West Africa Bouillon Fortification Initiative
Ghana Research Brief #1
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Bouillon Fortification in Ghana: Modeled Evidence

Key Policy Messages Related to Bouillon Fortification in Ghana

- The prevalence of micronutrient inadequacies in Ghana is substantial for women and young children, especially zinc and folate.
- Current national food fortification programs in edible oils (vitamin A) and wheat flour (iron, zinc, vitamin A, folic acid and vitamins B1, B2, B3, B12) reduce micronutrient inadequacies, especially for folate.
- Bouillon cubes are widely consumed throughout Ghana, including by poor households in rural and urban areas.
- Fortified bouillon cubes can further reduce micronutrient inadequacies, but dietary gaps remain at modeled levels of fortification, especially for zinc and vitamin A.
- Implementing a bouillon fortification program will require public- and private-sector investments.
- Micronutrient premixes generally represent the largest cost share; other smaller but important costs will be faced by government and industry.
- Technical and other challenges may need to be overcome to produce commercially viable fortified bouillon cubes.
- Modeling techniques provided evidence to help inform policy discussions around bouillon fortification program

Rationale and Objectives

Rationale: Micronutrient deficiencies impact health, growth, and development.[1] Bouillon is widely consumed in Ghana, including among rural and poor populations, and hence has the potential to deliver micronutrients to at-risk individuals.

Objectives: This research used national data to: (1) assess dietary inadequacy of iron, zinc, vitamin A (VA), folate, and vitamin B12 among women of reproductive age (WRA) and children 6-59 month of age; (2) model the contributions of existing large-scale food fortification (LSFF) programs to addressing micronutrient gaps; and (3) model the potential contributions of fortified bouillon to further meeting dietary requirements and to reducing child mortality. Fortification program costs and cost-effectiveness were also assessed.

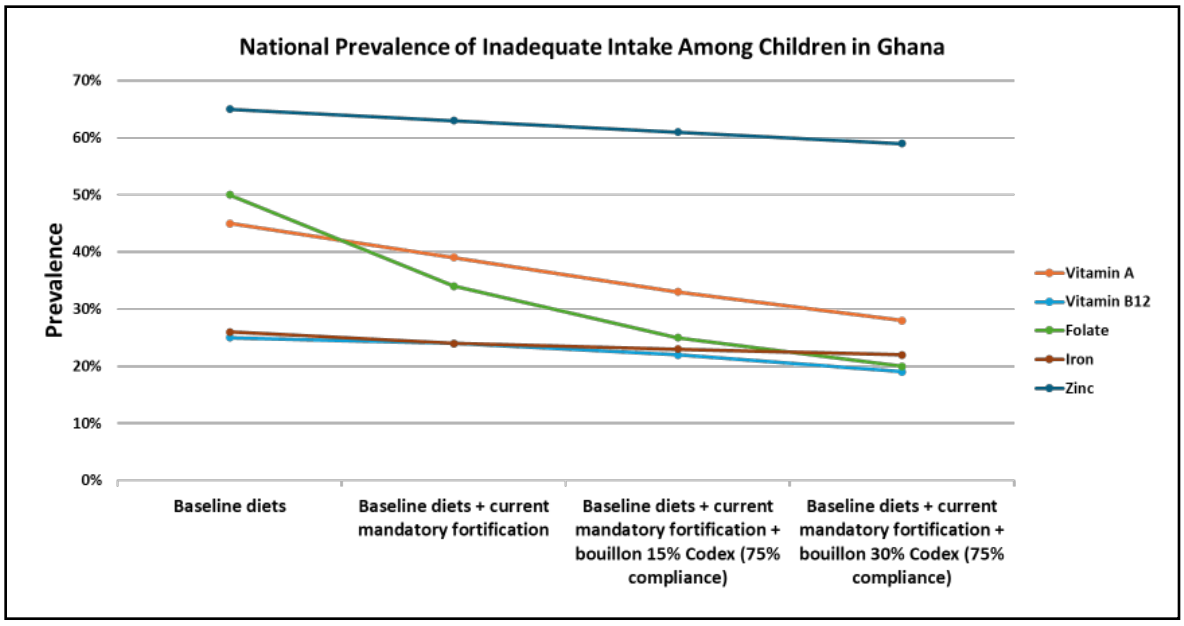
Methods

We used household food consumption data from the 2016/2017 Ghana Living Standard Survey (GLSS)[2] and the Micronutrient Intervention Modeling Project's nutritional needs/benefits model (MINIMOD-SD) to estimate the prevalence of dietary micronutrient inadequacies and to model the contributions of various combinations of fortification programs to reducing inadequacies.[3] The Lives Saved Tool (LiST)[4] was used to estimate the impacts of fortification on child mortality. The MINIMOD cost model[5] estimated the start-up and operational costs of hypothetical bouillon programs over 10 years, disaggregated by government, industry, and premix costs.

