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MODELLING SUGAR SWEETENED BEVERAGE ATTRIBUTABLE DISEASE BURDEN. DESCRIPTION OF THE SIMULATION MODEL.

Evidence for the implementation of health policies in Latin America and the Caribbean

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The general coordination of the project is in charge of the Institute of Clinical and Health Effectiveness (IECS). The IECS is one of the main institutions dedicated to public health in Latin America. As an independent and non-profit institution, it carries out research, education and technical cooperation tasks with the aim of contributing to improve the efficiency, equity, quality and sustainability of health systems and services. It is an institution affiliated with the University of Buenos Aires.

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INTRODUCTION

Non-communicable diseases (NCD) are responsible for more than half of the global health burden. Overweight and obesity are among the main modifiable risk factors worldwide; and their prevalence has been steadily increasing in Latin American and the Caribbean (LAC). Sugar-sweetened beverages (SSB) usually constitute a major source of discretionary calories and have been linked to an increased risk for obesity, type 2 diabetes, several cancer, hypertension, coronary heart disease, and tooth decay.

For these reasons many countries are considering, or have begun implementing, a series of measures aimed at reducing SSB consumption (i.e. fiscal policies, healthy environment, advertisement, regulation). The implementation of these complex interventions needs to be supported by adequate scientific evidence and requires the commitment of different stakeholders in order to be successful.

The lack of data on the burden of disease attributable to SSB in LAC, and the paucity of information and tools to assess the potential impact of SSB control policies, dictate that in many countries there is still no consensus on the need to implement these policies; or to what extent these policies should be prioritized over other NCDs interventions; and on how to select the top ones and implement them.

The aim of this project is to fulfill these needs through the empowerment of decision makers, generating country-level evidence-based knowledge on the SSB attributable disease burden, the available interventions and their evidence base; and developing the most appropriate health and economic model for LAC to estimate burden of disease as well as the cost-effectiveness of SSB control policies. We expect that this will contribute to the selection of the best set of interventions for moving policies forward, with the main objectives being the reduction of SSBs consumption and the related health and economic toll.

This project is being carried out in Argentina, Brazil, El Salvador and Trinidad & Tobago, with the additional aim to provide scalable framework and methods to other countries and/or regions.

The specific objectives of this component are:

- To develop the most appropriate model according to LAC information needs to estimate the burden of disease attributable to SSB and that latter can be used to estimate the cost-effectiveness of SSB control policies in LAC.
- To estimate the burden of disease attributable to SSB consumption, encompassing both their health (years of life lost, quality adjusted life years -QALYs-, disease events) as well as their economic impact (costs of illness) in the four participating LAC countries

