METHODOLOGY SUPPLEMENT: THE ESTIMATION MODEL, DISMOD-MR

Modeling Strategy[i]

As sodium exposure data were available for only selected country-time periods, we estimated levels of sodium excretion for all country-time periods by specifying an age-integrating Bayesian hierarchical model using as a parent model, DisMod-MR, developed for the Global Burden of Disease 2010 project.[1] . The model estimated fixed effects for study-specific and national-level covariates, and random effects for GBD super region, region, and country. Estimates for males and females in single year age groups, for 1990 and 2010 are produced.

We used both study-specific and national-level covariates in the model. We included one study-specific dummy variable to indicate whether the data are from non-nationally-representative studies/surveys. In addition, we allowed the variance of sub-national-level data to be different from nationally-representative data.

Time-varying country-level covariates were used in the model to inform the global and country-level trends and are not study-specific. We used data from the Food Balance Sheets of the Food and Agriculture Organization of the United Nations (FAO)[2] which captures a country's annual availability of food for human consumption based on reported local production, imports and exports adjusted for other uses (livestock, seed). Taking into account that many of the food covariates are very collinear (for example, red meat, pig meat, and animal fats), and that consuming more of one food necessitates consuming less of other types, we used dimension reduction through principal component analysis to generate four diet pattern components from the FAO data, based on the criteria that each component must have an eigenvalue greater than one. Table MS1 below shows the eigenvalue loadings on each of the 14 FAO variables, for the four components. Table MS2 gives the eigenvalues and variance explained for the four components. Although interpretation of these components s is not clear cut, red meats, pig meats, animal fats and alcohol have the highest loading in component 1. Component 1 can be thought of as representing a

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[i] Text from the following source is used here with permission: Andrews K, Carnahan E, Ezzati M, Lim S, Murray C, and Sanman E. GBD 2010 Estimation Strategy Report for Attributable Burden to High Dietary Sodium Consumption, Unpublished report, Institute for Health Metrics and Evaluation, University of Washington, 2012.

western diet. Seafood omega 3s, plant omega 6, whole grains, nuts, and vegetables have the highest loading in component 2; fruits, legumes and nuts have the highest loading in component 3. Component 4 is second highest for omega-3 fats and is somewhat high for sugars.. Its contribution to total variance explained is not statistically significant.

Lagged- distributed income (LDI) was also included as a country-level covariate. LDI per capita is GDP per capita smoothed with a 10-year weighted moving average.[3] We use LDI instead of straight GDP. Although GDP can experience sharp changes from year to year, changes in health and related outcomes are slower to materialize, meaning that the smoother measure of LDI better predict changes in health. The sources of GDP used are the Penn World Tables, The Maddison Project, the UN Statistics Agency, the World Bank, and the IMF (see[3] for detailed source information). The equation used to generate LDI was:

LDI_y = (GDP per capita$_y$ + 0.9(GDP per capita$_{y-1}$) + 0.8(GDP per capita$_{y-2}$) + 0.7(GDP per capita$_{y-3}$) + 0.6(GDP per capita$_{y-4}$) + 0.5(GDP per capita$_{y-5}$) + 0.4(GDP per capita$_{y-6}$) + 0.3(GDP per capita$_{y-7}$) + 0.2(GDP per capita$_{y-8}$) + 0.1(GDP per capita$_{y-9}$))/5.5 (5.5 = the sum of the weights).

Table MS3 gives the effect size estimated for the study-level and national covariates from the DisMod-MR model.

Table MS1. Eigenvalue loadings used to create 4 FAO diet pattern components

Variable	Component 1	Component 2	Component 3	Component 4
Red meats	0.3614	0.1615	-0.1718	-0.1419
Animal fats	0.3546	0.1596	-0.1604	-0.1271
Fruits	0.1012	0.0712	0.6665	-0.1791
Omega- 6	0.3229	-0.296	0.0186	0.0288
Omega-3	0.0741	0.427	0.2574	0.3815
Whole grains	0.237	-0.3968	-0.1517	0.3163
Nuts	0.221	-0.2804	0.4033	0.1464
Vegetables	0.2777	-0.3197	0.1922	0.2252
Pulses/legumes	-0.2044	-0.146	0.4078	-0.4013
Alcohol	0.2896	0.0907	0.0103	-0.4957
Pig meat	0.3654	0.194	-0.1009	-0.2432
Saturated fats	0.0318	0.5036	0.171	0.3399
Stimulants	0.3031	0.1163	0.0559	-0.0203
Sugars	0.2992	0.0277	0.0493	0.1765

Table MS2: Eigenvalues and variance explained by the 4 principal components

Component	Eigenvalue	Proportion of variance explained	Cumulative proportion of variance explained
Component 1	4.883	0.349	0.349
Component 2	1.916	0.137	0.486
Component 3	1.376	0.098	0.584
Component 4	1.308	0.093	0.677

Table MS3. Effect sizes and Monte Carlo standard errors for both study-level and national covariates.

Covariate	Mean Effect Size	Effect Size SE
Study-level covariate: non-nationally-representative data	0.995	0.013
Study-level covariate: male	0.135	0.011
National covariate: log LDI per capita	-0.100	0.051
National covariate: FAO component 1	0.271	0.043
National covariate: FAO component 2	-0.100	0.023
National covariate: FAO component 3	-0.152	0.030
National covariate: FAO component 4	-0.007	0.029

Monte Carlo standard errors were estimated with mean exposure, age and sex as the predictors.

Model output

Figure S1 gives an annotated output from the DisMod-MR model.

Figures S2 to S5 show the model outputs for the regions.

Figure Legends

Figure S1. Guide to model outputs for regions

Figure S2. Model output for regions (1)

Figure S3. Model output for regions (2)

Figure S4. Model output for regions (3)

Figure S5. Model output for regions (4)

Reference List

1. Murray CJ, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C et al. GBD 2010: design, definitions, and metrics. Lancet 2012 December 15;380(9859):2063-6, plus online supplement accessed from end of text and references cited therein.

2. FAO. FAOSTAT: Food Balance Sheets. FAO 2012;Available from: URL: http://faostat3.fao.org/home/index.html#DOWNLOAD

3. James SL, Gubbins P, Murray CJ, Gakidou E. Developing a comprehensive time series of GDP per capita for 210 countries from 1950 to 2015. Popul Health Metr 2012;10(1):12.