Results: Micronutrient inadequacies in Ghana & programs to address them

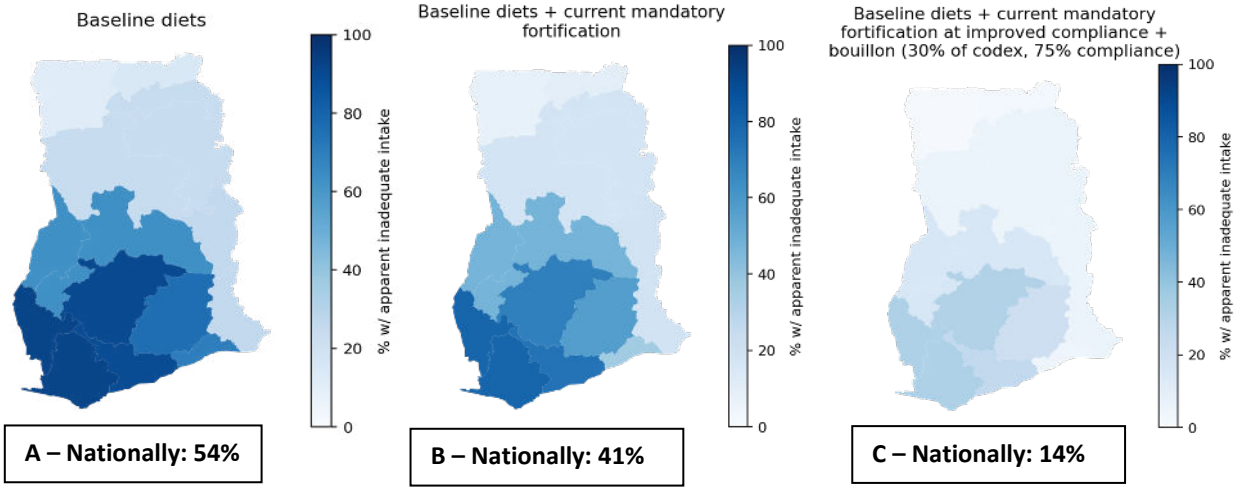
Nationally, based on unfortified food sources alone, inadequacies in VA, vitamin B12, folate, iron, and zinc are common among children, and especially high for zinc, folate, and vitamin A (**Figure 1**). Wheat flour (iron, zinc, VA, folic acid, vitamin B12, thiamine (B1), riboflavin (B2), and niacin (B3)) and refined edible oils (VA) fortification programs are in place in Ghana, and are delivering ~6% (based on iron) and ~56% of target micronutrient concentrations, respectively.[6] Bouillon fortification providing 30% of Codex Nutrient Reference Value (NRV) in 2.5 grams bouillon would decrease inadequacies among children, but only modestly for zinc, vitamin B12, and iron (**Figure 1**).

Figure 1: Prevalence of micronutrient inadequacies among young children, by group of intervention programs



