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Risk factors related to the global burden of disease in Brazil and its Federated Units, 2015

Fatores de risco relacionados à carga global de doença do Brasil e Unidades Federadas, 2015

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ABSTRACT: ***Objective:*** To analyze the global burden of disease related to disability adjusted life years (DALYs) attributed to selected risk factors in Brazil and its 27 Federated Units. ***Methods:*** Databases from the Global Burden of Disease study in Brazil and its Federated Units were used, estimating the summary exposure value (SEV) for selected environmental, behavioral, and metabolic risk factors (RFs), and their combinations. The DALYs were used as the main metric. The ranking of major RFs between 1990 and 2015 was compiled, comparing data by sex and states. ***Results:*** The analyzed RFs account for 38.8% of the loss of DALYs in the country. Dietary risks was the main cause of DALYs in 2015. In men, dietary risks contributed to 12.2% of DALYs and in women, to 11.1%. Other RFs were high systolic blood pressure, high body mass index, smoking, high fasting plasma glucose and, among men, alcohol and drug use. The main RFs were metabolic and behavioral. In most states, dietary risks was the main RF, followed by high blood pressure. ***Conclusion:*** Dietary risks leads the RF ranking for Brazil and its Federated Units. Men are more exposed to behavioral risk factors, and women are more exposed to metabolic ones.

Keywords: Risk factors. Mortality, premature. Diet. Hypertension. Tobacco. Disability-adjusted life years.

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RESUMO: ***Objetivo:*** Analisar a carga global de doença, quanto aos anos de vida ajustados por incapacidade (*disability adjusted life years* – DALYs) atribuídos a fatores de risco (FRs) selecionados, para Brasil e 27 Unidades Federadas (UFs). ***Métodos:*** Foram utilizadas bases de dados do estudo Carga Global de Doença (*Global Burden of Disease* – GBD) para Brasil e UFs estimando a síntese de exposição de risco (*summary exposure value* – SEV) para FRs selecionados, incluindo os ambientais, comportamentais, metabólicos e suas combinações. Os DALYs foram usados como métrica principal do estudo. Construiu-se o *ranking* dos principais FRs entre 1990 e 2015, com comparações por sexo e UF. ***Resultados:*** Os FRs analisados explicariam 38,8% da perda de DALYs no país. A dieta inadequada foi a principal causa de DALYs em 2015. Em homens, a dieta inadequada contribuiu com 12,2% dos DALYs, e, em mulheres, com 11,1% deles. Outros FRs importantes foram: pressão arterial sistólica elevada, índice de massa corporal (IMC) elevado, tabagismo, glicose sérica elevada; entre homens, destaca-se o uso de álcool e drogas. Os principais FRs foram metabólicos e comportamentais. Na maioria das UFs, predominou a dieta inadequada, seguida da pressão arterial elevada. ***Conclusão:*** A dieta inadequada lidera o *ranking* de FRs para Brasil e UF. Os homens estão mais expostos aos FRs comportamentais, e as mulheres, aos metabólicos.

Palavras-chaves: Fatores de risco. Morte prematura. Dieta. Hipertensão arterial. Tabaco. Anos de vida perdidos por incapacidade.

INTRODUCTION

A risk factor (RF) is considered as any exposure that increases the probability of occurrence of an illness or injury to health, and may occur in any part of the causal chain[1,2]. The risk factors can be monitored by adopted behavior or by choices and decisions made regarding lifestyles[3]. Moreover, social determinants such as socioeconomic and cultural conditions and level of education influence RFs[4].

There is already sufficient evidence which demonstrates that quantifying the effects of RFs, in particular the modifiable ones, can help to identify emerging threats to population health and opportunities for prevention[5-7]. In addition, prevention of diseases at population level, requires more than just quantifying relative risk, but to quantify the population attributable risk, that is, the proportion of risk that can be minimized if there is no RF exposure in a counterfactual context or if exposure is reduced[2].

Since 1990, the Global Burden of Disease (GBD) study has gained increasing interest and relevance in research on health systems in several countries[5,6]. Global measures for a broad set of countries started with GBD 2000. And they continued in 2010, expanding the list to 67 RFs in 185 countries between 1990 and 2010[7]. In 2015, the study comprised 79 RFs and their combinations, totaling 388 pairs of RFs, updated for the period from 1990 to 2015 for 195 countries, including Brazil and its 27 Federated Units (FUs)[2,8].

Brazil has innovated epidemiological surveys[9], such as household surveys (e.g. the National Health Survey – PNS)[10], telephone surveys[11], surveys with teenagers[12], surveys in emergency rooms[13], longitudinal follow-up studies[14], among others. Furthermore, the

information obtained through surveys complements the knowledge of health inequalities, supporting policies, to achieve greater equity [4,15,16].

