Galetti V, Kujinga P, Mitchikpe CES, Zeder C, Tay F, Tossou F, Hounhouigan JD, Zimmermann MB, Moretti D. **Efficacy of highly bioavailable zinc from fortified water: a randomized controlled trial in rural Beninese children**. Am J Clin Nutr 2015; doi: 1-.3945/ajcn.115/117028.

Introduction:

Zinc deficiency is common in low-income countries and adversely affects child health and survival; ~17% of the global population is estimated to have inadequate zinc intake, and 1.7% of total deaths among children < 5 y are attributable to zinc deficiency (~116,000 attributable deaths annually) (1). Prevention and treatment of zinc deficiency can be accomplished through provision of supplements, fortification of foods, and dietary modification and diversification.

This issue of NNA summarizes an article recently published in *The American Journal of Clinical Nutrition* which reports the results of two randomized controlled trials which tested a novel point-of use water ultrafiltration device fitted with zinc phosphate-based plates, designed to filter water and fortify it with zinc at the same time. The specific objectives of the studies were to: 1) assess the bioavailability (absorption) of zinc from zinc-fortified filtered water, and 2) assess the efficacy of simultaneous water filtration and zinc fortification to improve zinc status, as measured by plasma zinc concentration.

Methods:

Absorption study: The first study was designed to quantify zinc absorption in healthy adults from 3 zinc-fortified meals: 1) a zinc-fortified maize porridge consumed with ultrapure water, 2) an unfortified maize porridge consumed with zinc-fortified water, and 3) zinc-fortified water alone. Each meal contained 2 mg of zinc. 18 subjects in Switzerland participated in the study, and each participant received each of the three treatments, spaced > 24d apart, in a random order. To quantify zinc absorption, the researchers gave participants small doses of two different zinc stable isotopes (orally and intravenously) with each study meal. Researchers collected urine specimens at baseline and four days after the test meal, to quantify zinc absorption based on the ratio of zinc stable isotopes in the urine.

Efficacy trial: The second study, a randomized controlled trial, designed to assess the efficacy of zinc-fortified water on zinc status, was conducted among primary school-age children in Benin. Children were eligible to participate if they would be < 11 years of age at end line, and parents provided written informed consent. Children were excluded if they had severe anemia, a major chronic disease or long-term medication use, or consumed zinc supplements. 277 children were randomly assigned to one of three treatment groups: 1) zinc-fortified filtered water providing ~ 3 mg/zinc per serving, 2) non-fortified filtered water, or 3) non-fortified, non-filtered (pump) water. Children received two servings of their assigned water 4 days per week and one serving one day per week; the duration of the intervention was 20 weeks. Venous blood samples were collected to measure plasma zinc concentrations among the children at baseline, end line, as well as one randomly selected mid-study time point per individual. They also assessed child growth (height and weight) and diarrhea morbidity (via bimonthly interviews).

Results and Conclusions:

Absorption study: 16-17 participants completed each time point of the study. The geometric mean fractional absorption of zinc was significantly higher when zinc-fortified water was served alone (65.9%), than when it was served with an unfortified maize porridge (9.8%), or when a zinc-fortified maize porridge was served (9.1%). The geometric mean (standard deviation (-SD), +SD)) of total zinc absorbed was 1.32 mg (0.85, 2.05) when the fortified water was served alone, versus 0.18 mg (0.12, 0.27) and 0.20 mg (0.11, 0.33) from the fortified water served with unfortified maize porridge and the fortified maize porridge, respectively. The lower zinc absorption of the zinc-fortified maize porridge was likely due to the phytate in the maize flour.

Efficacy trial: 277 children were enrolled and 262 completed the study (94%). Median compliance with the intervention (% of intended doses consumed), as assessed during direct supervision, was 87% (78-92%) and did not differ significantly among treatment groups. The median (interquartile range) additional zinc intake in the group receiving zinc-fortified water was 2.8 mg/day (0.0 – 4.5) over all study days. Mean plasma zinc concentrations decreased significantly in all three groups from baseline to final (likely due to seasonality). However, when controlling for baseline plasma zinc concentrations, the decrease in plasma zinc concentration among individuals receiving the zinc fortified water was less than the decrease in plasma zinc concentrations among individuals receiving non-fortified filtered water or pump water.