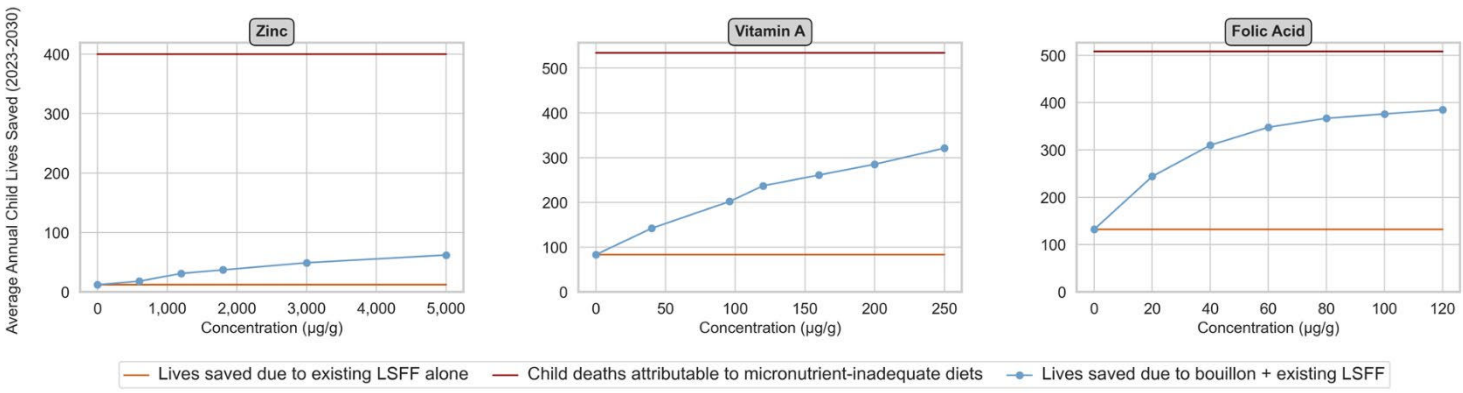
Regional variations exist in inadequacy levels and in the impacts of LSFF and potential bouillon fortification programs. For example, based on natural food intake alone, 54% of WRA nationally are at risk for dietary inadequacy of folate (**Figure 2A**), ranging from 92% in the southwestern zone (Western and Western North Regions) to 12% in the northwestern zone (Upper West Region). Wheat flour fortification contributes to reducing national inadequacy to 41% with similar subnational patterns (**Figure 2B**). Improving the performance of the wheat flour fortification and adding bouillon fortified at 30% of Codex NRVs in 2.5g (**Figure 2C**) would decrease national inadequacy to 14%, essentially eliminating this public health problem in the northern half of Ghana. Even with all of these programs in place, the national prevalence of the risk of consuming above the UL for WRA is estimated to be zero.

Figure 2: Prevalence of folate inadequacy among WRA in Ghana; various model scenarios



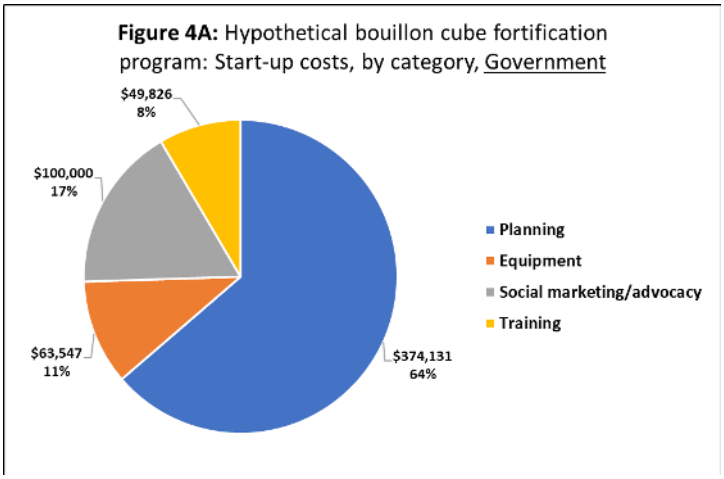
Reductions in folate inadequacy among WRA, and in VA and zinc inadequacies among children, can lead to reductions in child mortality.[4] **Figure 3** illustrates the potential number of lives saved among children (< 5 years) at different levels of fortification of bouillon (independently) with zinc, VA, and folic acid, respectively. The red line in each figure shows average annual child deaths attributable to dietary inadequacy of each micronutrient. The lower orange line shows child-lives saved by existing LSFF programs. Bouillon fortification with any of these micronutrients could save children's lives, although folic acid and VA fortification would impact a larger absolute number of children than zinc.