However, there is a need to advance in the study of the relationship between the estimated prevalence of RFs and the burden of disease. GBD complements this analytical perspective and innovates by estimating the proportion of disease burden that could be attributed to individual RFs or associated RFs[2].

Therefore, this study aimed at analyzing the proportion of the global burden of disease, according to disability adjusted life of years (DALYs) attributed to RFs, in Brazil and its 27 FUs, according to GBD 2015 data.

METHODS

This study is based on the analysis of data estimated for Brazil by the GBD 2015 study from the Institute of Health Metrics and Evaluation (IHME)[2]. The GBD study adopted a conceptual framework that integrates metabolic, pathophysiological, behavioral, and environmental RFs. The 79 RFs were grouped as follows:

1. behavioral (tobacco smoking, alcohol and drug use, low physical activity, dietary risks, maternal and child malnutrition, sexual abuse and violence, and unsafe sex);
2. metabolic or physiological (high fasting plasma glucose, high systolic blood pressure and cholesterol, high body mass index (BMI), low bone mineral density, and low glomerular filtration rate); and
3. environmental (air and water pollution, unsafe water, sanitation, and handwashing, occupational risks, and other environmental risks).

More details on RFs can be examined in previous publications[2,8].

Estimates of relative risk were based on evidence from the literature, such as randomized controlled trials with sufficient sample size, cohort studies, and others[2], to estimate population attributable risk. Prevalence of RFs was estimated from household surveys, census data, environmental measurements collected from various sources, including satellite measurements, among others. Exposure levels and relative risk due to exposure to each RF were measured according to the available literature[2].

GBD uses the Theoretical Minimum Risk Exposure Level (TMREL) concept to calculate the fraction of population attributable risk for different causes of death and diseases or disabilities[8]. It sought to measure what would be reduced in disease burden if, in the past, population exposure had been modified to a minimum level of theoretical exposure risk, which would result in less health loss. Considering the TMREL and available epidemiological studies, the GBD established a minimum level of exposure for each RF, in which the probability of occurrence of the event would be the lowest possible. For example, the minimum level of risk exposure for the occurrence of chronic diseases would be a daily consumption of 200–400g of fruits and vegetables, physical exercise equivalent to 8,000 METs (metabolic equivalent of tasks) per day, a BMI between 21 and 23 kg/m^2, no smoking, and the consumption of 1–5 g of salt[2,8].

GBD also adopts the concept called Summary Exposure Value (SEV). SEV translates the prevalence weighted by the risk. The scale for SEV ranges from 0 to 100%, with 0% reflecting no risk exposure and 100% indicating maximum risk. The decline in SEV indicates reduced exposure, and the increase in SEV indicates the opposite. More details on SEV are also available[2,8]. SEV was obtained by the Equation 1:

$$SEV = \frac{\sum_{i=1}^{n} Pr_i RR_i - 1}{RR_{max} - 1} \quad (1)$$

Where:
Pr_i is the prevalence of the risk factor,
RR_i is the relative risk and
RR_{max} is the observed maximum relative risk (between categories).

This amount is estimated for each age, sex, location, and year [8]. The study presents a summary table of SEV for selected RFs, with a 95% confidence interval (95% CI) and a 95% uncertainty interval (95% UI), according to sex, for the years 1990, 2005, and 2015, and the percentage of change during those periods.

The estimation process uses statistical models to adjust the different sources and possible inconsistencies between them. Modeling was performed using DisMod-MR 2 and metrics were presented with their respective uncertainty intervals[2].

In the case of Brazil, we consulted existing surveys such as PNS, the Telephone-based Surveillance of Risk and Protective Factors for Chronic Diseases (VIGITEL), the National Household Sample Survey (PNAD), the National School Health Survey (PeNSE), among others, totaling 118 sources. More details can be found at http://ghdx.healthdata.org/gbd-2015/data-input-sources. The online display of the results can also be accessed at http://vizhub.healthdata.org/gbd-compare.

The metrics used to estimate the disease burden in GBD are years of life lost due to premature death (years of life lost – YLLs); years lived with disability (YLD); and DALYs (the sum of YLLs and YLD)[8].

In this study, DALYs were used to measure the impact of RFs on the GBD in Brazil. The GBD presents the RFs in four levels of detail. We chose to use levels 1 and 2, as they present the RFs in a more aggregated way. In the comparison of time and among the FUs, the standardized rates by age were considered. For the others, we chose to present the non-standardized rates. Then, for each main group of RFs, we estimated the DALYs attributable to the different groups of diseases and injuries according to sex. The ranking of the main RFs was compiled, representing the change of those same RFs between 1990 and 2015, according to sex, as well as the ranking of the RF for each of the 27 FUs in 2015.

GBD Brazil 2015 was approved by the Research Ethics Committee of the *Universidade Federal de Minas Gerais*, Project CAAE – 62803316.7.0000.5149.