Plasma zinc, μg/dL	Zn + Filter water	Filter water	Pump water
Baseline	70.1 (62.8 – 77.2)	68.5 (62.3 – 76.1)	66.5 (58.4 – 73.4)
Week 20[1,2]	69.0 (61.3 – 75.0)[a]	64.4 (56.8 – 71.0)[b]	64.5 (57.6 – 71.7)[b]

[1]P-main effect. Time <0.001; Treatment = 0.002; Time-by-treatment interaction = 0.026

[2]Values in a row with different superscript letters differ significantly (P<0.05).

The authors concluded that consumption of filter water fortified with a low dose of highly bioavailable zinc is an effective intervention to increase plasma zinc concentrations and decrease the prevalence of zinc deficiency among school-age children in rural Africa.

Program and policy implications:

Previous studies have indicated that the novel point-of-use water ultrafiltration device used in this study may be efficacious in reducing the incidence of diarrhea in communities in sub-Saharan Africa [2; 3]. The present study demonstrated that adding glassy zinc phosphate-based plates to the existing filters (thus simultaneously filtering and fortifying water with zinc) may be efficacious in reducing zinc deficiency in these same communities. Additional large-scale randomized controlled trials are necessary to confirm these findings, evaluate the efficacy of this zinc delivery method on zinc-related functional outcomes and evaluate the effectiveness and acceptability of this filtration/zinc delivery method.

NNA Editors Comments*:

Combining the filtration of water with simultaneous zinc fortification is an interesting, innovative strategy to improve water quality and increase zinc intake simultaneously. The present NNA summarizes a proof of principal study showing an increase in plasma zinc concentrations among school-age children. As the investigators point out, large scale interventions are needed to assess zinc-related functional outcomes, such as growth and diarrhea prevalence among young children, who are most at risk of stunting. Moreover, to ensure zinc intakes below the tolerable upper intake level among all family members, the quantity of water consumed by all individuals in the household needs to be considered, as many may be exposed to zinc fortified wheat or maize flour at the same time. Although flour fortification with iron and folic acid only is mandatory in many African countries [(4)], other micronutrients including zinc are often added voluntarily to the micronutrient premix[(5)]. In the case of Benin, wheat flour fortification is mandatory with iron, folic acid, and zinc. Last but not least, it would also be of interest to assess the scalability of this filtration/fortification pump with regard to affordability among those who need access to filtered water the most.

* These comments have been added by the editorial team and are not part of the cited publication.

1. Black RE, Victora CG, Walker SP *et al.* (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* **382**, 427-451.
2. Boisson S, Kiyombo M, Sthreshley L *et al.* (2010) Field assessment of a novel household-based water filtration device: a randomised, placebo-controlled trial in the Democratic Republic of Congo. *PLoS ONE* **5**, e12613.
3. Peletz R, Simunyama M, Sarenje K *et al.* (2012) Assessing water filtration and safe storage in households with young children of HIV-positive mothers: a randomized, controlled trial in Zambia. *PLoS ONE* **7**, e46548.
4. Flour Fortification Initiative. Africa - Fotification legislation status by country and grain. Available at http://www.ffinetwork.org/regional_activity/africa.php. Accessed April 11, 2016.
5. Brown KH, Hambidge KM, Ranum P (2010) Zinc fortification of cereal flours: current recommendations and research needs. *Food Nutr Bull* **31**, S62-74.

Nutrition News for Africa is a monthly electronic newsletter whose aim is to disseminate state-of-the-art research and policy papers to scientists, program planners, policy makers, and opinion leaders working in the field of public health nutrition in Africa. The newsletter is prepared as a collaborative effort of Helen Keller International (HKI) and the Program in International and Community Nutrition (PICN) of the University of California, Davis. HKI regional staff members and students and faculty members of the PICN identify and summarize relevant articles and policy statements from the scientific literature and international agency publications. We also encourage members of this network to suggest possible documents of interest and to provide feedback on the articles selected.

To subscribe, please click "**Subscribe here**"

Editorial Office:
Helen Keller International
Regional Office for Africa
122, Toundoup Rya
PO Box 29.898
Yoff-Dakar
Senegal