**SUPPLEMENTARY MATERIAL FOR THE IMPACT MODEL**

**“EFFECTS OF REDUCING PROCESSED CULINARY INGREDIENTS AND ULTRA-PROCESSED FOOD IN THE BRAZILIAN DIET: A CARDIOVASCULAR MODELLING STUDY”**

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| **List of abbreviations** |
| BR | Brazil |
| CHD | Cardiovascular heart disease |
| CMC | Cumulative mortality change |
| CVD | Cardiovascular disease |
| G1 | Group 1 (Unprocessed or minimally processed food) |
| G2 | Group 2 (Processed culinary ingredients) |
| G3 | Group 3 (Processed food) |
| G4 | Group 4 (Ultra-processed food) |
| g | Grams |
| HBS | Household Brazilian Survey |
| IBGE | Instituto Brasileiro de Geografia e Estatística(Brazilian Institute of Geography and Statistics) |
| Kcal | Kilo Calorie |
| kJ | Kilo Joules |
| nCMC | Non cumulative mortality change |
| Na  | Sodium |
| POF | Pesquisa de Orçamento Familiar |
| PUFA | Polyunsaturated fatty acids |
| SATFAT | Saturated Fat |
| UK | United Kingdom |
| UPF |  Ultra-processed food |
| WHO |  World Health Organization  |
|  |  |

# QUANTIFYING THE AVERAGE NUTRIENT PROFILE OF PROCESSED CULINARY INGREDIENTS AND ULTRA-PROCESSED FOOD (UPF) IN THE BRAZILIAN DIET

The Brazilian Institute of Geography and Statistics (IBGE) in 2002/2003 and 2008/2009 conducted a national household budget survey and the total numbers of households was 48,470 in 2002-2003 and 55,970 in 2008-2009 (2,3). In this study we analyzed the purchased food items for consumption by household over seven consecutive days recorded by interviewers from the IBGE in 2008 and 2009.

**UPF typology description**

All items were classified into the typology from the NOVA classification, which is a new food classification based on the nature, extent and purpose of food processing devised by Monteiro et al. (2016) at the School of Public Health at the University of São Paulo in Brazil. NOVA classification categorizes foodstuffs into four groups(1). For further information on the classification system please see adapted Box 1(1).

**Box 1. Processing methods and examples of foods, ingredients and products.**

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| --- |
| **Group 1: Unprocessed or minimally processed foods** Minimal processing methods do not add or introduce any new substances to raw foods. Usually minimal processing involves subtracting parts of the food without significantly changing the nature or use of the food. Specific processes include:* Cleaning, scrubbing, washing
* Winnowing, hulling, peeling, flaking, skinning, boning, scaling, filleting, skimming
* Drying, chilling, refrigerating, freezing, pasteurization
* Sealing, wrapping, vacuum packing

Malting, which involves adding water, is also classed as a minimal process. Fermentation, where living organisms are added, is classed as a minimal process provided it does not generate alcohol.Minimal processes preserve foods and make them suitable for storage. They ease culinary preparation, can enhance their nutritional quality, make them easier to digest and make them more enjoyable to eat. Unprocessed or minimally processed foods include: * Fresh, chilled, frozen or vacuum packed vegetables
* Fresh fruits, dried fruits and 100% unsweetened fruit juices
* Fresh, dried, chilled or frozen meats, poultry and fish
* Fresh and pasteurized milk
* Eggs
* Fermented milk such as plain yoghurt
* Grains (cereals)
* Fresh, frozen and dried beans and other legumes (pulses)
* Roots and tubers
* Fungi
* Unsalted nuts and seeds
* Tea, coffee, herb infusions, tap water and bottled spring water
* Dried mixed fruits
* Granola made from cereals
* Nuts and dried fruits with no added sugar
* Honey or oil
* Foods with vitamins and minerals added to replace nutrients lost during processing, such as wheat or corn flour fortified with iron or folic acid.
 |
| **Group 2: Processed culinary ingredients**In isolation, culinary ingredients are unbalanced, usually being depleted in most nutrients. However, culinary ingredients are normally combined with other foods and are typically not normally consumed by themselves. Specific methods used to produce culinary ingredients include: * Pressing
* Pulverising
* Refining
* Milling
* Crushing
* Grinding

These are often used in addition to minimal processing methods. Stabilising or ‘purifying’ agents and other additives may also be used. Examples of ingredients in this category include: * Salt mined or from seawater
* Sugar and molasses obtained from cane or beet
* Honey extracted from combs and syrup from maple trees
* Vegetable oils crushed from olives or seed
* Butter and lard obtained from milk and pork
* Starches extracted from corn and other plants
* Salted butter
* Vinegar made by acetic fermentation of wine or other alcoholic drinks

Group 2 items may contain additives used to preserve the product’s original properties. |
| **Group 3: Processed foods**‘Processed food’ are directly derived from foods and are recognisable as versions of the original foods made by adding sugar, oil, salt or other group 2 substances to group 1 foods. Most processed foods have two or three ingredients. Manufactured through processes including: * Canning and bottling using oils, sugars or salt
* Salting, salt pickling
* Smoking, curing

Examples include: * Canned or bottled vegetables or legumes preserved in brine
* Whole fruits preserved in syrup
* Tinned fish preserved in oil
* Salted, cured or smoked meats
* Cheeses
* Unpackaged freshly made breads

