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Estimated sodium intake by the Brazilian population, 2002-2003

ABSTRACT

OBJECTIVE: To estimate the magnitude and distribution of sodium intake in Brazil and to identify major dietary sources contributing to this intake.

METHODS: Estimates were based on data from a Brazilian household budget survey carried out between July 2002 and June 2003. A total of 969,989 food purchase records from a probabilistic sample of 48,470 households located in 3,984 census tracts across the country were analyzed. Purchase records were converted into nutrients using food composition charts. Mean sodium availability per person per day and mean adjusted availability considering a 2,000 kcal daily energy intake were calculated, as well as the contribution of selected food groups to total household sodium availability. Estimates were presented according to geographical region, urban or rural status of the household, and income stratum.

RESULTS: Mean daily sodium availability in Brazilian households was 4.5 g per person (or 4.7 g considering a daily calorie intake of 2,000 kcal), thus exceeding by more than two times the recommended levels of intake for this nutrient. Although most of the sodium available for intake across all income strata was derived from kitchen salt or salt-based condiments (76.2%), the fraction derived from processed foods with added salt showed a strong linear increase as household purchasing power increased, representing 9.7% of total sodium intake in the lower quintile of the per capita income distribution and 25.0% in the upper quintile.

CONCLUSIONS: Results indicate that sodium intake in Brazil widely exceeds the maximum recommended intake level for this nutrient in all of the country's macro regions and across all income strata.

DESCRIPTORS: Sodium, Dietary. Food Consumption. Socioeconomic Factors. Brazil.

INTRODUCTION

There is extensive evidence linking excess sodium intake with the development of chronic diseases.[16] It is estimated that, between age 25 and 55 years, reducing daily sodium intake by only 1.3 g would lead to a 5 mmHg decrease in systolic arterial pressure, signifying a 20% decrease in prevalence of arterial hypertension. Such reduction would also lead to substantial decrease in mortality related to cerebrovascular event (14%) and coronary disease (9%), representing 150 thousand lives saved worldwide.[5] Excess salt intake is also associated with gastric cancer,[19] and may contribute to the development of osteoporosis.[7]

In developed countries, where reliable estimates of sodium intake are available, ingestion of this mineral tends to exceed the maximum limit of 2 g (or 5 g of salt) per person per day recommended by the World Health Organization

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(WHO),[21] most of this sodium originating from processed foods.[1,3,9] In developing countries, information on sodium intake are still scarce given the complexity of evaluating individual consumption.

Indirect estimates, calculated based on the amount of salt per inhabitant commercialized by Brazilian industries in the sector, indicate that sodium intake in Brazil exceeds the recommended limit.[a,b] Studies carried out in three Brazilian cities also arrived at similar conclusions based on family food purchase profiles[4] or on direct estimates obtained through evaluation of urinary sodium excretion.[11,12]

The aim of the present study was to estimate sodium intake among the Brazilian population, and to identify the major dietary sources contributing to this intake.

METHODS

The data analyzed are derived from the *Pesquisa de Orçamentos Familiares* (Household Budget Survey, HBS) carried out between July 2002 and June 2003 by the *Instituto Brasileiro de Geografia e Estatística* – IBGE (Brazilian Federal Bureau of Geography and Statistics). Briefly, the HBS is a survey aimed at obtaining information on the income and expenses of Brazilian families. The 2002/03 edition surveyed a probabilistic sample representative of all Brazilian households as well as of each of the country's five macroregions according to the urban/rural status of the household. Sampling was based on a complex strategy involving the prior definition of 443 sociogeographic strata that integrated census tracts within a same territorial domain (region, state, and urban/rural status) that were homogeneous in terms of head-of-household schooling (information obtained from the 2000 Demographic Census). Subsequently, census tracts were randomly selected from within each stratum, and households were randomly selected from within each tract. Finally, in order to make data collection uniform among the year's four trimesters, the interviews carried out within each stratum were spread out across the 12 months of the survey. A detailed description of the HBS sampling strategy is available elsewhere.[c]