Table 1. Summary of risk exposure standardized by age for selected risk factors by sex in 1990, 2005, and 2015. Brazil.

Risk Factors	Men (%)					Women (%)				
	1990	2005	2015	Variation 1990–2005	Variation 2005–2015	1990	2005	2015	Variation 1990–2005	Variation 2005–2015
Unsafe sanitation – no access to bathroom with sewer	22.6	15.0	10.6	-33.7	-41.6	22.7	15.0	10.6	-34.1	-40.6
Ambient particulate matter pollution	27.3	26.0	22.2	-4.7	-17.0	27.3	26.0	22.2	-4.8	-17.0
Occupational exposure to asbestos	4.8	2.1	1.8	-54.4	-84.6	4.3	1.3	0.9	-54.4	-83.1
Child underweight (weigh/age)	4.4	3.1	2.6	-29.6	-19.7	4.3	3.0	2.5	-30.2	-20.2
Smoking	26.0	17.5	13.0	-32.8	-34.9	15.7	12.2	9.3	-22.6	-30.7
Second-hand smoke	14.5	13.3	13.4	-8.3	0.3	16.8	16.7	19.4	-0.4	14.0
Alcohol use	12.6	15.3	14.9	20.9	-2.5	2.8	3.3	3.3	19.3	-2.1
Drug use	0.2	0.3	0.4	41.5	13.1	0.1	0.2	0.2	35.7	12.0
Diet low in vegetables	71.4	73.0	71.4	2.2	-2.2	70.7	72.3	70.5	2.4	-2.6
Diet high in sugar-sweetened beverages	11.4	12.2	13.1	7.4	7.1	11.0	11.4	12.3	3.7	6.7
Diet with high sodium	10.1	10.7	10.6	5.9	-0.5	9.4	9.6	9.5	1.9	-0.7
Childhood sexual abuse	1.5	1.4	1.4	-3.5	-3.4	3.5	3.3	3.3	-4.7	-0.9
Intimate partner violence	-	-	-			7.1	6.8	7.4	-3.0	7.8
Low physical activity	70.5	70.5	71.7	0.1	1.7	75.8	75.7	76.8	-0.1	1.5
High fasting plasma glucose	6.1	6.8	7.3	11.9	6.7	6.2	6.8	7.2	10.4	5.8
High total cholesterol	34.9	36.5	38.0	4.7	3.8	38.4	41.4	43.5	7.6	4.8
High systolic blood pressure	17.0	23.0	23.2	35.4	0.7	15.9	19.1	18.8	19.8	-1.8
Low bone mineral density	18.9	18.4	17.6	-2.9	-4.7	23.6	22.7	22.2	-3.6	-2.6
Low glomerular filtration rate	4.2	4.4	4.4	3.8	1.2	5.2	5.3	5.4	2.5	1.4

RESULTS

Table 1 presents SEV, standardized by age, for 19 RFs selected in the Brazilian population in the years 1990, 2005, and 2015. A decline in SEV indicates a reduction in RF exposure, and a rise in SEV indicates increased exposure. The analysis of SEV in relation to the changes occurred between 1990 and 2015 indicates that the greatest reductions in SEV occurred in occupational exposure to asbestos, unsafe sanitation – use of bathrooms without sanitary sewage, smoking, and child underweight. For some risks with high SEVs – approximately 70% – minimal changes occurred between 1990 and 2015, particularly for the diet low in vegetables and insufficient physical activity. There was an increase in SEV for metabolic RFs (such as high systolic blood pressure and high fasting glucose), dietary RFs (such as diet high in sugar-sweetened beverages), as well as alcohol and drug use.

Figure 1 presents the RFs at level 1, that is, metabolic, environmental, and behavioral risks and their contribution to the GBD. In 2015, 38.8% of the DALYs were attributed to the RFs in Brazil, whereas the non-attributable fraction corresponded to 61.2%. Behavioral risks contributed with 40.3% of the DALYs attributable to RFs and 15.6% of the total DALYs burden, followed by metabolic risks, with 16.1% of the risks attributable to RFs