When alcoholic drinks are identified as foods, those produced by fermentation of group 1 foods such as beer, cider and wine, are classified here in Group 3. |
| **Group 4: Ultra-processed food and drink products** Ultra-processed foods are typically not recognisable as versions of whole foods, although ultra-processing often includes techniques designed to imitate the appearance, shape and sensory qualities of whole foods. Some are directly derived from the combination of foods and ingredients such as oils, fats, flours, starches, and sugar. Others are made through further processing of food constituents. The majority contain many additives such as preservatives, stabilisers, emulsifiers, solvents, binders, sweeteners, sensory enhancers, flavours and colours. Most of these ingredients used by food manufacturers to make ultra-processed products are not available to consumers. Bulk is often added using air or water. Synthetic micronutrients may be added to ‘fortify’ the products. * Pre-prepared pies, pizza or pasta dishes
* Burgers and hotdogs
* Chips and French fries
* Poultry and fish ‘nuggets’, ‘sticks’ or ‘fingers’
* Animal products made from flour and salt with scraps/remnants of meat
* ‘Instant’ packaged soups and noodles and desserts
* Bread, breakfast ‘cereals’, ‘cereal’ and ‘energy’ bars
* Sweetened breads and buns
* Ice cream, chocolates, confectionery
* Cookies, biscuits, cakes, pastries and desserts
* Cake mixes
* Chips (crisps) and other fatty, salty or sweet snack products
* Sugared milk and sweetened fruit drinks
* ‘Energy’ drinks
* ‘Fruit’ yoghurts and ‘fruit’ drinks
* Carbonated drinks; milk drinks;
* Preserves
* Sauces
* Meat, yeast and other extracts
* Margarines and spreads
* Canned/dehydrated soups
* Instant formula, follow-on milks, other baby products
 |

# ESTIMATING THE IMPACT OF REDUCING CONSUMPTION OF THESE FOODS UPON MORTALITY FROM CORONARY HEART DISEASE AND STROKE

The next step to take is to quantify the effect of dietary change on average daily nutritional intake in each of the scenarios run in the model. We can then estimate the subsequent effects on CVD. This is achieved using information from existing studies which quantify such effects.

Figure 1 illustrates relationships between inputs and outputs within the model.

A Δ FOOD GROUP

B Δ NUTRIENT LEVEL

C Δ CORONARY HEART DISEASE AND STROKE MORTALITY

Figure 1: Links in the model

## DISTRIBUTION OF NUTRIENTS PER FOOD GROUP

To calculate the baseline nutrient level value in each of the food groups, we followed the methodology described below

### Saturated fats

It was necessary for the purposes of analysis to convert saturated fat content from grams into a percentage of total daily energy intakes (Box 2). To achieve this, we assumed the following:

**1g Saturated Fat = 9 Kcal** (5)

**Box 2: Conversion from saturated fat to proportion of daily energy intake**

|  |
| --- |
| Fatty Acids: Mean Brazil intake of Saturates per day (g) and proportion saturates as a percentage of total energy intake by groups |
| **G1** | **5.72 g** | **5.72\*9 = 51.48 Kcal** | **6.78%(1)** |
| **G2** | **3.50 g** | **3.50\*9 = 31.50 Kcal**  | **8.61%(1)** |
| **G3** | **1.44 g** | **1.44\*9 = 12.96 Kcal** | **28.1%(1)** |
| **G4** | **3.65 g** | **3.65\*9 = 32.85 Kcal** | **8.72%(1)** |

(1) % of availability of total energy per capita

\* Source: IBGE (HBS 2008/2009) after the classification in groups

### Salt

Salt is preferred to sodium as an input for this model, meaning that we needed to convert our figures from sodium content to salt content. Quantity of salt was calculated using the following assumption:

**1g Salt = 0.4 g sodium** (7)

|  |
| --- |
| Box 4: Conversion of Sodium into Salt |
| Assumption: 1g salt = 0.4g Na | SALT (g) |
| G1 | 0.17\*1/0.4= 0.43 |
| G2 | 2.69\*1/0.4= 6.73 |
| G3 | 0.22\*1/0.4 = 0.55 |
| G4 | 0.87\*1/0.4 = 2.17 |

Example 2:

|  |
| --- |
| Box 3: Na (g) Brazil per day |
|  G1 | 0.17 g |
| G2 | 2.69 g |
| G3 | 0.22 g |
| G4 | 0.87 g |

\* Source: IBGE 2008/2009

### Trans fats

The quantity of trans fat was provided by Brazilian Institute of Geography and Statistics (2008/2009)(9). In the Box 5 below, there are the values per age. We assumed trans-fat contents only in ultra-processed foods.

|  |
| --- |
| Box 5: Trans Fatty Acids (mean of % total energy) |
| Men 10-13 | 1.08871 |
| Men14-18 | 1.21887 |
| Men 19-59 | 1.08183 |
| Men >60 | 1.05292 |
| Women 10-13 | 1.04596 |
| Woman14-18 | 1.21244 |
| Women 19-59 | 1.15789 |
| Women >65 | 1.14765 |

 \* Source: IBGE (2008/2009)(9)

### Added sugar

It was necessary to convert added sugar content from grams into a percentage of total daily energy intakes (Box 6). To achieve this, we assumed the following:

**1g Added sugar = 4 Kcal** (5)

**Box 6: Conversion from added sugar to proportion of daily energy intake**

|  |
| --- |
| Mean Brazil intake of added sugar per day (g) and proportion as a percentage of total energy intake |
| **G1** | **0.09 g** | **0.09\*4 = 0.36 Kcal** | **0.05%(1)** |
| **G2** | **46.24 g** | **46.24\*4 = 184.96 Kcal**  | **49.81%(1)** |
| **G3** | **0.53 g** | **0.53\*4 = 2.12 Kcal** | **5.26%(1)** |
| **G4** | **17.07 g** | **17.07\*4 = 68.28 Kcal** | **18.11%(1)** |

(1) % of availability of total energy per capita

\* Source: IBGE (2008/2009) after the classification in groups

## CALCULATING THE CUMULATIVE MORTALITY CHANGE (CMC) AND THE NON-CUMULATIVE MORTALITY CHANGE (NCMC)

We evaluated the cumulative mortality change (CMC) and the non-cumulative mortality change (nCMC) for CHD and Stroke. The generic equations and examples below show how CMC and nCMC were calculated in the scenarios. For simplicity we have always used the grouping of men under the age of 35 as our examples.

The following table displays the **baseline** distribution of daily caloric intake for the Brazilian population among the four food groups:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **GROUP1** | **GROUP2** | **GROUP3** | **GROUP4** | **Total** |
| Daily caloric share | 49.73% | 22.26% | 2.83% | 25.17% | 100.00% |

In **Scenario A (Modest)**, we assumed that dietary intake of G4 (‘ultra-processed food’) should be reduced by quarter and substituting those calories by G1 (‘unprocessed or minimally processed food’) and additionally a reduction of G2 (‘processed culinary ingredients’) by quarter.