We analyzed the records of all food and drink purchases made during a period of seven consecutive days by the households sampled in the 2002-03 HBS (969,989 records contributed by 48,470 households located in 3,984 census tracts). Given that a seven-day reference period is insufficient for characterizing the food-purchase pattern of each household, we adopted as the survey unit, rather than individual households, each of the groups of households corresponding to the 443 HBS strata. These strata comprise household units that are homogeneous in terms of territorial domain and family socioeconomic status, and which were surveyed uniformly throughout the four trimesters of the year. The mean number of households surveyed in each HBS stratum was 109.6, ranging from 9 to 804. The sampling weight of each survey unit (household stratum) corresponds to the sum of the sampling weights of households included in the stratum.

Initially, we excluded, when necessary, any non-edible fraction from the crude quantity in grams of each food item purchased by the household using the correction factors recommended by IBGE.[d] The edible portion of each food item was then converted into energy (kcal) and sodium (grams) using the Brazilian Food Composition Table [*Tabela Brasileira de Composição dos Alimentos*], version 1[e] or, in its absence, the United States official food composition table, version 15. In the specific case of foods preserved in salt, such as salted/dried beef (*charque*, *carne seca*, and *carne de sol*) and salted fish, we considered the equivalent portion of the food after hydration and the sodium concentration referring to the desalted product.

After the conversion of weekly food purchase records into nutrients, we calculated, for each survey unit (household stratum), the daily *per capita* availability of energy and sodium. In addition, in order to correct for the difference between household sodium availability and actual intake – given that both meals outside home and the fraction of the food purchase that is not eaten – we calculated the adjusted sodium availability considering a total energy consumption of 2,000 kcal, which corresponds to the Brazilian recommendation for daily *per capita* energy intake.[f] Mean sodium availability (with respective standard errors) is presented for the country as a whole, for each of the five geographic macroregions, separated into urban and rural, and for fifths of the *per capita* income distribution observed in the 443 strata.

Percent participation of each food group in total household sodium availability is described for the country as a whole and according to *per capita* income fifths.

[a] Ministério da Saúde. Secretaria de Atenção à Saúde. Coordenação-Geral da Política de Alimentação e Nutrição. Guia alimentar para a população brasileira: promovendo a alimentação saudável. Brasília; 2005.
[b] Serviço Nacional de Aprendizagem Industrial. Plano de apoio ao desenvolvimento da cadeia produtiva do sal [internet] [cited 2008 Apr 18]. Available from: http://www.fiern.org.br/servicos/estudos/mossoro/cadeia_produtiva_sal.htm
[c] Instituto Brasileiro de Geografia e Estatística. Coordenação de Índices de Preços. Pesquisa de orçamentos familiares 2002-2003: análise da disponibilidade domiciliar e estado nutricional no Brasil. IBGE: Rio de Janeiro;2004.
[d] Instituto Brasileiro de Geografia e Estatística. Estudo Nacional da Despesa Familiar – ENDEF 1974/75. Rio de Janeiro; 1978.
[e] Universidade Estadual de Campinas. Núcleo de Estudos e Pesquisas em Alimentação. Tabela brasileira de composição de alimentos – TACO: versão 1. Campinas; 2004.
[f] Ministério da Saúde. Secretaria de Atenção à Saúde. Coordenação-Geral da Política de Alimentação e Nutrição. Guia alimentar para a população brasileira: promovendo a alimentação saudável. Brasília; 2005.

Table 1. Household energy and sodium availability based on food purchases according to macroregion and urban/rural status of the household. Brazil, 2002-03.