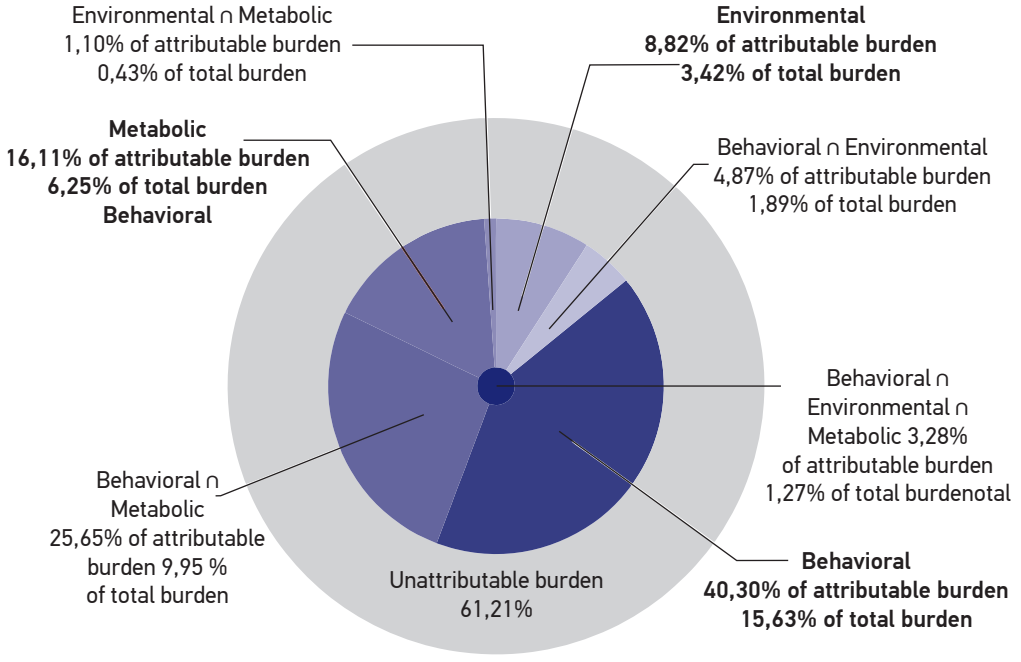

Figure 1. All causes of disability adjusted life years (DALYs) attributable and unattributable to level 1 risk factors for both sexes, all ages, GBD Brazil, 2015.