The daily caloric share of scenario A is displayed in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | **GROUP1** | **GROUP2** | **GROUP3** | **GROUP4** | **Total** |
| Daily caloric share | 56.03% | 16.70% | 2.83% | 18.88% | 94.43% |

The cumulative mortality change occurring in G1 (**CMC1 (Scenario A))** can be expressed as:

**CMC1(Scenario A) = 1- {[1-(βSatFat\*SatFat**Baseline**G1-SatFat**ScenarioA**G1]\*[1-(βSalt\*Salt**Baseline**G1-Salt**ScenarioA**G1)]\*[1-(βTransFat\*TransFat**Baseline**G1-TransFat**ScenarioA**G1)]\*[1-(βAddedSugar\*AddedSugar**Baseline**G1-AddedSugar**ScenarioA**G1)]}**

Where the β is the age and sex specific beta value that quantifies the estimated relative change in CVD mortality that would result from a one-unit change in the nutrient level. Beta values for all nutrients can be found in the data sources section of this document. The age and sex specific baseline estimate of the nutrient (SatFatBaselineG1, SaltBaselineG1, etc.) can be found in the data source section. The new age and sex specific nutrient level estimate in scenario A (SatFatScenarioAG1, SaltScenarioAG1, etc.) was calculated by adjusting the baseline estimate according to the change in the daily caloric share for G1. For example if the caloric share in G1 increased from 49.7% in the baseline scenario to 56.03% in Scenario A, the nutrient value will increase by the same proportion.

Changes in G2 and G4 were calculated analogously with the following equations:

**CMC2(Scenario A) = 1- {[1-(βSatFat\*SatFat**Baseline**G2-SatFat**ScenarioA**G2]\*[1-(βSalt\*Salt**Baseline**G2-Salt**ScenarioA**G2)]\*[1-(βTransFat\*TransFat**Baseline**G2-TransFat**ScenarioA**G2)]\*[1-(βAddedSugar\*AddedSugar**Baseline**G2-AddedSugar**ScenarioA**G2)]}**

**CMC4 (Scenario A) = 1- {[1-(βSatFat\*SatFat**Baseline**G4-SatFat**ScenarioA**G4]\*[1-(βSalt\*Salt**Baseline**G4-Salt**ScenarioA**G4)]\*[1-(βTransFat\*TransFat**Baseline**G4-TransFat**ScenarioA**G4)]\*[1-(βAddedSugar\*AddedSugar**Baseline**G4-AddedSugar**ScenarioA**G4)]}**

Example: CMC for CHD in men under 35 years in the scenario A

CMC1= 1- {[1-(0.072947368\*-0.009108)] \* [1-(0.048315789\*-0.054165)] \* [1-(0.165789474\*0.000000)]\*[1-(0.010453333\*-0.000055)]}

**= -0.003** CMC for CHD

CMC2 = 1- {[1-(0.072947368\*0.018154)] \* [1-(0.048315789\*1.684583)] \* [1-(0.165789474\*0.0000)] \* [1-(0.010453333\*0.1181)]}

**= 0.084** CMC for CHD

CMC4 = 1- {[1-(0.072947368\*0.022519)] \* [1-(0.048315789\*0.542917)] \* [1-(0.165789474\*0.0027)] \* [1-(0.010453333\*0.0459)]}

**= 0.029** CMC for CHD

Example: CMC for Stroke in men under 35 years of age in the scenario A

CMC1= 1- {[1-(0.018236842\*-0.009108)] \* [1-(0.066789474\*-0.054165)] \* [1-(0.082894737\*0.0000)] \* [1-(0.010453333\*-0.000055)]}

= -**0.004**  CMC for Stroke

CMC2= 1- {[1-(0.018236842\*0.018154)] \* [1-(0.066789474\*1.684583)] \*

[1-(0.082894737\*0.0000)] \* [1-(0.010453333\*0.1181)]}

= **0.114** CMC for Stroke

CMC4= 1- {[1-(0.018236842\*0.022519)] \* [1-(0.066789474\*0.542917)] \*

[1-(0.082894737\*0.0027)] \* [1-(0.010453333\*0.0459)]}

= **0.037** CMC for Stroke

Likewise, the equations for the non-cumulative mortality changes in the **scenario A** can be expressed as

**nCMC1(Scenario A) = {[(βSatFat\*SatFat**Baseline**G1-SatFat**ScenarioA**G1] + [(βSalt\*Salt**Baseline**G1-Salt**ScenarioA**G1)] + [(βTransFat\*TransFat**Baseline**G1-TransFat**ScenarioA**G1)] + [(βAddedSugar\*AddedSugar**Baseline**G1-AddedSugar**ScenarioA**G1)]}**

**nCMC2(Scenario A) ={[(βSatFat\*SatFat**Baseline**G2-SatFat**ScenarioA**G2] + [(βSalt\*Salt**Baseline**G2-Salt**ScenarioA**G2)] + [(βTransFat\*TransFat**Baseline**G2-TransFat**ScenarioA**G2)] + [(βAddedSugar\*AddedSugar**Baseline**G2-AddedSugar**ScenarioA**G2)]}**

**nCMC4 (Scenario A) = {[(βSatFat\*SatFat**Baseline**G4-SatFat**ScenarioA**G4] [(βSalt\*Salt**Baseline**G4-Salt**ScenarioA**G4)] + [(βTransFat\*TransFat**Baseline**G4-TransFat**ScenarioA**G4)] + [(βAddedSugar\*AddedSugar**Baseline**G4-AddedSugar**ScenarioA**G4)]}**

The cumulative mortality change and the non-cumulative mortality for the rest of the scenarios were calculated analogously.

## ESTIMATING THE REDUCTION IN DEATHS WITH CUMULATIVE AND NON-CUMULATIVE EFFECTS

Finally, to precisely estimate absolute figures for mortality reduction we multiplied the predicted change (CMC or nCMC) by the projected population in 2030. The projected figures used account for changes in population demographic as well as simply population size. This is important given the distribution of CVD mortality.