Macroregion/household status	Energy (kcal/p/day)		Sodium (g/p/day)		Sodium (g/p/2,000 kcal)	
	Mean	(Standard-error)	Mean	(Standard-error)	Mean	(Standard-error)
North						
Urban	1848.6	(75.0)	4.3	(0.4)	4.7	(0.4)
Rural	2951.6	(142.2)	11.4	(3.9)	7.4	(2.2)
Total	2111.9	(107.5)	6.0	(1.1)	5.4	(0.6)
Northeast						
Urban	1720.6	(27.2)	3.9	(0.1)	4.5	(0.1)
Rural	2092.3	(52.3)	6.5	(0.4)	6.2	(0.4)
Total	1818.4	(30.9)	4.6	(0.2)	5.0	(0.2)
Southeast						
Urban	1760.8	(61.8)	3.8	(0.2)	4.3	(0.1)
Rural	2623.4	(316.2)	7.0	(1.0)	5.8	(1.3)
Total	1830.0	(64.3)	4.0	(0.2)	4.4	(0.2)
South						
Urban	1858.5	(67.1)	4.4	(0.2)	4.8	(0.2)
Rural	3008.7	(244.5)	8.0	(0.9)	5.4	(0.4)
Total	2045.8	(94.5)	5.0	(0.3)	4.9	(0.1)
Center-West						
Urban	1654.3	(47.0)	3.4	(0.2)	4.1	(0.3)
Rural	2588.3	(136.5)	8.7	(2.1)	6.4	(1.3)
Total	1763.7	(61.6)	4.0	(0.4)	4.3	(0.3)
Brazil						
Urban	1764.6	(33.5)	3.9	(0.1)	4.4	(0.1)
Rural	2489.5	(110.0)	7.5	(0.6)	6.1	(0.4)
Total	1875.1	(34.7)	4.5	(0.1)	4.7	(0.1)

To achieve this, we classified food purchases into four groups: 1) salt and salt-based condiments; 2) processed foods with added salt; 3) *in natura* foods, or processed foods without added salt; and 4) ready-made meals. Linear regression analysis was used to test the relationship between family income (fifths of the distribution) and the contribution of each of these groups to total sodium intake.

In order to convert crude amounts (g or ml) of purchased foods into nutrients (kcal and sodium), we used the AQUINUT[a] application. For all other procedures and for statistical analysis, we used Stata software v. 9.2, taking into account the sampling weight of each survey unit.

RESULTS

Table 1 presents estimated household sodium availability for Brazil and for each macroregion. For the country as a whole, the amount of sodium available for consumption was 4.5 g per person per day, (g/p/d), more than twice the 2 g/p/d maximum recommended intake level. Sodium availability was not lower than 4 g/p/d in any of the five macroregions. In all five macroregions, sodium availability was higher in rural areas. Sodium availability was lowest in the urban Center-West, even though exceeding maximum recommended intake by 70%. Adjustment of daily sodium intake based on a 2,000 kcal diet did not alter substantially the intake scenario in any of the country's five regions, although it did attenuate the additional excess found in rural areas.

Table 2 presents estimated household availability according to fifths of the *per capita* income distribution of household strata. Household sodium availability adjusted for a 2,000 kcal/p/d diet was two-and-a-half times higher than the maximum recommended intake in the two lower quintiles of the income distribution, and slightly over two times higher in the three upper quintiles.

[a] Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde. Conversor de aquisições de alimento em energia e nutrientes (AQUINUT): versão 1.0 [internet] [cited 2007 Oct 12]. Available from: ttp://www.fsp.usp.br/nupens

Table 2. Household energy and sodium availability based on food purchases according to increasing fifths of *per capita* family income. Brazil, 2002-03.

Per capita income fifth	Energy (kcal/p/day)		Sodium (g/p/day)		Sodium (g/p/2,000 kcal)	
	Mean	(Standard-error)	Mean	(Standard-error)	Mean	(Standard-error)
1st	1950.6	(59.3)	4.9	(0.3)	5.0	(0.2)
2nd	1976.7	(87.7)	5.1	(0.4)	5.0	(0.2)
3rd	1922.9	(93.2)	4.6	(0.4)	4.7	(0.3)
4th	1735.0	(92.2)	3.8	(0.2)	4.4	(0.1)
5th	1787.7	(46.1)	3.8	(0.2)	4.3	(0.2)
Brazil	1875.1	(34.7)	4.5	(0.1)	4.7	(0.1)