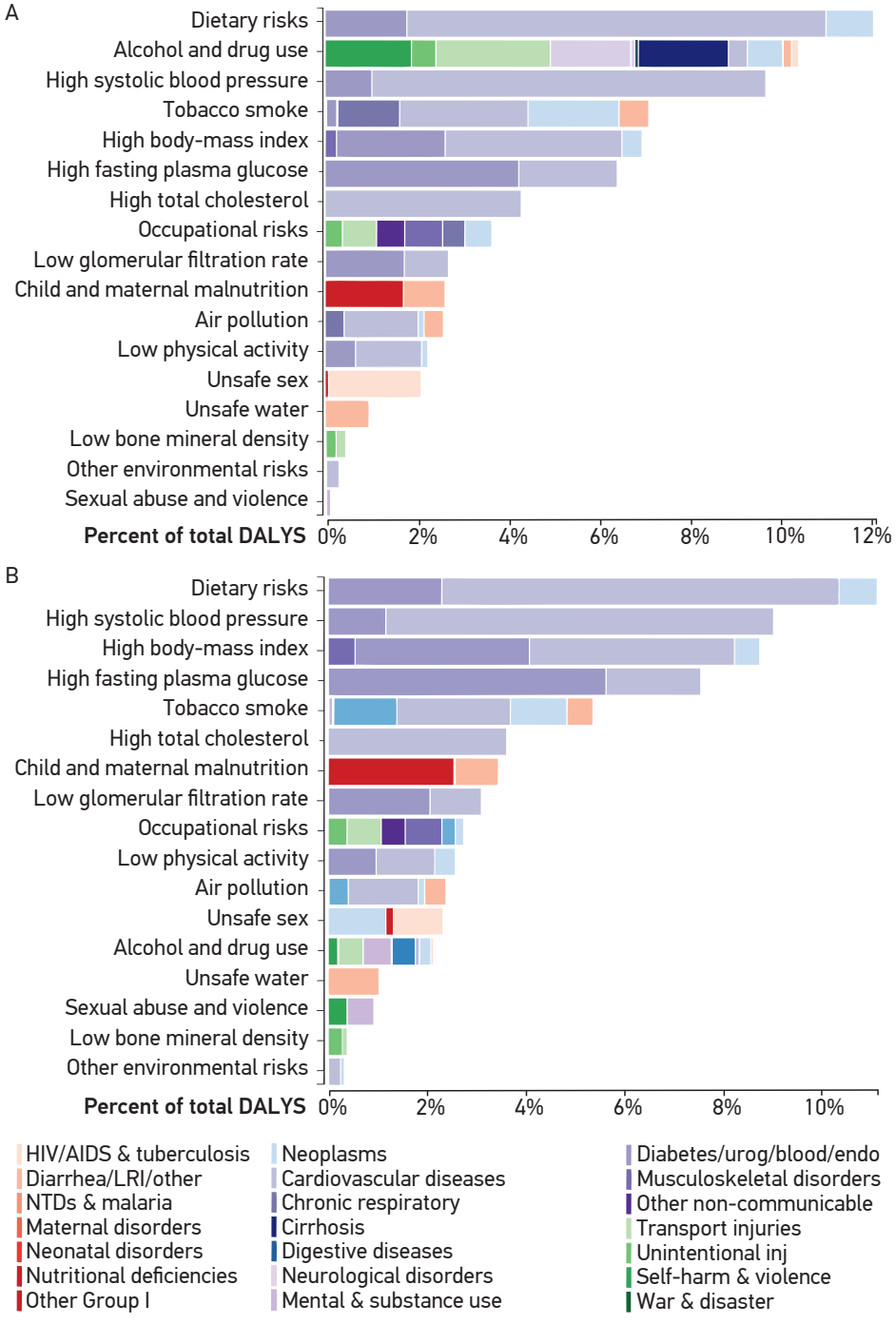

Figure 2. Disability adjusted life years (DALYs) attributable to level 2 risk factors for (A) men and (B) women, all ages, GBD Brazil, 2015.

and 6.3% of the total burden. Environmental risks contributed 8.8% of the burden attributable to RFs and 3.4% of the global burden of DALYs. The contribution of associated risks is detailed in Figure 1.

Figure 2 shows DALYs attributable to 17 RFs (level 2) for all ages and according to sex in 2015. In men, dietary risks, which includes a sodium-rich and fruit-poor diet, accounted for 12.2% of all DALYs in 2015. This dietary pattern was associated with three groups of causes of mortality and disability, accounting for 9.28% of the DALYS of cardiovascular diseases, 1.82% of diabetes, and 1.06% of neoplasms. In men, alcohol and drug use was the second most important RF in 2015, being associated with causes of deaths and disabilities, such as transport injuries, cirrhosis, and other liver diseases, interpersonal violence and suicides, neurological disorders, and other diseases. The third RF for men was high systolic blood pressure, followed by smoking, high BMI, and high fasting plasma glucose. The other RFs attributable to the disease burden in men were high cholesterol, occupational risks, low glomerular filtration, malnutrition, air pollution, low physical activity, unsafe sex, no hand washing, low bone mineral density, and other environmental risks, in that order (Figure 2A).

In the case of women, 11.1% of DALYs were attributed to inadequate diet, with 8.0% for cardiovascular diseases, 2.3% for diabetes and 0.77% for neoplasms. The second RF for DALYs among women was high systolic blood pressure. High BMI was in third place, the fourth main RF was high fasting glucose, and smoking was the fifth. It was observed that the use of alcohol and other drugs RF was less important among women, ranking in 13th place. The other RFs for women were malnutrition, high cholesterol, low glomerular filtration, occupational risks, low physical activity, air pollution, unsafe sex, alcohol and drug use, indicators related to water and sanitation, violence and sexual abuse, low bone mineral density, and other environmental risks, in that order (Figure 2B).

The change in the major RFs between 1990 and 2015 for all causes of DALYs according to sex is presented in Figure 3. In 1990, dietary risks, smoking, high systolic blood pressure, and maternal and child malnutrition were the main RFs for DALYs for men and women. Dietary risks remained at the top of the list in 1990 and in 2015, and systolic blood pressure rose from third to second place in both men and women. Maternal and child malnutrition showed a marked decrease, going from the 4th to 11th position among men and from the 2nd to the 6th position among women. Smoking increased from second to fourth in the ranking of men, and from fourth to fifth place among women (Figure 3).

The changes in the period also indicate the rise of high BMI, from eighth to fifth place in men and fifth to third place in women, as well as alcohol and drug use from fifth to third place in men, and elevated fasting serum glucose from sixth to fourth place in women. There was an increase in other behavioral factors, such as insufficient physical activity, unsafe sex, and all of the metabolic risks. Finally, a reduction of environmental RFs was observed, including air pollution and excluding occupational risks (Figure 3).

