**Paper 1: Global impact and costs of fortification**

*How does fortification impact micronutrient inadequacies and what does it cost to implement?*

**OBJECTIVES**

1. To estimate country- and population group-specific prevalences of inadequate micronutrient intakes accounting for LSFF programs as currently implemented (i.e., “current programs with current compliance”).
2. To estimate the potential impacts of improving existing LSFF programs or establishing new ones on the estimated prevalences of inadequate micronutrient intakes. This will be done by modelling the following scenarios:
3. Improved industry compliance with existing fortification standards (i.e., “current programs with improved compliance”)
4. [other scenarios TBD]

Table 1. Overview of scenarios modelled to estimate the prevalence of inadequate micronutrient intakes and potential impacts of improving food fortification programs

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| --- | --- | --- | --- | --- | --- |
| **Scenario1** | **Fortification standard** | **Compliance** | **Countries to which the scenario was applied** | **Fortified foods** | **Micronutrients2** |
| 1. Current programs with current compliance | Existing (as reported in GFDx) | As reported in the GFDx (estimated if data were missing) | All 185 countries that were included in Passarelli et al. | Salt, oil, rice, wheat flour, maize flour | The 15 that were included in Passarelli et al. |
| 1. Current programs with improved compliance | Existing (as reported in GFDx) | 90% | All 185 countries that were included in Passarelli et al. | Salt, oil, rice, wheat flour, maize flour | The 15 that were included in Passarelli et al. |

1 [Passarelli et al.](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4853281) used the same model (without fortification) and thus can be considered the “baseline” scenario against which these results can be compared.

2 Some fortified foods include fluoride and vitamin D in the standards, but these two nutrients are excluded from the 15.

**METHODS**

**Subnational population groups**

34 subnational age-sex groups, i.e., males and females in 17 age groups: 0- to 80-yrs-old in 5-yr groups, plus an 80+ age group) for 185 countries (same groups and countries as in Passarelli et al.).

**Estimation of micronutrient intake inadequacy**

*Step 1: Estimation of micronutrient intake from diet (without fortification)*

* Apply method from Passarelli et al. that accounts for shape of a population’s micronutrient intake distribution, based on dietary intake from 31 countries to estimates of micronutrient intake from food from individual-level global dietary database (GDD)

*Step 2: Estimation of additional micronutrient intake from fortified foods for each fortification scenario*

* Calculation for each fortified food and micronutrient combination (e.g., salt-iodine, wheat flour-iron):
  + ***Average daily per capita availability of food vehicle x Micronutrient content in fortification standards x Proportion of food vehicle industrially processed x % Compliance with fortification standards***
    - Where multiple foods are fortified with the same micronutrient in a country, estimate the additional micronutrient intake for each fortified food-micronutrient combination separately and sum intakes by micronutrient
* For scenario 1, current programs with current compliance:
  + For all countries:
    - Average daily per capita availability of each food vehicle is taken from GFDx (i.e., *Daily food intake/availability (g/c/d)*), which is based on data from FAO Supply Utilization Accounts (for most foods) or other sources (for salt)
      * Values will need to be adjusted for overall energy supply to energy expenditure for different age sex groups [method for adjustment TBD]
  + For countries with a current fortification program (i.e., they have mandatory or voluntary legislation status for the specific food vehicle according to GFDx (i.e., *Legislation status)*):
    - Micronutrient content in fortification standards is taken from GFDx (i.e., *Nutrient level in standard (mg/kg)*)
    - Proportion of food vehicle industrially processed is taken from GFDx (i.e., *Proportion industrially processed (%)*) or estimated if missing data [approach for missing data TBD once we see how much is missing]
    - % compliance with fortification standards is taken from GFDx (i.e., *Proportion fortified (%)*) or estimated if missing data [approach for missing data TBD once we see how much is missing]
  + For countries with no current fortification program:
    - Additional micronutrient intakes from fortified foods are set at zero
* For scenario 2, current programs with improved compliance:
  + For countries with a current fortification program (mandatory or voluntary):
    - Same as scenario #1 above but % compliance with fortification is set to 90% for all fortified food-micronutrient combinations
  + For countries with no current fortification program:
    - Additional micronutrient intakes from fortified foods are set at zero

Table 2. Data sources and relevant variables

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| --- | --- | --- |
| **Source (excel file name)** | **Relevant variables** | **Notes** |
| Food Intake and Availability\_20240730 | Country, Food vehicle, Legislation Status, Data year, **Daily food intake/availability (g/c/d)** | * Use most recent year for which data are available for * An adjustment for overall energy supply to energy expenditure for different age-sex groups will be applied later once determined |
| Number of Food Vehicles with Standards\_20240729 | Country, Food vehicle, Legislation status, Nutrient, **Nutrient level in standard (mg/kg)** |  |
| Proportion of Industrially Processed Food Vehicle\_20240729 | Country, Food vehicle, Legislation status, Data year, **Proportion industrially processed (%)** | * Use most recent year for which data are available |
| Proportion of Fortified Food Vehicle\_20240730 | Country, Food vehicle, Legislation status, Data year, **Proportion fortified (%)** | * Use most recent year for which data are available |

*Step 3: Estimation of micronutrient intake inadequacy prevalence for each fortification scenario*

* Sum micronutrient intake from diet + micronutrient intake from fortified foods
* Then apply probability method to determine prevalence of intake inadequacy
* Then calculate number of people within each subnational group

**Estimation of mean probability of adequacy across all micronutrients**

[details to be added later]