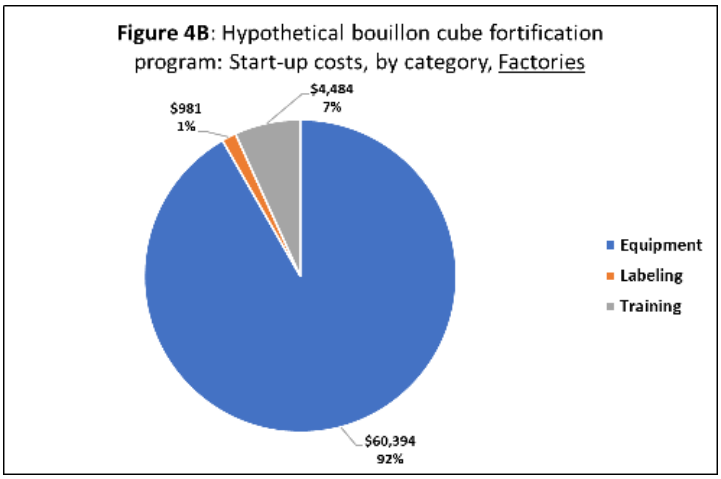
Figure 3: Child-lives saved by different levels of bouillon fortification in Ghana



Results: Bouillon fortification program costs and cost-effectiveness over 10 years

Public-sector and private-sector investments will be required to design and launch (modeled over two years), and to manage bouillon fortification programs (modeled over eight years).[5] Planning costs are substantial for government (**Figure 4A**), while equipment investments are the main start-up cost driver for industry (**Figure 4B**).





Operational costs for government for bouillon fortification programs (**Figure 4C**) are mainly comprised of training/retraining, factory inspections and monitoring, and import monitoring. Operational costs for industry (**Figure 4D**), on the other hand, are dominated by the management of premix flows (purchasing, shipping, storing, etc.) and to a lesser extent by managing the fortification process internally (fortification and QA/QC activities). Once operational in year 3 of the model simulation period, the annual cost of the flow of premix required by a program designed to meet 30% of Codex NRVs for all five micronutrients for WRA consuming 2.5g of bouillon per day is ~$7.8m, or ~$0.001 per 2.5 gram serving.

Figure 4C: Hypothetical bouillon cube fortification program: non-premix operations costs, by category, Government

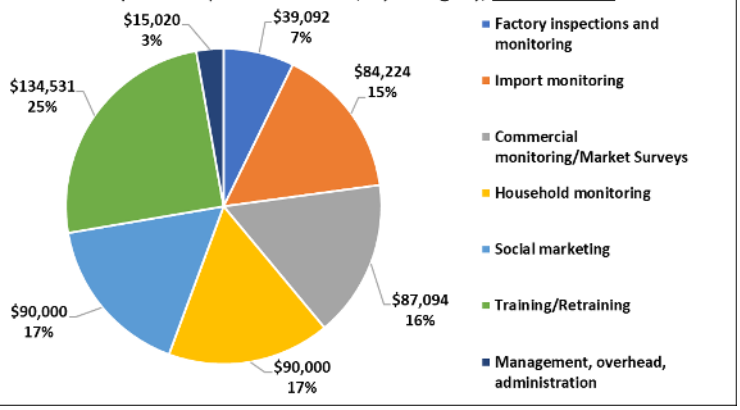


Figure 4D: Hypothetical bouillon cube fortification program: non-premix operational costs, by category, Factories

