Risk factors for dementia in Brazil: differences by region and race

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Abstract

INTRODUCTION: Twelve risk factors (RF) account for 40% of dementia cases worldwide. However, most data for population attributable fractions (PAFs) is from high-income countries. We estimated how much these RFs account for dementia cases in Brazil, stratifying estimates by race and socioeconomic level.

METHODS: We calculated the prevalence and communalities of twelve RF using 9,412 Brazilian Longitudinal Study of Aging participants, then stratified according to self-reported race and country macro-regions.

RESULTS: The overall weighted PAF was 48.2%. Less education had the largest PAF (7.7%), followed by hypertension (7.6%), and hearing loss (6.8%). PAF was 49.0% and 54.0% in the richest and poorest regions, respectively. PAFs were similar among Whites and Blacks (47.8% and 47.2%, respectively); but the importance of the main RF varied by race.

DISCUSSION: Brazil's potential for dementia prevention is higher than in high-income countries. Education, hypertension, and hearing loss should be priority targets.

1. Background

It is estimated that 57 million people live with dementia worldwide, and this number is expected to increase to 153 million by 2050.[1] Currently, most people with dementia live in low and middle-income countries (LMIC),[2] and the forecasted increase in the number of cases in 2050 is larger in these countries, particularly in areas with low sociodemographic index, with a predicted increase of 330% between 2019 and 2050 compared to regions with high sociodemographic index with a forecasted 140% increase.[1] Moreover, dementia is the main cause of disability in high-income countries (HIC), and it is among the top ten causes of disability in LMIC.[3] The dementia burden seems to be particularly high in Latin America (LA). In a meta-analysis published in 2013, the prevalence of dementia among those aged 60 years and older was estimated to be 8.5%, the highest prevalence worldwide, where the estimates varied from 5 to 7% in most regions.[4] Moreover, it is estimated that 4.5 million people in LA were living with dementia in 2019 and more than 40% of them were Brazilians.[5] A 200% increase in the number of dementia cases is expected from 2019 to 2050 in both, Brazil and LA, compared to only 100% for United States.[5] Currently, there is no disease-modifying treatment for Alzheimer's disease or other neurodegenerative dementias, and primary prevention is likely to be the best way to reduce the disease burden.[6, 7] The Lancet Commission estimated that up to 40% of dementia cases worldwide are potentially preventable or delayed through the control of 12 risk factors: fewer years of education, hearing loss, midlife hypertension, midlife obesity, diabetes, excess alcohol, traumatic brain injury, physical inactivity, depression, smoking, social isolation, and air pollution.[8] This work used worldwide meta-analyses of risk factors, but these were predominantly from White individuals from HIC.

Since then, other studies have provided estimates for other specific regions, including for LMIC.[9-12] The potential for dementia prevention was estimated in India, China, and LA using data for the 10/66 study, with the highest population attributable fraction (PAF) (56%) in LA, using data from six LA countries (Cuba, Dominican Republic, Mexico, Peru, Puerto Rico, and Venezuela) but these data were not nationally-representative. One study estimated that 32% of dementia cases in Brazil could be attributable to seven risk factors (low educational attainment, midlife hypertension, midlife obesity, diabetes, physical inactivity, depression, and smoking).[10] However, the authors did not take into account the local measures of risk factor clustering in individuals (communality), but rather used an English measure of communality [6] and did not include other known risk factors.

Moreover, PAFs are not homogeneous within each country.[13] Recently, PAF and the relative contribution of each risk factor in New Zealand were calculated to vary by ethnic groups and was higher overall in Maori and Pacific people, who mostly live in disadvantaged areas.[13] Additionally, the impact of each risk varied among ethnicities, with obesity having the largest potential for dementia prevention among Maori and Pacific ethnic groups. Finally, geographic disparities across the United States are associated with a higher prevalence of stroke and dementia in Southeastern regions compared to the Northern states.[14, 15]

Brazil is the largest country in LA with around 214 million people, and is divided into five macro-regions (North, Northeast, Central West, Southeast, and South) according to geography and socioeconomic development. [16] Moreover, Brazil is a multiethnic country with 56% of the population self-reported as Black or admixed (mixed of Black and White). The poorest regions are also those with the highest proportions of people identifying as Black. [17] We aimed to calculate the PAF of 12 dementia risk factors for

Brazil, using population-based information for risk factor prevalence and communalities and investigated whether these estimates varied by race and socioeconomic level of Brazilian macro-regions.