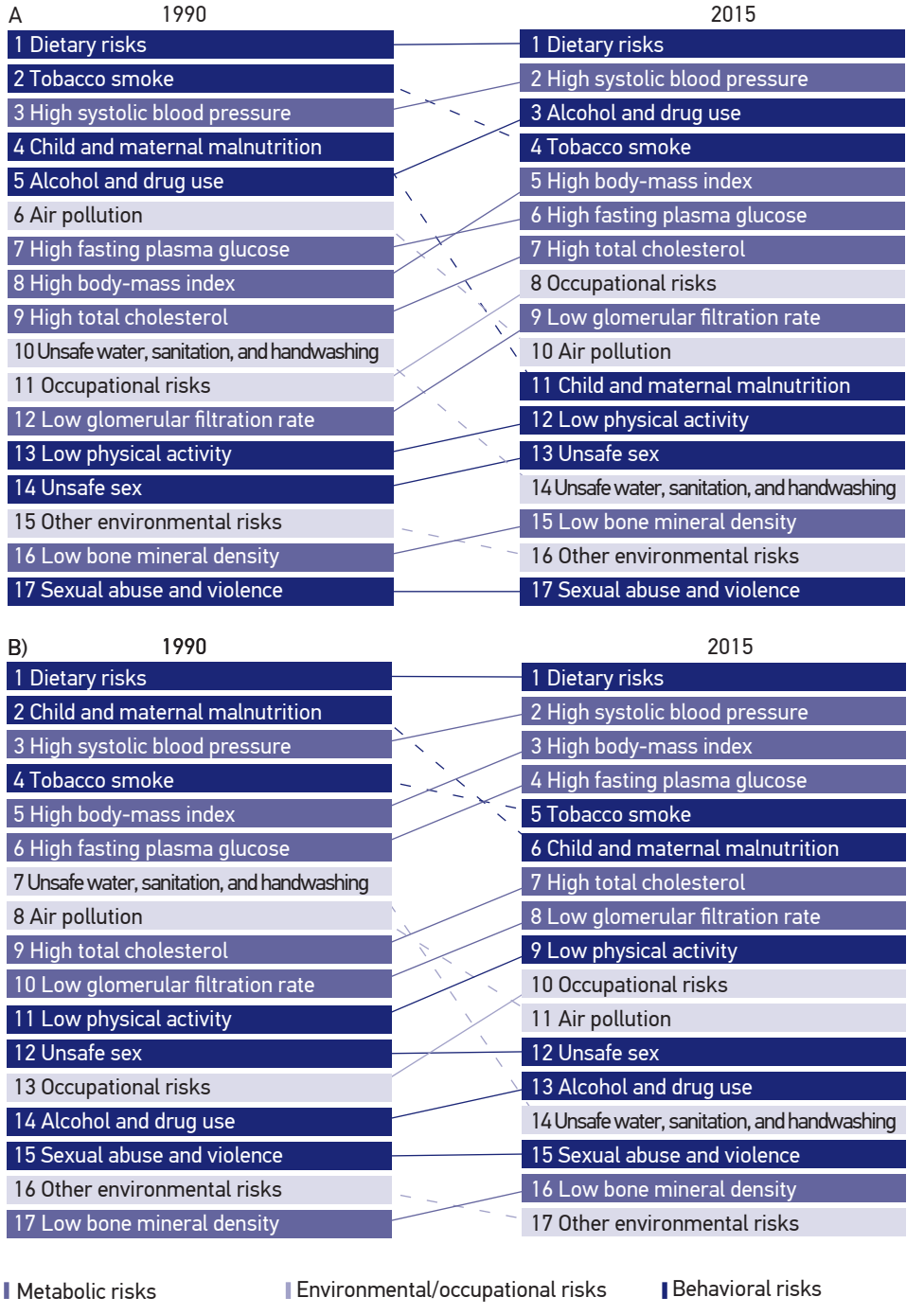

Figure 3. Level 2 ranking of the main risk factors for Disability Adjusted Life Years (DALYs) standardized by age, males (A) and females (B) in 1990 and 2015, GBD Brazil, 2015.