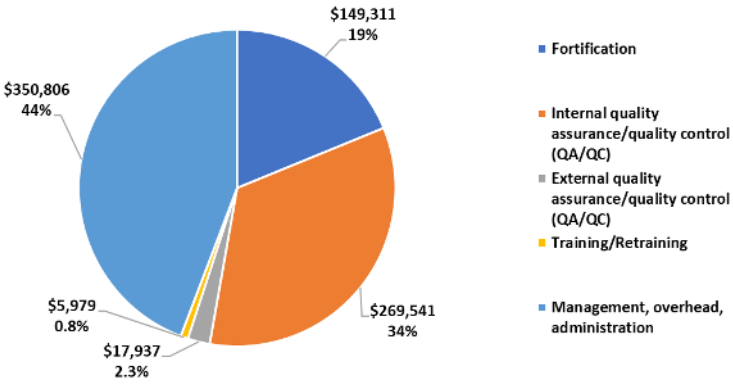
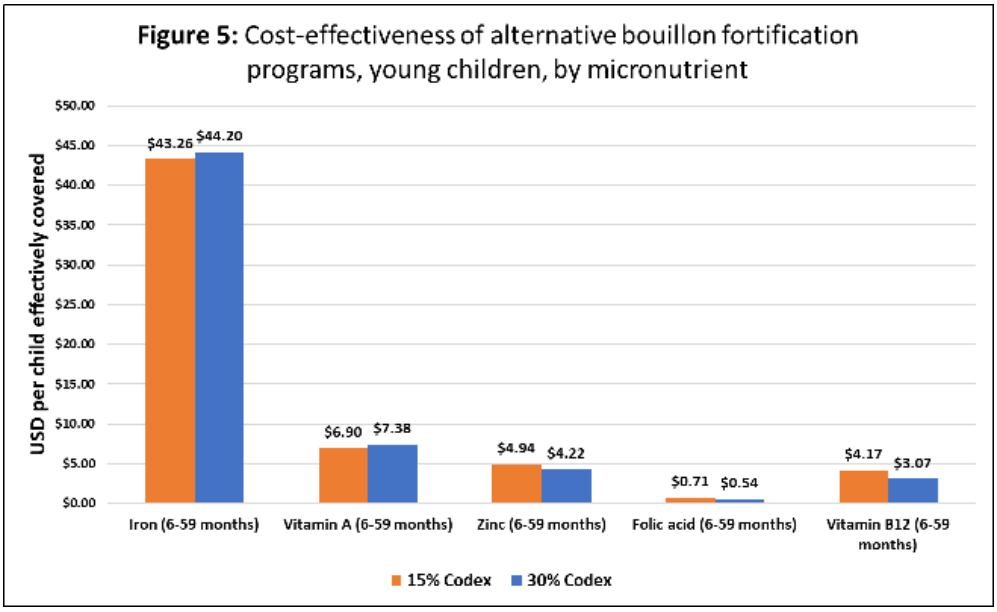


Figure 5 reports the cost-effectiveness of bouillon fortification for each of the micronutrients included in this study, at fortification levels equivalent to 15% and 30% of Codex NRV for WRA consuming 2.5g/day. Fortificant costs and (especially) predicted low absorption make iron the least efficient. VA is more cost-effective than iron, and zinc, folic acid, and B12 are the most efficient in terms of reducing micronutrient-specific dietary inadequacy per dollar invested.

Figure 5: Cost-effectiveness of alternative bouillon fortification programs, young children, by micronutrient



Partners and Funding

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Further information

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References

[1] For example: Imdad A., Yakoob M.Y., Sudfeld C., Haider B.A., Black R.E. & Bhutta Z.A. (2011). Impact of vitamin A supplementation on infant and childhood mortality. *BMC Public Health,* 11, S20. doi: 10.1186/1471-2458-11-S3-S20, and Schmidt MK, Muslimatun S, West CE, Schultink W, Hautvast JG. (2004). Mental and psychomotor development in Indonesian infants of mothers supplemented with vitamin A in addition to iron during pregnancy. *Br J Nutr* 2004; 91: 279–86.

[2] Ghana Living Standards Survey (GLSS) 7. (2019). Ghana Statistical Service, Republic of Ghana, June, 2019

[3] For details regarding methods, see Adams, K. P., Vosti, S. A., Becher, E., Ishaya, F., and Engle-Stone, R. (2024). Bouillon fortification as a strategy to address inequities in micronutrient adequacy of diets in Nigeria. Ann NY Acad Sci., First published: 10 September 2024, https://doi.org/10.1111/nyas.15207

[4] Thompson, L., Becher, E., Adams, K. P., Haile, D., Walker, N., Tong, H., Vosti, S. A., & Engle-Stone, R. (2024). Modeled impacts of bouillon fortification with micronutrients on child mortality in Senegal, Burkina Faso, and Nigeria. Ann NY Acad Sci., 1537, 82–97 https://doi.org/10.1111/nyas.15174

[5] Vosti, S. A., Jarvis, M., Anjorin, O. M., Engle-Stone, R., Beye, M., Ishaya, F., Koudougou, K., Oni, B., Somda, H., & Adams, K. P. (2024). The costs and the potential allocation of costs of bouillon fortification: The cases of Nigeria, Senegal, and Burkina Faso. Ann NY Acad Sci., 1541, 181–201. https://doi.org/10.1111/nyas.15234

[6] University of Ghana, GroundWork, University of Wisconsin-Madison, KEMRI-Wellcome Trust, UNICEF. Ghana Micronutrient Survey 2017. Accra, Ghana; 2017