2. Methods

The Brazilian Longitudinal Study of Aging (ELSI-Brazil) study was approved by the local ethical committee and all participants signed an informed consent form.

2.1. Participants

This study used the baseline data from the ELSI-Brazil collected in 2015-2016.[18] The ELSI-Brazil is a home-based survey conducted in a nationally representative sample of 9,412 community-dwelling adults aged ≥50 years. The participants' mean age was 63.6 (SD=10.1) years old, 56% were women, 57% were Black/Mixed, and 55% lived in the South and Southeast regions. The sampling method was stratified by municipalities, census areas, and households to include urban and rural cities of different sizes. Sample weights were calculated to deal with different probabilities of selection and nonresponse. The baseline survey included information on sociodemographic variables, clinical history, lifestyle, functional status, and utilization of health resources. Anthropometric and functional measures were measured during a home visit. Additional information on ELSI-Brazil can be found elsewhere.[18]

2.2. Risk factor definitions and prevalence

The Lancet Commission described 12 risk factors for dementia in 2020 with consistent, biologically plausible data.[8] Whenever possible, risk factor definitions for this study were in line with previous publications.[8, 9, 19] The prevalence for most risk factors was calculated using data from the ELSI-Brazil since the study sampling method allows for prevalence estimations that are representative of the factor frequency in the Brazilian

population. The prevalence of diabetes and hypertension was defined as previous diagnoses by health care professionals or the current use of insulin, hypoglycemic, or antihypertensive drugs. Weight and height were measured during the home interview and body mass index (BMI) was calculated. A small proportion of participants (4.1%) could not have their anthropometrics measured and self-reported weight and height were used to calculate the BMI. Obesity was defined as a BMI $\geq$30 kg/m^2. Physical inactivity was defined as doing vigorous activities for less than 75 minutes per week, moderate activities or walking for less than 150 minutes per week, or an equivalent combination of moderate and vigorous activities according to the World Health Organization definition.[20] Hearing loss was defined as self-reporting hearing as bad or very bad, or current use of hearing aids. Alcohol use was determined by the current intake of >21 units of alcohol per week (one unit=10grams), and smoking by the current use of tobacco. Depression was defined by a previous diagnosis of depression by a health care professional. Seeing family members or friends less than once per month was defined as social isolation.

We did not have an objective measure of air pollution in the ELSI-Brazil, so we follow the previous definition of using living in an urban area as a proxy measure of having exposure to this risk factor.[8] The classification of urban and rural areas is determined by the Brazilian Institute of Geography and Statistics, considering the density of inhabits and the number of built houses per area.

We used another dataset to determine the prevalence of less education to follow the life course approach defined by the Lancet Commission. Since the ELSI-Brazil study enrolled adults aged 50 years and older, the prevalence of less education was estimated using data from the 2019 National Household Sample Survey that used sample weights to calculate the educational attainment in age groups.[21] Less education was defined

by the proportion of Brazilians aged 25 years, who had completed ≤8 years of formal education (e.g. elementary school).[21] Finally, information on traumatic brain injury was also not available in the ELSI-Brazil, so we used the reported prevalence of 12.1% based on a previous meta-analysis,[22] which was also used for population attributable fraction (PAF) in the Lancet Commission report.[8]

2.3. Statistical analysis

Besides the risk factor prevalence, PAF is calculated from the relative risk (RR) and the communality of each factor. RRs were derived from the previous meta-analysis of the Lancet Commission.[8, 19] The RRs are measures of the association between each risk factor and dementia and they are not expected to vary significantly across countries.

The PAF was then calculated according to the formula:

$PAF = P_e (RR_e-1)/[1+P_e (RR_e-1)]$, where P_e is the risk factor prevalence and the RR_e is the relative risk of dementia for the risk factor.