Generic formulas are given along with an example. The examples all apply to men under 35 years of age.

*Reduction in CHD mortality using cumulative effects:*

Expected Deaths from CHD\*CMC1­+ Expected Deaths from CHD\*CMC2 +Expected Deaths from CHD\*CMC4

Expected Deaths for CHD = age group CHD mortality rate in 2010\* projected population demographics in 2030

Examples:

Reduction in CHD mortality for men under 35 years of age in scenario A using cumulative effects:

= [(0.00002\*52399731)\*-0.003] + [(0.00002\*52399731)\*0.029] + [(0.00002\*52399731)\*0.084] = **90**

Reduction in CHD mortality for men under 35 years of age in scenario B using cumulative effects:

= [(0.00002\*52399731)\*-0.007] + [(0.00002\*52399731)\*0.057] + [(0.00002\*52399731)\*0.167] = **179**

Reduction in CHD mortality for men under 35 years of age in scenario C using cumulative effects:

= [(0.00002\*52399731)\*-0.006] + [(0.00002\*52399731)\*0.087] + [(0.00002\*52399731)\*0.170] = **206**

*Reduction in CHD mortality using non-cumulative effects:*

Expected Deaths from CHD\*nCMC1 + Expected Deaths from CHD\*nCMC2 + Expected Deaths from CHD\*nCMC3

Expected Deaths for CHD = age group CHD mortality rate in 2010\* projected population demographics in 2030

Examples:

Reduction in CHD mortality for men under 35 years of age in scenario A using non-cumulative effects

= [(0.00002\*52399731)\*-0.003] + [(0.00002\*52399731)\*0.029] + [(0.00002\*52399731)\*0.084] = **90**

Reduction in CHD mortality for men under 35 years of age in scenario B using non-cumulative effects

= [(0.00002\*52399731)\*-0.007] + [(0.00002\*52399731)\*0.058] + [(0.00002\*52399731)\*0.168] = **180**

Reduction in CHD mortality for men under 35 years of age in scenario C using cumulative effects:

= [(0.00002\*52399731)\*-0.006] + [(0.00002\*52399731)\*0.088] + [(0.00002\*52399731)\*0.172] = **208**

*Reduction in stroke mortality using cumulative effects:*

Expected Deaths from stroke\*CMC1 + Expected Deaths from stroke\*CMC2 + Expected Deaths from stroke\*CMC4

Expected Deaths for Stroke = age group Stroke mortality rate in 2010\* projected population demographics in 2030

Examples:

Reduction in stroke mortality for men under 35 years of age in scenario A using cumulative effects:

= [(0.00002\*52399731)\*-0.004] + [(0.00002\*52399731)\*0.037] + [(0.00002\*52399731)\*0.114] = **123**

Reduction in stroke mortality for men under 35 years of age in scenario B using cumulative effects:

= [(0.00002\*52399731)\*-0.008] + [(0.00002\*52399731)\*0.075] + [(0.00002\*52399731)\*0.227] = **245**

Reduction in stroke mortality for men under 35 years of age in scenario C using cumulative effects:

= [(0.00002\*52399731)\*-0.010] + [(0.00002\*52399731)\*0.112] + [(0.00002\*52399731)\*0.229] = **276**

 *Reduction in stroke mortality using non-cumulative effects:*

Expected Deaths from stroke\*nCMC1+ Expected Deaths from stroke\*nCMC2 + Expected Deaths from stroke\*nCMC3

Expected Deaths for Stroke = age group Stroke mortality rate in 2010\* projected population demographics in 2030

Examples:

Reduction in stroke mortality for men under 35 years of age in scenario A using cumulative effects:

= [(0.00002\*52399731)\*-0.004] + [(0.00002\*52399731)\*0.037] + [(0.00002\*52399731)\*0.114] = **123**

Reduction in stroke mortality for men under 35 years of age in scenario B using cumulative effects:

= [(0.00002\*52399731)\*-0.008] + [(0.00002\*52399731)\*0.075] + [(0.00002\*52399731)\*0.228] = **246**

Reduction in stroke mortality for men under 35 years of age in scenario C using cumulative effects:

= [(0.00002\*52399731)\*-0.010] + [(0.00002\*52399731)\*0.113] + [(0.00002\*52399731)\*0.231] = **277**

The same reasoning and process is applied to all age groups and both sexes in all scenarios.

The figures derived from the examples given above are shown in the following box:

**Box 7: Number of reduction in CHD and stroke deaths in scenarios A, B, and C (age group under 35 male)**

|  |  |  |
| --- | --- | --- |
| **Age group < 35 Male** | Reduction in CHD deaths | Reduction in Stroke Deaths |
| **Scenario A** | **Scenario B** | **Scenario C** | **Scenario A** | **Scenario B** | **Scenario C** |
| **With cumulative effects** | 90 | 179 | 206 | 123 | 245 | 276 |
| **With non-cumulative effects** | 90 | 180 | 208 | 123 | 246 | 277 |

## PROBABILISTIC SENSITIVE ANALYSIS (PSA)

Every model involves uncertainty. To explore the potential effects of reducing consumption of UPF on risk factors and CVD deaths we performed a probabilistic sensitivity analysis. Simulations were performed using the Monte Carlo methodology. This allowed stochastic variation of parameters based on the sizes of the effects obtained from the literature. Using this technique, we were able to recalculate the model iteratively. Confidence intervals of 95% were generated for the median using the bootstrap percentile method. The model simulation was implemented using MS Excel with the addition of the package Ersatz ([www.epigear.com](http://www.epigear.com)).

Box 8 shows the distribution of values used for each nutrient/food input.

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| --- |
| Box 8: Standard distribution function used in the model |
| Nutrient/food | **Distribution used** |
| Salt | Erpert \*= (lower confidence interval, mean, upper confidence interval) |
| Saturated Fat | Erpert \*= (lower confidence interval, mean, upper confidence interval) |
| Trans-fat | Erpert \*= (lower confidence interval, mean, upper confidence interval) |
| Added sugar | Erpert \*= (lower confidence interval, mean, upper confidence interval) |
| \*Erpert = Pert standard distribution function |

# RESULTS

## Nutrient level in different food groups

Table 1 shows the average nutrient intake from each food group for the entire sample population (males and females of all age groups). Ranges are given along with a weighted average.