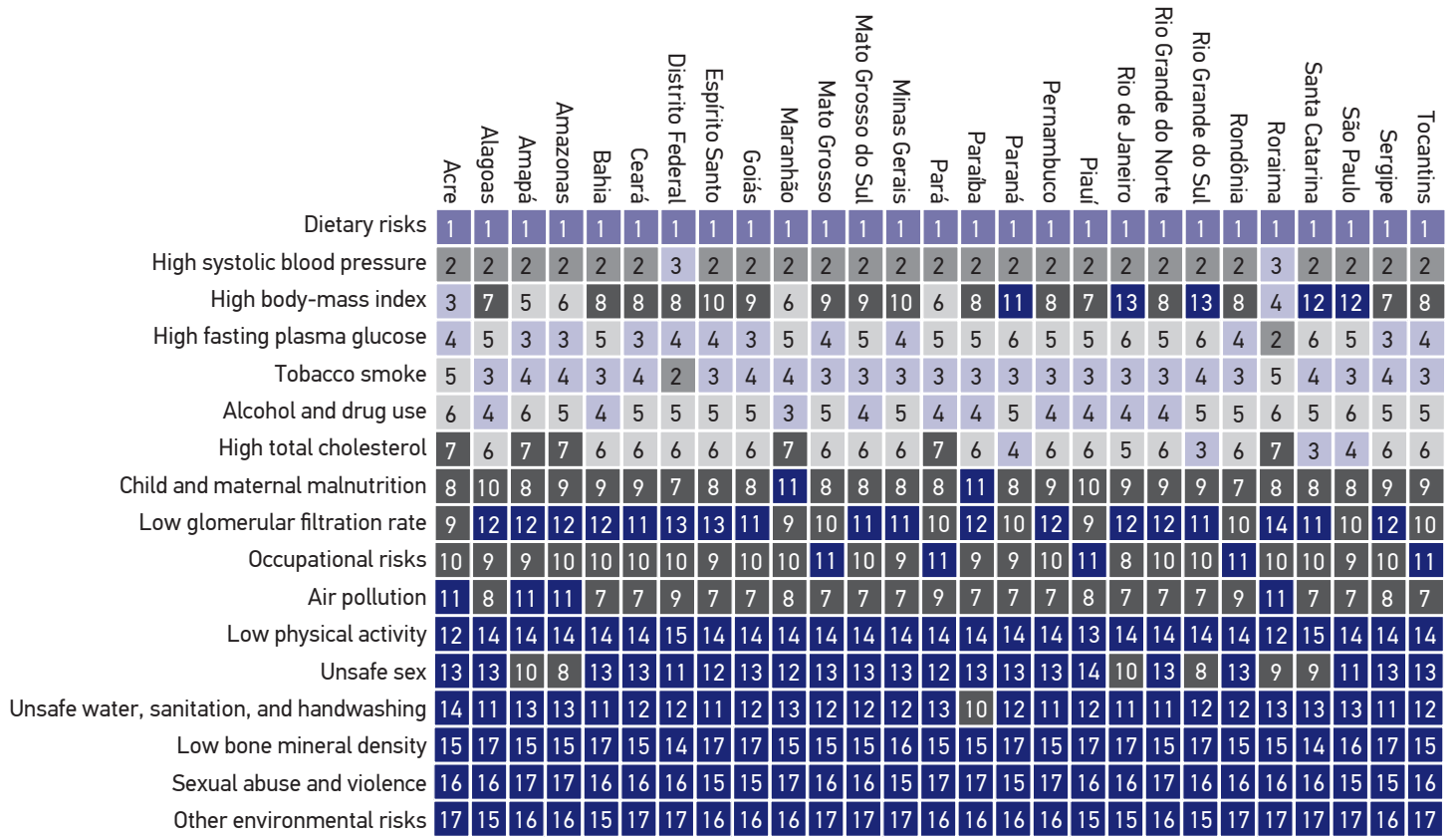

Figure 4. Ranking of the 17 major risk factors, level 2, for all causes of Disability Adjusted Life Years (DALYs), standardized by age for both sexes in 2015 by Federal Unit of Brazil, GBD Brazil, 2015.

Figure 4 shows the ranking of the main level 2 RFs for all causes of DALYs standardized by age for both sexes in 2015 by FU in Brazil. We observed that dietary risks ranked first in all FUs and high systolic blood pressure ranked second in most FUs. High fasting plasma glucose, smoking, and alcohol and drug use were among the five most important RFs in most FUs. High BMI ranked in middle positions in most of the FUs. Malnutrition ranked 8th in the majority of FUs, ranging from 7th to 11th place. Physical inactivity ranked 14th in most of the FUs and unsafe sex ranked 8th in Rio Grande do Sul and Amazonas, while in other states it ranked between 9th and 14th.

DISCUSSION

The current study of GBD advances, in relation to previous years, by performing a specific analysis for Brazil and its 27 FUs. The study included analyzes of environmental, behavioral, and metabolic RFs and their combinations, pointing out that they explain 38.8% of the DALYs in the country. Dietary risks was the main cause of DALYs. Among the metabolic risks, high systolic hypertension stands out. Among women, greater exposure to metabolic RFs was observed, and among men, greater exposure to behavioral RFs was observed.

In global terms, it was estimated that RFs, together, were responsible for 57.8% (95%CI 56.6–58.8) of deaths and 41.2% (39.8–42.8) of DALYs[2]. In this study, specifically in Brazil, we observed a similar result.

In the analysis by FU, dietary risks and blood pressure led the ranking of RFs, pointing out the importance of these factors throughout the country and in the causality of non-communicable diseases (NCDs)[17]. Inadequate diet may also contribute to other RFs, such as arterial hypertension (AH), obesity, and malnutrition. Prospective[18], case–control[19], and other types of studies[20] have indicated that consumption of fruits and vegetables is associated with the prevention of cardiovascular diseases, some cancers, and neural tube defects, which has been explained by the content of micronutrients such as potassium, lycopene, folic acid, carotenoids, fibers, polyphenols, water, and low caloric density. Because it is a modifiable factor, it becomes important to adopt public policies that may interfere with behaviors, such as the publication of the Food Guide for the Brazilian Population (2014)[21] and voluntary agreements for the reduction of sodium and trans fats in industrialized foods[22,23].