Table 3 describes the contribution of different groups of foods to total household sodium availability. Considering the entirety of households, roughly three-quarters of available sodium originates from purchases of kitchen salt (71.5%) or salt-based condiments (4.7%). The remaining sodium available for consumption originated from purchases of processed foods with added salt (15.8%), *in natura* foods, or processed foods without added salt (6.6%), and ready-made meals (1.4%). Though still predominant in all income groups, the contribution of kitchen salt decreased linearly with increased income ($p < 0.001$), ranging from 83.8% in the lowest income fifth to 62.5% in the highest. On the other hand, the contribution of processed foods with added salt showed a direct relationship with *per capita* income ($p < 0.001$), increasing 2.5-fold between the lowest (9.7% of total sodium) and highest (25.0% of total sodium) fifth. The contribution of ready-made meals to total household sodium availability, although small, also increased markedly with income ($p < 0.001$), representing 0.4% of total sodium in the lowest fifth and 3.7% in the highest. The contribution of *in natura* foods and processed foods without added salt to total sodium was relatively low. This contribution remained stable at around 6% for the first three income fifths, increasing to 7.3% and 8.8% in the two upper fifths.

DISCUSSION

Our results indicate that the amount of sodium available for consumption in Brazilian households is more than two-fold higher than maximum recommended ingestion levels.[21] Excessive availability was detected in all five Brazilian macroregions, in both rural and urban settings, and across all income strata. Although most of the available sodium in all income strata originates from kitchen salt and salt-based condiments, the portion derived from processed foods increases in importance as household purchasing power increases, representing 9.7% of all sodium in the lowest, and 25.0% in the highest fifth of the *per capita* income distribution.

We must emphasize the fact that HBS data refer to the household availability of sodium, rather than to actual consumption levels, given that food eaten away from home is not included and the fraction of food purchased but not consumed is not excluded. As an attempt to counter these limitations, we present estimates for sodium availability adjusted to a fixed calorie availability of 2,000 kcal/p/d. The efficacy of such an adjustment is based on two underlying assumptions: 1) that the sodium content of home and away from home meals is similar; and 2) that the wasted fraction of different foods does not depend on sodium content.

Although we are unaware of Brazilian studies comparing the sodium content of home and away from home meals, the salt content of outside meals is generally assumed to be higher.[8] If this is also true in Brazil, actual sodium intake by the Brazilian population could be even higher than that estimated in the present study. Sodium intake may have been particularly underestimated in urban settings, where the habit of having meals away from home is more frequent. Based on data from the

Table 3. Distribution (%) of household sodium availability based on food purchases according to increasing fifths of the *per capita* income distribution and to food group. Brazil, 2002-03.

Food group	Fifth of *per capita* income distribution					
	Brazil	1st	2nd	3rd	4th	5th
Salt and salt-based condiments	76.2	83.8	81.9	77.8	70.2	62.5
Processed foods with added salts	15.8	9.7	11.8	15.2	21.0	25.0
In natura foods or processed foods without added salt	6.6	6.1	5.6	6.0	7.3	8.8
Ready-made meals	1.4	0.4	0.7	1.0	1.5	3.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

2002/03 HBS, we estimated that food ingested outside home represent 24% of total food expenditures among urban households, and 12% among rural ones.

There are two domestic culinary procedures that may lead to greater wasting of kitchen salt – the major source of sodium in the Brazilian diet – when compared to other foods, namely cooking foods in salted water and the preparation of salted foods. In Brazil, the food items most often cooked in salted water are pasta, potatoes, and carrots. Considering the mean amount of these foods purchased by Brazilian families,[a] the usual concentration of salt in cooking water[6,b] and the estimated fraction of the total salt retained by these foods after cooking,[17] we estimate that cooking pasta, potatoes, and carrots wastes approximately 9% of all sodium purchased by Brazilian families. This degree of waste would not be enough to change our conclusions with regard to excess sodium intake in Brazil.

It is difficult to estimate the potential impact of the preparation of salted foods on salt waste. In any case, the rarity of such a practice in urban settings suggests that this effect would be small on estimates made for the four-fifths of the Brazilian population that live in cities. The potentially higher frequency of food salting at home in rural settings could, on the other hand, account for the greater sodium availability in rural households.

