G., Ryan Close, and Elizabeth Lowenthal. "Evaluation of Iron Deficiency Anemia in a Pediatric Clinic in the Dominican Republic." *Annals of Global Health* 83, no. 3–4 (August 2017): 550–56. <https://doi.org/10.1016/j.anngh.2017.07.004>.
3. Charles, C.V., Dewey, C.E., Hall, A., Hak, C., Channary, S., Summerte, A.J. A randomized control trial using a fish-shaped iron ingot for the amelioration of iron deficiency anemia in rural Cambodian women. *Trop. Med. Surg.* 2015, 3.
4. Duggan, Maureen B. "Prevention of Childhood Malnutrition: Immensity of the Challenge and Variety of Strategies." *Paediatrics and International Child Health* 34, no. 4 (November 1, 2014): 271–76. <https://doi.org/10.1111/ped.12444>.
5. Walker, Susan P., Theodore D. Wachs, Sally Grantham-McGregor, Maureen M. Black, Charles A. Nelson, Sandra L. Huffman, Helen Baker-Henningham, et al. "Inequality in Early Childhood: Risk and Protective Factors for Early Child Development." *Lancet (London, England)* 378, no. 9799 (October 8, 2011): 1325–38. [https://doi.org/10.1016/S0140-6736\(11\)00555-2](https://doi.org/10.1016/S0140-6736(11)00555-2).