AH was the second RF in the ranking for Brazil and for most FUs, as it is considered one of the main modifiable RFs for coronary artery disease and one of the most important public health problems. Thus, studies indicate that preventive measures (such as healthy eating, salt reduction, physical activity, and AH control) are essential in preventing cardiovascular diseases[24].

This study indicated an increase in obesity, high fasting plasma glucose, and alcohol use that are consistent with data from most countries around the world[2]. Excess weight and

obesity are the second most important RF for the GBD and are associated with several NCDs, such as cardiovascular diseases, diabetes, colon, rectum, and breast cancer, and cirrhosis, among others[24]. The estimates of 2012 performed by the International Association for the Study of Obesity indicate that 1 billion adults are overweight in the world and approximately 475 million are obese[25]. More recent data from GBD 2015 indicate a growth to 604 million obese adults and 112 million obese children worldwide, with prevalence doubling between 1980 and 2015 in more than 70 countries around the world[2]. In Brazil, more than half of the population is overweight, being the greatest risk among women. It is important to note the great change in the ranking, which points to rapid growth[25-27].

Elevated fasting plasma glucose also increased in the period, which is consistent with other longitudinal studies[28] and telephone[29] and household surveys[30]. Studies have explained this increase by the growth of obesity, aging of the population, and unhealthy lifestyles, such as inadequate diet and physical inactivity[28-30]. Similar results were identified globally[2,7].

The results presented here show an increase in the percentage of DALYs due to alcohol and drug use. Alcohol consumption is associated with several diseases: gastrointestinal diseases, cancers, mental disorders, cardiovascular diseases, infectious diseases (such as tuberculosis and AIDS), as well as injuries due to accidents and violence[31]. The World Health Organization (WHO) has adopted a target of 10% relative reduction in per capita alcohol consumption by 2025[17]. To this end, measures are recommended to make it less available, such as price increases, advertising bans, and restriction of times and places of sale[32]. In Brazil, abusive consumption of alcoholic beverages is high and is more frequent in men and in the young population[33,34].

Tobacco used to be among the major RFs; however, the burden attributable to smoking has been decreasing due to the decline in its prevalence in Brazil[35]. In 1989, the prevalence of smoking was 36.4%. In 2013, it was reduced to 15%, one of the lowest rates in the world, due to measures adopted in the country[36]. In 2014, the presidential decree on smoke-free environments banned the use of tobacco products in enclosed collective venues and vetoed cigarette advertisements and promotion. In addition, it expanded health messages, warnings on cigarette packaging, and taxes on tobacco products[22,36,37]. Such measures are in line with the good practices advocated by the WHO[24]. In the ranking of FUs, tobacco, in general, is among the main RFs, with emphasis on the three southern states and São Paulo, which is in third place. The results of VIGITEL confirm these data, and point out that these states have the highest prevalence rates of smoking[37].

Insufficient physical activity is an important cause of death around the world and a significant RF for breast and colon cancers, cardiovascular diseases, among others[38]. Studies indicate that physical activity, like leisure, is associated with higher levels of education, the male sex, and a young age[38]. The present study showed the increase of physical inactivity in the ranking of FRs, demonstrating that public policies should be prioritized to cope with it, since it is a modifiable RF[24].

It is notable that in Rio Grande do Sul, unsafe sex is in eighth place, which corroborates studies that show a high incidence of AIDS in the state [39].

In relation to the disease burden attributable to environmental risks, there was a downward trend, especially due to air and water pollution (sewage); no hand washing; and other environmental risks, including exposure to lead and radiation. However, occupational risks showed a rise. This pattern is consistent with global studies[2,7].

LIMITATIONS

One of the assumptions of the GBD approach assumes that the relative risks are evenly distributed in all countries, for a given age and gender. This needs to be carefully evaluated because it can affect the results[2]. In addition, there is a lack of sufficient studies regarding all the risks. Among them, the risk due to intimate partner violence among men was not estimated due to lack of studies[2]. We also observed that some exposure values differed significantly from those found in the most recent national surveys. For example, GBD 2015 estimated a prevalence of less than half the prevalence found for high BMI in men and women (data not shown) [26,27]. The GBD results for water supply and hand washing indicators also did not match the data found by the Demographic Census in 2010[40] and by the 2015 PeNSE Survey[41], respectively, which demonstrates the need to compare data and detect possible inconsistencies in order to contribute to the improvement of these estimates, since GBD is an important tool to support public policies. This study only addressed a selected set of RFs for Brazil and its FUs. Information on all 79 FRs can be found in other publications[2,7,8].

FINAL CONSIDERATIONS

Risk assessments such as this enable the identification of several groups of RFs that deserve public health attention and direct public policies and interventions which would benefit the population, especially those addressing modifiable RFs. Quantification of the health impacts of a set of RFs is an important contribution to improving the health of the population[2,7].

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