In spite of the limitations typical of household budget surveys, mean intake estimates from different food groups based on food purchasing surveys tend to agree with results obtained by individual intake surveys.[2,13] Furthermore, in the case of items used as cooking ingredients, such as oil, sugar, and condiments, household budget surveys are believed to provide better estimates of actual individual intake, since it may be difficult for individuals to accurately estimate the amount of such ingredients that they ingest as part of prepared meals.[2]

Another limitation concerning our sodium intake estimations, which is common to all dietary surveys, is related to the use of food composition tables, which do not always estimate precisely the sodium content of the food consumed by participants. In the present study, we used a table constructed based on the direct analysis of food items commercialized in Brazil (*Tabela Brasileira de Composição de Alimentos*). Items whose composition is analyzed in this table accounted for 97% of all sodium available for ingestion in households surveyed by the 2002/03 HBS (data not shown).

A comparison of our estimates with those from other countries is complicated by the use of different methods for evaluating sodium intake. Population-based surveys carried out in developed countries usually show evidence of excess sodium intake, their estimates ranging from 3.0 to 4.2 g/p/d.[3,9] Though less frequent, studies carried out in developing countries also show excess sodium intake, with estimates that range from 3.4 to 5.6 g/p/d.[15,22]

Based on data obtained from the Brazilian salt industry on the production of salt for human consumption, and on the Brazilian population in the year 2000, it was estimated that *per capita* sodium availability for that year was 6.0 grams per day, or three times the recommended level of intake.[c,d] An analysis of data from a household budget survey carried out by the *Fundação Instituto de Pesquisas Econômicas* in the city of Sao Paulo in 1999 estimated a daily household sodium availability of 4.4 g per 2,000 kcal purchase,[4] which agrees with our present estimate for the entire Brazilian population.

Two studies carried out in Brazil around the year 2000 evaluated sodium intake based on urinary excretion of this mineral, finding intake levels similar to those observed in the present study. The first of these studies, carried out on a probabilistic sample of the population of the city of Vitória (Southeastern Brazil) aged 25-64 years, reported an estimated sodium intake of 5.0 g/p/d.[12] The second of these studies, carried out among children and adolescents from Porto Alegre (Southern Brazil), estimated a sodium intake of 3.4 g/p/d.[11]

The inverse relationship between income and sodium availability found in the present analysis has also been reported in other studies carried out in developed countries.[14,20]

Even though excess sodium intake in Brazil does not seem to differ substantially from that reported in developed countries, differences in terms of the origin of this nutrient are much more marked. In the developed world, it is estimated that the majority of ingested sodium – between 60% and 90% – originates from industrially processed foods rather than from salt added to foods by individuals.[1,3] Scenarios similar to the Brazilian one, where most ingested sodium seems to originate from kitchen salt and salt-based condiments, seem to be the norm among developing countries.[18] Be that as it may, the strong positive association between family income and the portion of sodium originating from processed foods, as well as the rapid and intense expansion of

[a] Instituto Brasileiro de Geografia e Estatística. Coordenação de Índices de Preços. Pesquisa de Orçamentos Familiares 2002-2003: análise da disponibilidade domiciliar e estado nutricional no Brasil. IBGE; 2004.
[b] Pinheiro ABV, Lacerda EMA, Benzecry EH, Gomes MCS, Costa VM. Tabela para avaliação de consumo alimentar em medidas caseiras. 3. ed. Rio de Janeiro; 1993.
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[d] Serviço Nacional de Aprendizagem Industrial. Plano de apoio ao desenvolvimento da cadeia produtiva do sal [internet] [cited 2008 Apr 18]. Available from: http://www.fiern.org.br/servicos/estudos/mossoro/cadeia_produtiva_sal.htm

processed food consumption in Brazil,[10] provide evidence of the growing importance of processed foods to overall sodium intake in Brazil.

In conclusion, our results confirm the notion that sodium intake in Brazil widely exceeds maximum recommended intake levels for this nutrient in all regions and across all income strata. Our results also confirm the pertinence to Brazil of recent WHO recommendations regarding the adoption of public policies aimed simultaneously at informing the population about the importance of reducing the amount of salt added to food and at regulating the sodium content of processed foods.

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