We then calculated the overall PAF for the 12 risk factors:

$PAF= 1 – [(1-PAF_1) (1-PAF_2) \ldots (1-PAF_{12})]$

The communality among risk factors was calculated using a principal component analysis on the correlation matrix among variables from ELSI-Brazil. This generates eigenvectors, which represent the unobserved factors underlying all variables associated with the observed variance. Five principal components explained 52% of the variance between the 11 factors. Communality was the sum of the square of all factor loadings, which represents how much each unobserved component explains the measured variable. The weight (w) for each risk factor was 1 minus its communality. The weighted PAF was calculated according to this formula:

$PAF = 1- [(1-w_1*PAF_1) (1- w_2*PAF_2) \ldots (1- w_{12}*PAF_{12})]$

Moreover, individual weighted PAF calculations followed the formula:

Individual weighted PAF = $\frac{Indivudal\ PAF}{\sum(individual\ PAF)}$ x Overall PAF

We could not calculate the communality for traumatic brain injury, as it was not measured in the ELSI-Brazil study. We then use the mean communality among the other 11 measured risk factors and imputed this value as the communality for traumatic brain injury.[8] 95% confidence intervals for the PAFs were calculated using the binomial approximation to the proportion.

Brazil is divided into five macro-regions according to their location and sociodemographic development.[16, 23] We stratified our analyses according to Brazilian macro-regions indicators of development. The South and Southeast regions are the richest regions [corresponding to 17% and 53% of the gross domestic product (GDP), respectively], while the North, Northeast, and Central West have less economic development (5%, 14%, and 10% of Brazil's GDP) and were analyzed together.[23] Additionally, we examined whether risk factors prevalence was different according to self-reported race. To perform this particular analysis, we excluded participants who self-reported themselves as being Indigenous people (n=220) or Asian (n=90), and stratified the analysis by White and Black races. Participants self-reporting to be "Pardos" (admixed of Black and White) were grouped into the Black race category since Pardo and Black individuals face similar racism and socioeconomic burden.[24]

3. Results

Total PAF

Forty-eight percent of dementia cases in Brazil were attributable to 12 risk factors (PAF=48.2%, 95% CI=47.2-49.2) (Table 1). The five most impactful risk factors were less education (PAF=7.7%, 95% CI=7.2-8.3), midlife hypertension (PAF=7.6%, 95% CI=6.9-8.3), midlife hearing loss (PAF=6.8%, 95% CI=6.2-7.5), midlife obesity

(PAF=5.6%, 95% CI=5.0-6.2), and late-life physical inactivity (PAF=4.5%, 95 CI=3.8-5.2).

PAF by region

When we examined the PAFs by rich and poor regions, we found a larger overall weighted PAF in the poor regions (PAF=54.0%, 95% CI=52.5-55.5) compared to rich regions (PAF=49.0%, 95% CI=47.6-50.4) (Table 2). Less education, hypertension, and hearing loss were the three most important risk factors in both regions; however, less education was the most important risk factor in poor regions (PAF=9.6%, 95% CI=8.7-10.5), while it was the second largest PAF in rich regions (PAF=7.2%, 95% CI=6.5-7.9). Midlife hypertension was the most important risk factor in rich regions (PAF=7.8%, 95% CI=7.1-8.6), and the second one in poor regions (PAF=8.5%, 95% CI=7.7-9.4). Midlife hearing loss presented the third largest PAF in both regions; the impact on dementia prevention by avoiding hearing loss seems to be higher in poor regions (PAF=8.5%, 95% CI=7.7-9.4) than in rich regions (PAF=6.4%, 95% CI=5.8-7.1) (Figure 1).

PAF by race

We did not observe differences in the overall weighted PAF by race (Table 3). Early-life low education, midlife hypertension, and hearing loss still had the three largest PAF in both Black and White individuals. However, the importance of these risk factors varied by race. Among the White population, hypertension was the most important risk factor (PAF=7.3%, 95% CI=6.3-8.5), followed by low education (PAF=6.8%, 95% CI=6.0-7.7) and hearing loss (PAF=6.8%, 95% CI=5.8-8.0). In Blacks, less education had the largest PAF (8.2%, 95% CI=7.5-9.0), followed by hypertension (PAF=7.7%, 95% CI=6.8-8.6) and hearing loss (PAF=6.6%, 95% CI=5.8-7.5) (Figure 2).

4. Discussion

To the best of our knowledge, this is the first study in a large LMIC of PAF for dementia using people representative of the population to consider the impact of race and sociodemographic differences per region. The potential for dementia prevention in Brazil is greater than previously described for HIC. Forty-eight percent of dementia cases could be preventable through the control of 12 modifiable risk factors. Less early-life education, midlife hypertension, hearing loss, and obesity had the higher PAFs, which highlights the importance of early and midlife risk factors as potential targets for dementia prevention policies. The overall weighted PAF was larger in poor Brazilian regions compared to rich regions, and the importance of risk factors differed between these regions. Although the overall PAFs were similar among Black and White individuals, the order of importance of individual PAFs differed.