Tables 2 and 3 show salt and saturated fat intake from G1 and G2 respectively. Results are stratified by age group and gender. These values are also shown as their percentage contribution to total energy intake. It was assumed that trans-fat content in G1 and G2 would be zero [sec 2.a].

**Table 1: Nutrient level in different food groups and weighted average in Brazil 2008/2009**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Food/Nutrient | G1 | G2 | G3 | G4 |
| Salt intake (g/day) | 0.43-0.44(WA 0.43) | 6.74-6.90(WA 6.75) | 0.55-0.56(WA 0.55) | 2.17-2.22(WA 2.17) |
| Saturated Fat (% energy intake/day) | 0.068-0.075(WA 0.07) | 0.073-0.143(WA 0.08) | 0.264-0.290 (WA 0.27) | 0.086-0.091(WA 0.088) |
| Trans Fat \*(% energy intake/day)\* | 0.00 | 0.00 | 0.00 | 0.010-0.012(WA 0.011) |
| Added sugar(% energy intake/day) | 0.0004-0.0005(WA 0.0004) | 0.473-0.815(WA 0.52) | 0.053-0.087(WA 0.06) | 0.168-0.190(WA 0.18) |
| WA = weighted average\*The values for trans-fat are assumptions based on data collected from Brazilian Institute of Geography and Statistics (9) |

**Table 2: Salt and saturated fat inputs by age and gender in G1**

|  |  |  |
| --- | --- | --- |
|  | SALT in Group 1 (g) | SAT FAT in Group 1% of energy |
| Age and gender | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** |
| 25-34 M\* | 0.43 | 0.40 | 0.45 | 0.072 | 0.069 | 0.074 |
| 25-34 F\*\* | 0.43 | 0.40 | 0.45 | 0.072 | 0.069 | 0.074 |
| 35-44 M | 0.43 | 0.40 | 0.45 | 0.068 | 0.065 | 0.070 |
| 35-44 F | 0.43 | 0.40 | 0.45 | 0.068 | 0.065 | 0.070 |
| 45-54 M | 0.43 | 0.40 | 0.45 | 0.066 | 0.064 | 0.069 |
| 45-54 F | 0.43 | 0.40 | 0.45 | 0.066 | 0.064 | 0.069 |
| 55-64 M | 0.43 | 0.40 | 0.45 | 0.069 | 0.067 | 0.072 |
| 55-64 F | 0.43 | 0.40 | 0.45 | 0.069 | 0.067 | 0.072 |
| 65-74 M | 0.44 | 0.41 | 0.46 | 0.070 | 0.068 | 0.073 |
| 65-74 F | 0.44 | 0.41 | 0.46 | 0.070 | 0.068 | 0.073 |
| 75+ M | 0.44 | 0.41 | 0.46 | 0.075 | 0.073 | 0.078 |
| 75+ F | 0.44 | 0.41 | 0.46 | 0.075 | 0.073 | 0.078 |

**\*M = male; \*\*F = female (It was assumed the same values for male and female)**

 **Table 3: Salt and saturated fat inputs by age and gender in G2**

|  |  |  |
| --- | --- | --- |
|  | SALT in Group 2 (g) | SAT FAT in Group 2% of energy |
| Age and gender | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** |
| 25-34 M\* | 6.74 | 6.04 | 7.43 | 0.073 | 0.071 | 0.075 |
| 25-34 F\*\* | 6.74 | 6.04 | 7.43 | 0.073 | 0.071 | 0.075 |
| 35-44 M | 6.74 | 6.04 | 7.43 | 0.086 | 0.084 | 0.088 |
| 35-44 F | 6.74 | 6.04 | 7.43 | 0.086 | 0.084 | 0.088 |
| 45-54 M | 6.74 | 6.04 | 7.43 | 0.095 | 0.092 | 0.098 |
| 45-54 F | 6.74 | 6.04 | 7.43 | 0.095 | 0.092 | 0.098 |
| 55-64 M | 6.74 | 6.04 | 7.43 | 0.119 | 0.116 | 0.122 |
| 55-64 F | 6.74 | 6.04 | 7.43 | 0.119 | 0.116 | 0.122 |
| 65-74 M | 6.90 | 6.19 | 7.61 | 0.143 | 0.139 | 0.147 |
| 65-74 F | 6.90 | 6.19 | 7.61 | 0.143 | 0.139 | 0.147 |
| 75+ M | 6.90 | 6.19 | 7.61 | 0.140 | 0.136 | 0.144 |
| 75+ F | 6.90 | 6.19 | 7.61 | 0.140 | 0.136 | 0.144 |

 **\*M = male; \*\*F = female (It was assumed the same values for male and female)**

Tables 4 and 5 show salt, saturated fat and trans-fat intake from G3 and G4 stratified by age group and gender using the Ersatz Pert Distribution (mean, lower confidence interval and upper confidence interval). In G3 it was assumed that the quantity of trans-fat would be zero.

Table 6 shows added sugar from G1, G2, G3 and G4 stratified by age group and gender.