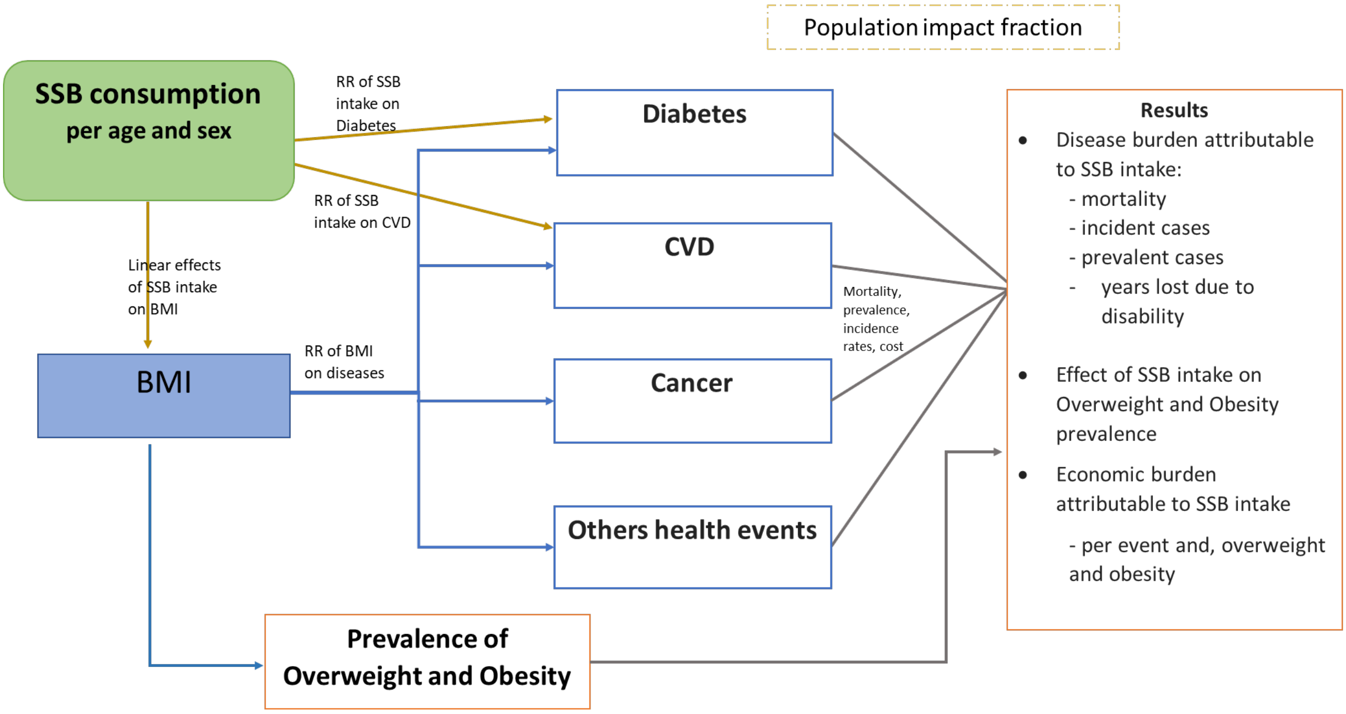
METHODS

Model Structure

To estimate the health and economic impact of sugar-sweetened beverages (SSB) intake, our approach uses a comparative risk assessment framework. In adults, the model causal framework estimates the effects of SSB consumption on health through two main paths: one of the paths is mediated through the effects on body mass index (BMI), overweight and obesity and their related health (and economic) effects; and the other path reflects the additional independent effects of SSB consumption beyond BMI on diabetes mellitus and cardiovascular diseases (CVD). Both pathways, as well as the choice of health events associated with BMI was defined after an exhaustive gathering of information from various sources: a policy dialogue, consult experts, and a literature review, among others. Then, a prioritization of which health events, based on their individual disease burden, was performed in order to select the final set of health conditions.

As the causal link from childhood SSB consumption to adulthood health conditions is somewhat less well established, and in order to be conservative, in the case of children, the model estimates only the effects of SSB consumption on overweight and obesity prevalence. See in Figure 1 the model framework.

Figure 1. Analytical model



Notes: SSB: sugar-sweetened beverages, BMI: Body Mass Index; RR: relative risk; CVD: Cardiovascular diseases include stroke isquemic, intracerebral hemorrhage, subarachnoid hemorrhage; atrial fibrillation and flutter; ischemic heart disease; hypertensive heart disease. Other health events include alzheimer and dementias, asthma, chronic kidney disease, gallbladder and biliary diseases, low back pain, osteoarthritis.

Estimation of Population Impact Fraction

The comparative risk approach was adopted to determine the Population Impact Fraction (PIF) for each selected disease. The PIF is the proportion of cases that can be attributed to a certain exposure. In this approach, the distribution of the population exposed to the risk factor is compared with a hypothetical exposure distribution that corresponds to the minimal theoretical risk of exposure. The equation used to calculate the PIF is as follows:

$$PIF = \frac{\int_{i=1}^{max} PiRRi - \int_{i=1}^{max} Pi' RRi}{\int_{i=1}^{Max} PiRR_i}$$

where i=SSB consumption level; P=current distribution in the age and sex stratum; P'=alternative distribution (zero consumption); RR=relative risk of mortality at SSB consumption level i; and m=maximum exposure level.

For example, mortality attributable to SSB consumption was calculated by multiplying the calculated population-attributable fraction by the observed number of cause-specific deaths, as follows:

$M'_{ij} = PIF_{ij} * M_{ij}$

Where M'_{ij}= mortality attributable to SSB consumption and M_{ij} he observed number of cause-specific deaths.

Analyses were done for sex and age group and assessed as both absolute and proportional mortality.