As expected, PAFs for the 12 risk factors were overall larger in Brazil than in HIC.[6-8] While 40% of dementia cases were estimated to be preventable through the control of the 12 risk factors using worldwide data,[8] 40%, 41%, and 56% of dementia cases would be preventable in China, India, and LA, respectively when nine potentially-modifiable risk factors were considered.[9] Another study found that 24%, 32%, and 40% of cases would be preventable through the control of seven risk factors in Mozambique, Brazil, and Portugal, respectively. However, communalities among risk factors in each country were the same as the Norton et al study,[6] which was estimated using the data for adults aged 16 years and over from the 2006 Health Survey for England.[10] Our estimation of 48% of dementia cases attributable to 12 risk factors is higher than in HIC data but not as high as previous estimates for LA.[8] The larger overall PAF for LA (56%) calculated previously did not use nationally representative data,[9] and our estimation of a combined weighted PAF of 48% for Brazil is more

likely to represent the contribution of the modifiable risk factors and it is in line with estimations of a higher prevalence of dementia in LA,[4] and younger ages of dementia onset in LMIC.[25]

The main dementia risk factor in Brazil was less education, which can be tackled and is already being addressed to an extent through public policies reducing illiteracy and increasing primary education in LMIC, but retention of students in secondary education needs improvement.[26] In Brazil, 99% of children aged 6-14 are enrolled in schools; but only 27% complete high school education.[27] Midlife hearing loss is increasingly recognized as a risk factor for dementia,[28, 29] and it was among the three most important risk factors for dementia in Brazil, independent of race and socioeconomic development. Casual and common mechanisms can explain the link between hearing loss and dementia.[30] Depletion of cognitive reserve caused by low auditory stimulation, a decline in brain volume caused by hearing loss, and social isolation are potential causal pathways linking hearing loss and dementia.[30]. The fact that midlife hearing loss has been related to dementia years later and the use of hearing aids reduces or removes the excess risk are strong evidence that the relationship between these two conditions may be causal.[8, 31, 32] . Moreover, diagnosis and control of cardiovascular risk factors would be expected to impact dementia burden in LMIC more than in HIC, since the prevalence of vascular dementia seems to be higher in LMIC.[33] The steady increase in obesity in these countries has led to an increased prevalence of hypertension and diabetes.[34, 35] which may have been countered in part by the decrease in physical inactivity and smoking as the result of public policies through aggressive advertising campaigns and restriction of smoking in public spaces.[36, 37]

We found a similar overall PAF to New Zealand (48%) when investigating the contribution of the same 12 risk factors.[13] Their estimations varied across different

ethnic groups. Maori and Pacific people had the higher PAFs (51% each) compared to European (48%) and Asian (41%) descendants.[13] Although we did not find differences in the overall PAF for Black people and White people, the relative contribution for some risk factors varied, as in New Zealand, where obesity and hearing loss had the highest PAFs among Maori and Pacific people, hearing loss and social isolation were more important in Europeans, and hearing loss and physical inactivity in Asians.[13]

The top three risk factors in Brazil were less education, hypertension, and hearing loss. However, the order of their importance varied by race. Early-life less education was the main contributor to dementia risk among Black people, followed by midlife hypertension and hearing loss, while hypertension was the most important factor among Whites, followed by less education and hearing loss. The prevalence of fewer years of education was 53% in Black people and 39% in Whites, highlighting that social inequalities in education access and school retention rates disproportionally affect vulnerable ethnic groups. Therefore, public policies designed to increase access to high-quality education should be tailored to and targeted toward Blacks to increase its impact on health outcomes in this population, including in respect of dementia prevention.

In addition to stratified analysis by race, we investigated the regional differences by exploring geographical regions with different socioeconomic development within the same country. This analysis is particularly important in large countries with social inequalities. Geographic disparities are well-described in the United States concerning stroke and dementia risk with higher rates in the Southeastern states, where the socioeconomic level is lower than in the Northern American regions. The Stroke Belt is a term used to describe Southeastern areas with higher stroke mortality.[38] Being born or living in these areas has also been related to higher dementia risk.[14] Therefore,

investigating the potential dementia risk in areas with different socioeconomic levels within the same country is a reasonable approach to tailoring more effective public policies. However, to the best of our knowledge, this analysis has not been performed before.