 **Table 4: Salt and saturated fat inputs by age and gender in G3**

|  |  |  |
| --- | --- | --- |
|  | SALT (g) in G3 | SAT FAT (%) in G3 |
| Age and gender | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** |
| 25-34 M\* | 0.55 | 0.50 | 0.61 | 0.274 | 0.270 | 0.277 |
| 25-34 F\*\* | 0.55 | 0.50 | 0.61 | 0.274 | 0.270 | 0.277 |
| 35-44 M | 0.55 | 0.50 | 0.61 | 0.280 | 0.276 | 0.284 |
| 35-44 F | 0.55 | 0.50 | 0.61 | 0.280 | 0.276 | 0.284 |
| 45-54 M | 0.55 | 0.50 | 0.61 | 0.274 | 0.270 | 0.277 |
| 45-54 F | 0.55 | 0.50 | 0.61 | 0.274 | 0.270 | 0.277 |
| 55-64 M | 0.55 | 0.50 | 0.61 | 0.288 | 0.284 | 0.292 |
| 55-64 F | 0.55 | 0.50 | 0.61 | 0.288 | 0.284 | 0.292 |
| 65-74 M | 0.56 | 0.51 | 0.62 | 0.290 | 0.286 | 0.293 |
| 65-74 F | 0.56 | 0.51 | 0.62 | 0.290 | 0.286 | 0.293 |
| 75+ M | 0.56 | 0.51 | 0.62 | 0.264 | 0.261 | 0.268 |
| 75+ F | 0.56 | 0.51 | 0.62 | 0.264 | 0.261 | 0.268 |

\*M = male; \*\*F = female; \*\*\* these values can vary with Ersatz running (Stochastic Values)

**Table 5: Salt, saturated fat and trans-fat inputs by age and gender in G4**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SALT (g) in G4 | SAT FAT (%) in G4 | TRANS FAT (%) in G4 |  |
| Age/gender | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** | **% of energy** | **LIC** | **UIC** |
| 25-34 M\* | 2.17 | 2.08 | 2.27 | 0.090 | 0.089 | 0.092 | 0.011 | 0.009 | 0.013 |
| 25-34 F\*\* | 2.17 | 2.08 | 2.27 | 0.090 | 0.089 | 0.092 | 0.012 | 0.009 | 0.014 |
| 35-44 M | 2.17 | 2.08 | 2.27 | 0.087 | 0.086 | 0.089 | 0.011 | 0.009 | 0.013 |
| 35-44 F | 2.17 | 2.08 | 2.27 | 0.087 | 0.086 | 0.089 | 0.012 | 0.009 | 0.014 |
| 45-54 M | 2.17 | 2.08 | 2.27 | 0.087 | 0.086 | 0.089 | 0.011 | 0.009 | 0.013 |
| 45-54 F | 2.17 | 2.08 | 2.27 | 0.087 | 0.086 | 0.089 | 0.012 | 0.009 | 0.014 |
| 55-64 M | 2.17 | 2.08 | 2.27 | 0.086 | 0.084 | 0.087 | 0.011 | 0.008 | 0.013 |
| 55-64 F | 2.17 | 2.08 | 2.27 | 0.086 | 0.084 | 0.087 | 0.011 | 0.009 | 0.014 |
| 65-74 M | 2.22 | 2.13 | 2.33 | 0.086 | 0.085 | 0.088 | 0.011 | 0.008 | 0.013 |
| 65-74 F | 2.22 | 2.13 | 2.33 | 0.086 | 0.085 | 0.088 | 0.011 | 0.009 | 0.014 |
| 75+ M | 2.22 | 2.13 | 2.33 | 0.091 | 0.090 | 0.093 | 0.011 | 0.008 | 0.013 |
| 75+ F | 2.22 | 2.13 | 2.33 | 0.091 | 0.090 | 0.093 | 0.011 | 0.009 | 0.014 |

**\*M = male; \*\*F = female (It was assumed the same values for male and female)**

**Table 6: Added sugar inputs by age and gender in G1, G2, G3 and G4**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ADDED SUGAR in G1 | ADDED SUGAR in G2 | ADDED SUGAR in G3 | ADDED SUGAR in G4 |
| Age/gender | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** | **Mean** | **LIC** | **UIC** |
| 25-34 M\* | 0.0004 | 0.0004 | 0.0005 | 0.473 | 0.460 | 0.485 | 0.072 | 0.0649 | 0.0789 | 0.184 | 0.178 | 0.190 |
| 25-34 F\*\* | 0.0004 | 0.0004 | 0.0005 | 0.473 | 0.460 | 0.485 | 0.072 | 0.0649 | 0.0789 | 0.184 | 0.178 | 0.190 |
| 35-44 M | 0.0005 | 0.0004 | 0.0005 | 0.498 | 0.485 | 0.511 | 0.053 | 0.0475 | 0.0577 | 0.181 | 0.175 | 0.187 |
| 35-44 F | 0.0005 | 0.0004 | 0.0005 | 0.498 | 0.485 | 0.511 | 0.053 | 0.0475 | 0.0577 | 0.181 | 0.175 | 0.187 |
| 45-54 M | 0.0005 | 0.0004 | 0.0005 | 0.590 | 0.574 | 0.605 | 0.063 | 0.0565 | 0.0686 | 0.190 | 0.183 | 0.196 |
| 45-54 F | 0.0005 | 0.0004 | 0.0005 | 0.590 | 0.574 | 0.605 | 0.063 | 0.0565 | 0.0686 | 0.190 | 0.183 | 0.196 |
| 55-64 M | 0.0004 | 0.0004 | 0.0005 | 0.596 | 0.580 | 0.611 | 0.065 | 0.0587 | 0.0712 | 0.174 | 0.168 | 0.180 |
| 55-64 F | 0.0004 | 0.0004 | 0.0005 | 0.596 | 0.580 | 0.611 | 0.065 | 0.0587 | 0.0712 | 0.174 | 0.168 | 0.180 |
| 65-74 M | 0.0004 | 0.0003 | 0.0005 | 0.815 | 0.793 | 0.837 | 0.081 | 0.0727 | 0.0883 | 0.168 | 0.162 | 0.173 |
| 65-74 F | 0.0004 | 0.0003 | 0.0005 | 0.815 | 0.793 | 0.837 | 0.081 | 0.0727 | 0.0883 | 0.168 | 0.162 | 0.173 |
| 75+ M | 0.0005 | 0.0004 | 0.0005 | 0.810 | 0.789 | 0.832 | 0.087 | 0.0784 | 0.0952 | 0.172 | 0.167 | 0.178 |
| 75+ F | 0.0005 | 0.0004 | 0.0005 | 0.810 | 0.789 | 0.832 | 0.087 | 0.0784 | 0.0952 | 0.172 | 0.167 | 0.178 |

## Expected mortality reduction

***Baseline***

In 2010, 99,822 CHD deaths and 99,646 stroke deaths were reported in Brazil, according to Ministry of Health(12). If 2010 age-specific rates persist in 2030, approximately 390,368 CVD deaths will occur.