In brief, the model was developed in three stages in order to estimate the impact of a risk factor (in this case, SSB consumption) on different diseases. Firstly, changes in the risk factor distribution between baseline (current behavior) and selected scenarios are estimated. Secondly, changes in diabetes, CVD, and BMI as a result of changes in SSB consumption are calculated. Thirdly, changes in disease burden are estimated using population impact fraction and applied to baseline levels of each selected disease in the population. The model is fed with parameters corresponding to risk factor, baseline disease status, and epidemiological relationships between risk factors and diseases.

Table 1 presents the data used for the impact of a one unit serving (8oz) of SSB on BMI, diabetes and cardiovascular disease. We applied all results to the population 2019 (using Argentina as the first country example to calibrate) and made separate estimates for each outcome by sex and age using age-specific and sex-specific estimates of baseline SSB consumption and disease burden.

The model measures the number of prevented incident and prevalent cases, the number of deaths prevented, the years lost due to ill health and total healthy years, as well as the economic burden associated with the SSB consumption. It also reports as intermediate outcomes the change in obesity and overweight distribution in the different scenarios.

Table 1. Sources and Magnitudes of the Effects of SSBs on Diabetes Mellitus and Cardiovascular Disease, SSB on BMI, and BMI on Chronic Disease Outcomes

Risk factor	**Type of effect estimate**	**Parameter**	**Source**
SSB-BMI	Linear effect	Adults: - BMI<25, 0.10 (95%CI, 0.05–0.15) kg/m2 - BMI ≥25, 0.23 (95%CI, 0.14–0.32) kg/m2 Per additional serving per day Children:- 0.57 kg/m2 for a 1.7 servings/day	Khatibzadeh et al (2012), de Ruyter et al (2012), Ebbeling et al (2012)
BMI-health events	Relative risk	Data that varies according to health event, and is specific age and specific gender in adults	GBD (2017)
SSB-Incidence of type 2 Diabetes	Linear effect	1.37 (95%CI 1.15, 1.63) per serving/day of SSB	Imamura et al (2015)

SSB-Cardiovascular mortality	Linear effect	1.08 (95% CI, 1.04 to 1.13) per serving/day of SSB	Yin et al (2020)
SSB-Cardiovascular incidence	Linear effect	1.08 (95% CI, 1.02 to 1.14) per serving/day of SSB	Yin et al (2020)

Calibration

The model was calibrated using national vital statistics and considering as acceptable a variation of plus or minus 10% in the model results. In the case that these are not achieved, a modification of +/- 20% was made in the lethality or incidence risk equations to adjust the results. However, in cases where vital statistics are suspected to be underreported or data are unreliable, mortality and incidence data from the original sources was used without calibration.

REFERENCES

1. Khatibzadeh S, Micha R, Afshin A, Rao M, Yakoob MY, Dariush M. Abstract: Major dietary risk factors for chronic diseases: a systematic review of the current evidence for causal effects and effect sizes. Circulation. 2012;125(Suppl10):AP060.
2. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. N Engl J Med. 2012;367:1397–1406. doi: 10.1056/NEJMoa1203034.
3. Ebbeling CB, Feldman HA, Chomitz VR, Antonelli TA, Gortmaker SL, Osganian SK, Ludwig DS. A randomized trial of sugar-sweetened beverages and adolescent body weight. N Engl J Med. 2012;367:1407–1416. doi: 10.1056/NEJMoa1203388.
4. James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., ... & Abdollahpour, I. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1789-1858.
5. Jiawei Yin, Yalun Zhu, Vasanti Malik, Xiaoqin Li, Xiaolin Peng, Fang Fang Zhang, Zhilei Shan, Liegang Liu, Intake of Sugar-Sweetened and Low-Calorie Sweetened Beverages and Risk of Cardiovascular Disease: A Meta-Analysis and Systematic Review, *Advances in Nutrition*, nmaa084, https://doi.org/10.1093/advances/nmaa084
6. Imamura F, O'Connor L, Ye Z, Mursu J, Hayashino Y, Bhupathiraju SN, Forouhi NG. Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes: systematic review, meta-analysis, and estimation of population attributable fraction. BMJ. 2015 Jul 21;351:h3576. doi: 10.1136/bmj.h3576. PMID: 26199070; PMCID: PMC4510779.