BFA Burden of Health Calculations

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Calculation of Burden of disease for changes in fish consumption

The GBD project is the most comprehensive methodology to assess health burden across countries, age and sex groups and various forms of disease and risks. The GBD project has calculated the burden of malnutrition for vitamin A, zinc, iron (and other nutrient deficiencies) and low seafood consumption (PUFA->heart disease) (Murray 2020, Afshin 2019 and James 2018) - four risk factors associated with fish. While not comprehensive of all outcomes associated with consuming fish (in the health literature) e.g. omega n-3 impact on child development), it seems to include both micronutrient contribution and low omega n-3 derived from fish. Using the DALYs metrics, our results can be comapred to other GBD global metrics results, enabling us to assess the magnitude of health burdens associated with reduced or increased fish consumption in future alternatives.

calculating fish-associated burden of disease in 2030

1. Build GBD dataset. As a first step, we coalesced the GBD historical data for all countries per age-sex groups and for the specific risks and causes associated with fish consumption that exist in the GBD database, namely zinc, iron, vitamin A and low omega n-3 consumption.

2. Extract and upload population data from present till 2030 per age-sex country group.

3. Using that historical data we extrapolated the burden of disease in year 2030 (hereafter DALY2030) for each age-sex-location using a moving regression.

intake distributions (I) per age-sex-location groups

1. Deriving national level distribution of micronutrients from SPADE: This stage will be done using the SPADE software (https://www.rivm.nl/en/spade) which analyzes existing HCES data and translates 24h recall into average distributions. Currently we will have estimates for a handful of countries, in all continents, from which we will infer on the distributions for all countries.

2. Deriving average micronutrient intakes from the Aglink Cosimo: This FAO model will simulate consumption of fish in future scenarios based on price elasticities, supply and demand curves and will output average nutrient intakes for reference and alternative futures per age-sex-country group.

Deriving age-sex-location changes in DALYs of micronutrient deficiences and seafood omega n-3 burdens due to perturbations in 2030

We compute the changes in DALYs (changes in health burden) per age-sex-country for each of the four risks as response to moving from the reference scenario (ref) to the alternative scenario (alt) in year 2030 using the following equation:

$$\Delta DALY_{c,a,s,r} = DALY^{2030}_{c,a,s,r} * (SEV^{alt}_{c,a,s,r}/SEV^{ref}_{c,a,s,r} - 1)$$

Where $DALY_{2030,c,a,s,r}$ is the DALY per age (a), sex (s), country (c) and risk (r) value for year 2030 derived above, and $SEV^{alt}_{c,a,s,r}$ and $SEV^{ref}_{c,a,s,r}$ are the population level average weighted exposure to risk for the alternative ("perturbed") and reference ("baseline") scenarios, respectively. SEVs are summary exposure values and they reflect excess average weighted prevelance of exposure (or inadequancy in this case). This value is equal to:

$$SEV^{ref/alt}_{c,a,s,r} = \int (I^{ref/alt}_{c,a,s,r} * RR_{c,a,s,r})$$

Usually SEV is derived by dividing the above term with the maximal risk R_{max}; however in our calculation the maximal risk is 1 (no consumption of the micronutrient).As consumption increases, RR effectively decreases. RR curves For omega n-3 can be derived from the GBD source (either the GBD 2017 log-linear curve or the GBD 2020 spline) or any other one we want to use (for example the Thomsen paper used the Mozaffarian and Rimm 2006 curve and simplified it to a descending linear curve, until a consumption level of 250 mg/cap/d EPA+DHA).

For the micronutrient calculation, I suggest two possible approaches. In the first, we use GBD relative risk curves. A second approach can be building the RR distributions by taking country level EAR values and constructing a descending risk curve based on the CDF (cumulative distribution function) of a normal distribution. IOM suggest using a CV of 10%-15% when there is no sufficient data on the requirements. Multiplying intake distribution with these RR curves and integrating will result in the prevalence of inadequacy (probability method for calculating deficiency), in effect a population-level risk (RR). As the above reference indicates, as long as the requirement distribution is symmetrical (not for iron) the results are insensitive to the shape and SD of the requirement curve. As for intakes, these are derived by taking the average nutrients/PUFA from the FAO model (for both scenarios) and building a distributions around them based on the shape deduced from SPADE; using Monte Carlo we can then assess how changes in the tail of this distribution affect the overall calcs.

Overall health burden resulting from the perturbation in consumption will be the sum of all burdens examined for each country per age-sex groups:

$$\sum_r \Delta\, DALY_{a,s,c,r}.$$

This approach allows comparison across the different risks and assess their relative contribution to the total health burden following a shock. For example in developing countries one might expect that the DALY values from micronutrient deficiencies will be sensitive to shocks more than in developed countries and possibly on par with changes in EPA+DHA contribution to health.

1. Load RR functions

```
summary(cars)
```

```
##      speed           dist       
##  Min.   : 4.0   Min.   :  2.00  
##  1st Qu.:12.0   1st Qu.: 26.00  
##  Median :15.0   Median : 36.00  
##  Mean   :15.4   Mean   : 42.98  
##  3rd Qu.:19.0   3rd Qu.: 56.00  
##  Max.   :25.0   Max.   :120.00
```

2. Make the calculations of Δ DALYs

Assessing age-sex-country micronutrient deficiences at present and in 2030 (using SEVs)

1. The burden of health of vitamin A and zinc occurs according to the GBD at ages 1-5. However to assess the prevalence of micronutrient deficiency we can use the SEV defined above. For the purpose of this calculation are in fact the prevalence of micronutrient deficiency using the probability method. It however requires to derive continuous RR curves, rather than the dichotomous RR for vitamin A and zinc used in the GBD methodology.

Therefore the change (in percentage) in micronutrient prevalence for each sex-age-country group and micronutrient r following a perturbation (increase/decrease consumption of fish) will be

$$\Delta SEV_{c,a,s,r} = (SEV^{alt}_{c,a,s,r}/SEV^{ref}_{c,a,s,r} - 1) * 100$$