The results for the scenarios are illustrated in Table 7. Predictions have been made assuming both cumulative effect and non-cumulative effects.

Table 8 shows the predicted number of deaths prevented or postponed in scenario A with stochastic outputs using *cumulative* and *non-cumulative* effects by gender and age group.

Table 9 shows the predicted number of deaths prevented or postponed in scenario B with stochastic outputs using *cumulative* and *non-cumulative* effects by gender and age group.

Table 10 shows the predicted number of deaths prevented or postponed in scenario C with stochastic outputs using *cumulative* and *non-cumulative* effects by gender and age group.

**Table 7: Estimated CHD and stroke deaths prevented or postponed by achievement of scenarios A, B and C in specific food policy options by sex in Brazil**

|  |
| --- |
| **MODEST SCENARIO (A)** |
|  | **CHD****deaths prevented** | **STROKE****deaths prevented** |
|  | MenDeaths prevented95% CI | WomenDeaths prevented95% CI | MenDeaths prevented95% CI | WomenDeaths prevented95% CI |
| **With cumulative effects** | 5,570(4,000-7,330) | 3,730(2,590-5,120) | 6,100(4,410-8,170) | 5,700(3,970-7,950) |
| **With** **non-cumulative effects** | 5,600(4,010-7,360) | 3,750(2,590-5,140) | 6,130(4,430-8,200) | 5,730(3,980-7,980) |
| **IDEAL SCENARIO (B)** |
| **With cumulative effects** | 11,460(8,360-14,670) | 7,880(5,470-10,320) | 12,720(9,370-16,370) | 12,130(8,550-15,970) |
| **With** **non-cumulative effects** | 11,540(8,420-14,780) | 7,940(5,500-10,400) | 12,800(9,420-16,480) | 12,200(8,600-16,090) |
|  | **OPTIMISTIC SCENARIO (C)** |  |
| **With cumulative effects** | 27,440(12,220-44,080) | 20,300(9,140-32,830) | 32,070(15,510-50,290) | 31,330(15,160-49,560) |
| **With** **non-cumulative effects** | 27,800(12,360-44,080) | 20,570(9,260-33,270) | 32,330(15,620-50,670) | 31,570(15,270-49,980) |

**Table 8: Stochastic Outputs for the Probabilistic Sensitive Analysis in relation to number of deaths reduction by CHD and stroke (MODEST SCENARIO A)**

|  |  |  |
| --- | --- | --- |
|  | Cumulative effects | Non-cumulative effects |
|  | Number of DeathsCHD | Number of DeathsStroke | Number of DeathsCHD | Number of DeathsStroke |
| AGES | Men | Women | Men | Women | Men | Women | Men | Women |
| Under 35 | 90 | 34 | 122 | 106 | 90 | 34 | 122 | 106 |
| 35-44 | 371 | 160 | 314 | 308 | 372 | 161 | 314 | 309 |
| 45-54 | 924 | 401 | 684 | 576 | 921 | 402 | 685 | 577 |
| 55-64 | 1280 | 578 | 1076 | 688 | 1283 | 580 | 1078 | 689 |
| 65-74 | 1446 | 921 | 1594 | 1202 | 1451 | 924 | 1599 | 1206 |
| 75+ | 1486 | 1657 | 2358 | 2884 | 1494 | 1665 | 2368 | 2897 |
| Total | **5596** | **3751** | **6147** | **5764** | **5611** | **3766** | **6166** | **5784** |

|  |  |  |
| --- | --- | --- |
|  | Cumulative effects | Non-cumulative effects |
|  | Number of DeathsCHD | Number of DeathsStroke | Number of DeathsCHD | Number of DeathsStroke |
| AGES | Men | Women | Men | Women | Men | Women | Men | Women |
| Under 35 | 179 | 68 | 244 | 211 | 180 | 68 | 245 | 212 |
| 35-44 | 741 | 319 | 627 | 615 | 745 | 321 | 629 | 617 |
| 45-54 | 1844 | 800 | 1365 | 1152 | 1854 | 805 | 1370 | 1156 |
| 55-64 | 2565 | 1182 | 2154 | 1398 | 2580 | 1188 | 2164 | 1404 |
| 65-74 | 2880 | 1835 | 3174 | 2396 | 2901 | 1848 | 3194 | 2411 |
| 75+ | 3249 | 3621 | 5186 | 6351 | 3278 | 3654 | 5228 | 6402 |
| Total | **11457** | **7836** | **12750** | **12123** | **11538** | **7885** | **12830** | **12202** |

**Table 9: Stochastic Outputs for the Probabilistic Sensitive Analysis in relation to number of deaths reduction by CHD and stroke (IDEAL SCENARIO B)**

**Table 10: Stochastic Outputs for the Probabilistic Sensitive Analysis in relation to number of deaths reduction by CHD and stroke (OPTIMISTIC SCENARIO C)**

|  |  |  |
| --- | --- | --- |
|  | Cumulative effects | Non-cumulative effects |
|  | Number of DeathsCHD | Number of DeathsStroke | Number of DeathsCHD | Number of DeathsStroke |
| AGES | Men | Women | Men | Women | Men | Women | Men | Women |
| Under 35 | 207 | 79 | 275 | 237 | 209 | 79 | 276 | 238 |
| 35-44 | 861 | 370 | 703 | 695 | 869 | 374 | 707 | 699 |
| 45-54 | 2981 | 1309 | 2172 | 1811 | 3013 | 1322 | 2185 | 1822 |
| 55-64 | 5717 | 2722 | 4668 | 3108 | 5782 | 2751 | 4697 | 3126 |
| 65-74 | 8411 | 5342 | 9100 | 6862 | 8526 | 5415 | 9172 | 6917 |
| 75+ | 9730 | 10851 | 15333 | 18847 | 9873 | 11010 | 15464 | 19008 |