The potential for dementia prevention is higher in regions with low socioeconomic levels (54%) compared to those with high socioeconomic levels (49%). Moreover, the order of importance differed among poor and rich regions. Education is the most important factor in poor regions, while hypertension is the factor with larger PAF in areas with higher socioeconomic levels. Our results highlight the importance of early life education in more vulnerable populations in Brazil and point out this factor as a key factor to decrease the dementia burden in the country. Indeed, a recent path analysis using data on more than 13 thousand Brazilians showed that education is the most important factor related to cognitive function when compared to early and late socioeconomic factors.[39]

We used nationally representative data to calculate the prevalence and communality of the dementia risk factors. This study is important to expand previous studies from HIC on the potential for dementia prevention[6, 8] because local information on the risk factors determines the overall PAF, as well as the contribution of each risk factor. Another strength of this study is the inclusion of 12 risk factors, which adds to previous studies that evaluated seven to nine risk factors and allows comparison with worldwide numbers.[8-10, 12, 13] The increase in the number of risk factors reflected the increase of the PAF as expected.

Our study should be examined also in light of its limitations. We did not have direct measures of air pollution and we used the same approach as the Lancet Commission, which considered urban residence as an indicator of polluted areas.[8] The level of air

pollution varies considerably among urban areas and we may be overestimating the PAF for this risk factor when we considered all urban areas as polluted. We classified diabetes and hypertension according to diagnosis and treatment and those with the least resources may have been systematically underdiagnosed, which probably has underestimated the prevalence and PAF for these risk factors. Similarly, hearing loss was self-reported, which usually means that the prevalence of this risk factor is underreported and our PAF estimate may be underestimated.[40] Moreover, we did not have information on the nationally representative prevalence of traumatic brain injury in Brazil and used the prevalence from a meta-analysis from 15 studies from high-income countries, which may not reflect the prevalence of this risk factor in Brazil. In addition, 4% of measures of weight and height values were self-reported, which could have led to some measurement bias in BMI; but is unlikely to have impacted our estimate of obesity prevalence (Prevalence of obesity using measured weight and height: 31.6%; using self-reported measures: 31.4%). Race was also self-reported in ELSI-Brazil and probably may not reflect ancestry in admixed countries like Brazil.[41] However, the self-reported race is closely related to ethnicity and reflects cultural and socioeconomic factors. Finally, we are to unable to estimate the specific RR for each risk factor since these risks could not be calculated from the ELSI-Brazil study.

In conclusion, almost 50% of dementia cases were attributable to 12 modifiable risk factors in Brazil. PAF was higher in poor regions compared to rich areas and the importance of the main risk factors differed. We did not observe an overall difference in the attributable fraction for these risk factors between Whites and Blacks, but the relative contribution of some risk factors diverged although the lesser contribution of medical conditions may reflect underdiagnosis and treatment, and therefore may lead to even greater risk. Tailored prevention policies for socioeconomic level and race in

continental and diverse countries, like Brazil, may help to deliver more effective programs for dementia prevention. Future studies on modifiable risk factors for dementia in other LMICs are essential to delivering country-specific preventive interventions.

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8. Keywords: dementia, prevention, risk factors, epidemiology

9. Figure legends

Figure 1. Overall and relative population attributable fraction contributions of each dementia risk factor for rich (South and Southeast) and poor regions (North, Northeast, and Central West) in Brazil.

Figure 2. Overall and relative population attributable fraction contributions of each dementia risk factor for Black and White people in Brazil.