# DATA SOURCES

**Table 11: Population and data sources used in the UPF IMPACT model**

|  |  |
| --- | --- |
| **Information** | **Source** |
| **Population data** |  |
| Population counts by age and sex 2010 and population projection 2030. | Brazilian Institute of Geography and Statistics – Demographic Census 2010  |
| <http://www.ibge.gov.br/home/estatistica/populacao/censo2010/><http://www.ibge.gov.br/home/estatistica/populacao/projecao_da_populacao/2013/default.shtm> |
| **Number of deaths by CHD and Stroke** |
| CHD deaths stratified by age and sexStroke deaths stratified by age and sex | Mortality Information System (MIS). Ministry of Health. Brazil. ([www.datasus.gov.br](http://www.datasus.gov.br))**Coronary heart disease (CHD) - (I20-I25)****Stroke - (I60-I69)** |

**Table 12: Data sources for Nutrient profile indicators of the food groups**

|  |  |
| --- | --- |
| **Information** | **Source** |
| Fatty Acids Saturates (g) Brazil per day  | IBGE. Brazilian Household Budget Survey (2008/2009)(3) |
| Na (g) Brazil per day | IBGE. Brazilian Household Budget Survey (2008/2009)(3) |
| Trans Fatty Acids (mean of % food energy) | Food Consumption Analysis(9) |
| Added sugar (mean of % food energy) | IBGE. Brazilian Household Budget Survey (2008/2009)(3) |

Beta values for CHD and Stroke **for saturated fat** (See Box 9) were taken from a meta-analysis by Jakobsen et al. (2009)(6). These authors proposed replacing 5% of total energy intake coming from saturated fats with energy from polyunsaturated fats and estimated the resulting reduction in cardiovascular mortality.

**Box 9: Beta values for CHD and Stroke in relation to age and sex for saturated fat**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ages | CHDMen | STROKEMen | CHDWomen | STROKEWomen |
| 25 to 34 | β = 0.073894737 | β = 0.081710526 | β = 0.073894737 | β = 0.081710526 |
| 35 to 44 | β = 0.073894737 | β = 0.081710526 | β = 0.073894737 | β = 0.081710526 |
| 45 to 54 | β = 0.052 | β = 0.0575 | β = 0.052 | β = 0.0575 |
| 55 - 64 | β = 0.036947368 | β = 0.040855263 | β = 0.036947368 | β = 0.040855263 |
| 65 - 74 | β = 0.027341053 | β = 0.030232895 | β = 0.027341053 | β = 0.030232895 |
| 75-84 | β = 0.026027368 | β = 0.028780263 | β = 0.026027368 | β = 0.028780263 |

\* Source: Jakobsen et al. (2009)(6)

Beta values for the effect of salt on CHD and stroke (See Box 10) for salt were taken from a meta-analysis by Strazzullo et al. (2009)(8). Here the authors demonstrate that reducing salt intake by 5 g/day (equivalent to 2000 mg sodium less per day) translates into approximately 17% fewer CVD deaths each year.

**Box 10: Beta values for CHD and Stroke in relation to age and sex for salt**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ages | CHDMen | STROKEMen | CHDWomen | STROKEWomen |
| 25 to 34 | β = 0.048315789 | β = 0.065368421 | β = 0.048315789 | β = 0.065368421 |
| 35 to 44 | β = 0.048315789 | β = 0.065368421 | β = 0.048315789 | β = 0.065368421 |
| 45 to 54 | β = 0.034 | β = 0.046 | β = 0.034 | β = 0.046 |
| 55 - 64 | β = 0.024157895 | β = 0.032684211 | β = 0.024157895 | β = 0.032684211 |
| 65 - 74 | β = 0.017876842 | β = 0.024186316 | β = 0.017876842 | β = 0.024186316 |
| 75-84 | β = 0.017017895 | β = 0.023024211 | β = 0.017017895 | β = 0.023024211 |

\* Source: Strazzullo et al. (2009) (8)

A reduction in the consumption of 1.0% of the total energy from trans-fat, according to meta-analysis proposed by Mozaffarian & Clark (2009)(10), in which was demonstrated a 12% decrease in CVD deaths for every 1% absolute reduction of trans-fat consumption (Mozaffarian meta-analysis). From this meta-analysis was extracted the beta values for CHD and Stroke (See Box 11).

**Box 11: Beta values for CHD and Stroke in relation to age and sex for trans fat**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ages | CHDMen | STROKEMen | CHDWomen | STROKEWomen |
| 25 to 34 | β = 0.163421053 | β = 0.081710526 | β = 0.163421053 | β = 0.081710526 |
| 35 to 44 | β = 0.163421053 | β = 0.081710526 | β = 0.163421053 | β = 0.081710526 |
| 45 to 54 | β = 0.115 | β = 0.0575 | β = 0.115 | β = 0.0575 |
| 55 - 64 | β = 0.081710526 | β = 0.040855263 | β = 0.081710526 | β = 0.040855263 |
| 65 - 74 | β = 0.060465789 | β = 0.030232895 | β = 0.060465789 | β = 0.030232895 |
| 75-84 | β = 0.057560526 | β = 0.028780263 | β = 0.057560526 | β = 0.028780263 |

\* Source: Mozaffarian & Clark (2009)(10)

Beta values for CHD and stroke (See Box 12) for trans fats were taken from a meta-analysis by Yang et al. (2014)(11). These authors proposed a reduction in 38% risk of CVD by consuming 8% per day of added sugar (11).

**Box 12: Beta values for CVD in relation to age and sex for added sugar**

|  |  |  |
| --- | --- | --- |
| Ages | CVDMen | CVDWomen |
| 25 to 34 | ß= 0.0104 | ß= 0.0104 |
| 35 to 44 | ß= 0.0104 | ß= 0.0104 |
| 45 to 54 | ß= 0.013 | ß= 0.013 |
| 55 - 64 | ß= 0.0156 | ß= 0.0156 |
| 65 - 74 | ß= 0.01872 | ß= 0.01872 |
| 75-84 | ß= 0.022464 | ß= 0.022464 |

 \* Source: Yang et al. (2014)(11)

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