Figure 1

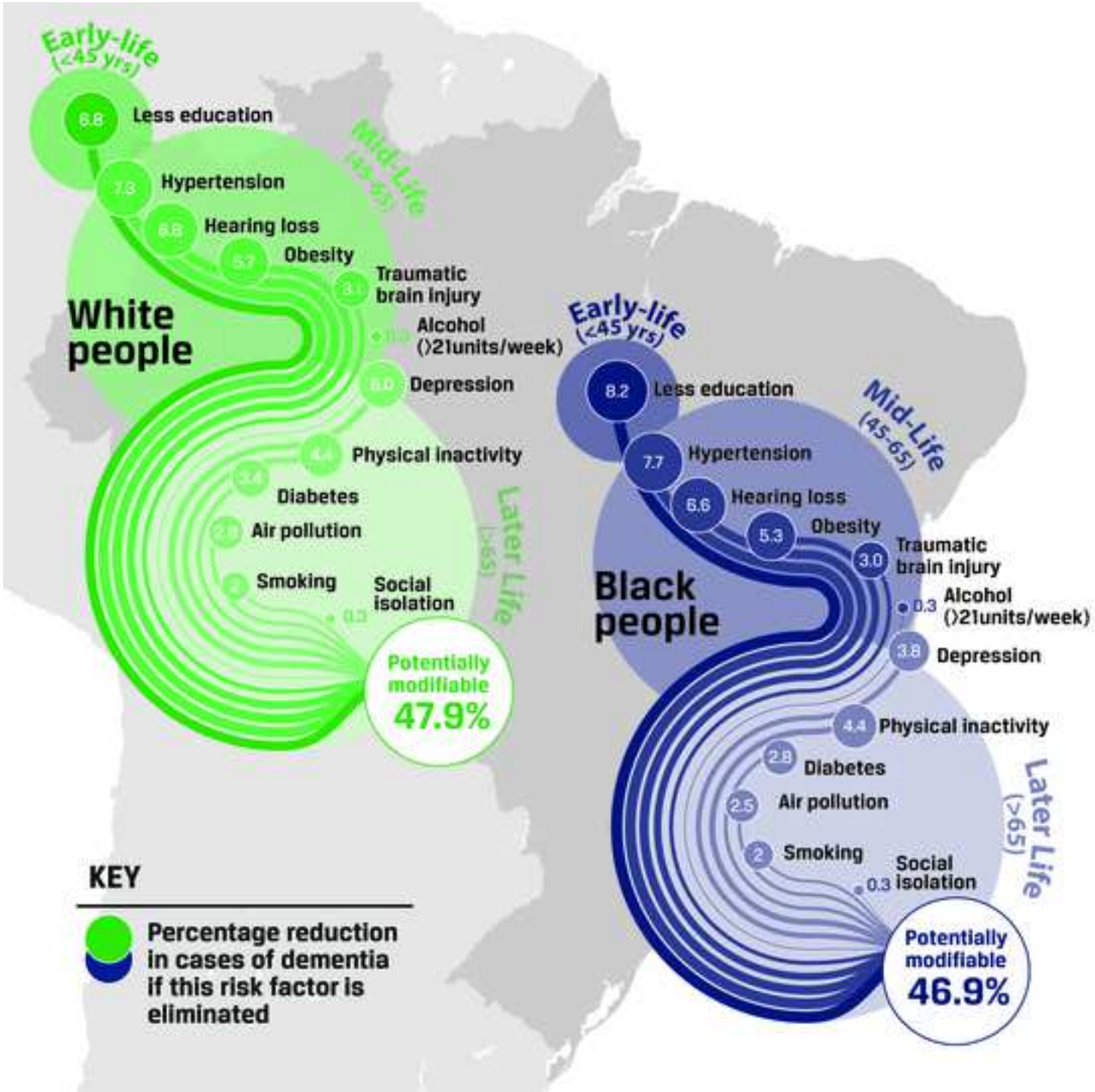

Figure 2

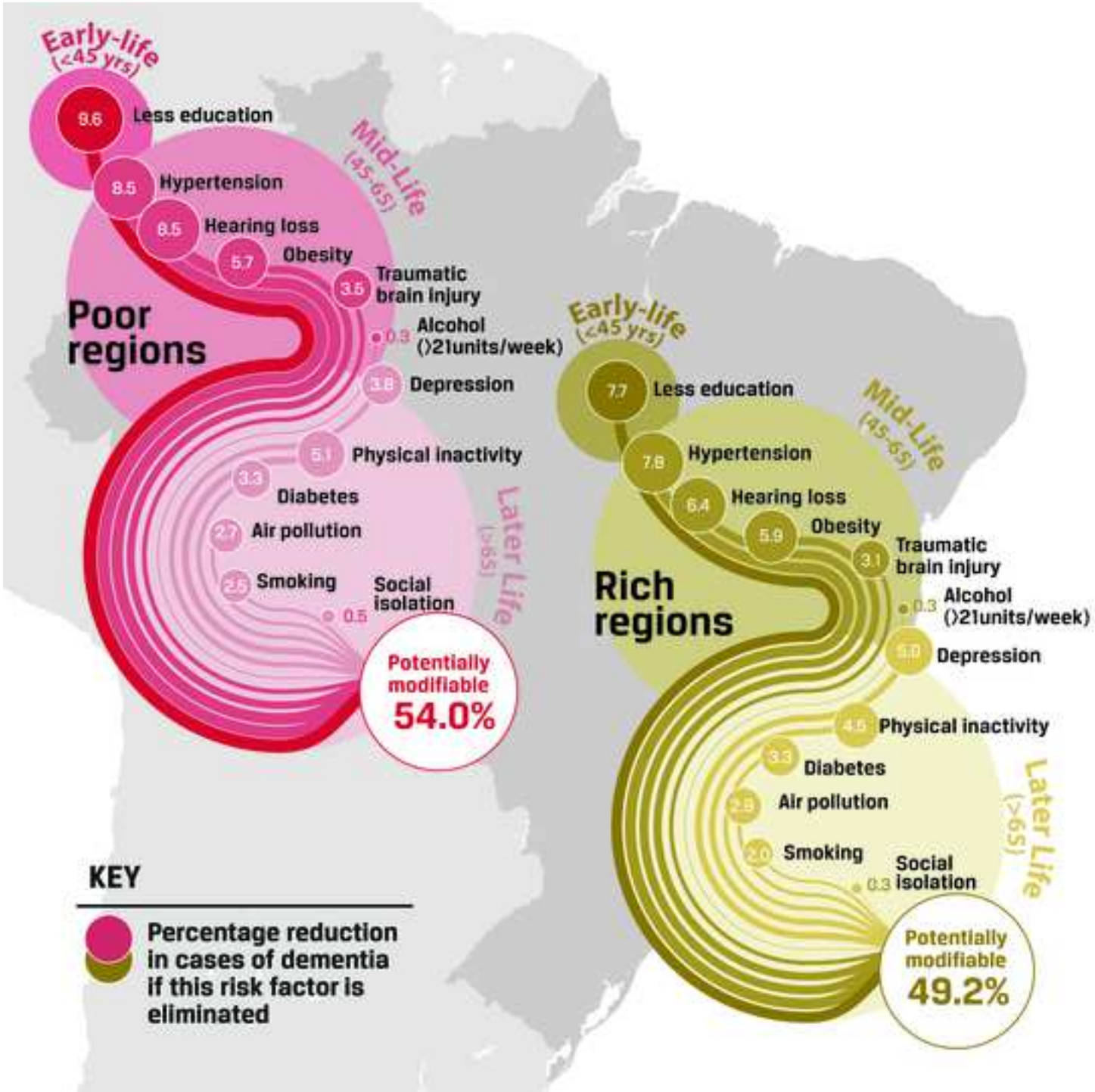

Table 1. Population attributable fraction (PAF) for 12 dementia risk factors in Brazil (n=9,412)

Risk factor	RR for dementia (95% CI)	Risk factor prevalence	Communality	PAF	Weighted PAF
Early life (<45 years)					
Less education	1.6 (1.3-2.0)	46.6%	61.8%	21.9% (21.1-22.8)	7.7% (7.2-8.3)
Midlife (45-65 years)					
Hypertension	1.6 (1.2-2.2)	46.4%	53.5%	21.8% (20.8-22.9)	7.6% (6.9-8.3)
Obesity	1.6 (1.3-1.9)	31.4%	48.1%	15.9% (15.0-16.9)	5.6% (5.0-6.2)
Hearing loss	1.9 (1.4-2.7)	26.5%	40.8%	19.2% (18.2-20.2)	6.8% (6.2-7.5)
TBI	1.8 (1.5-2.2)	12.1%	52.3%	8.8% (8.1-9.6)	3.1% (2.7-3.6)
Alcohol	1.2 (1.1-1.3)	4.3%	56.1%	0.9% (0.7-1.2)	0.3% (0.2-0.5)
Late life (> 65 years)					
Smoking	1.6 (1.2-2.2)	10.6%	61.7%	6.0% (5.2-6.8)	2.1% (1.7-2.6)
Depression	1.9 (1.6-2.3)	15.8%	67.9%	12.4% (11.3-13.5)	4.4% (3.7-5.1)
Social isolation	1.6 (1.3-1.9)	1.6%	24.3%	1.0% (0.7-1.4)	0.3% (0.1-0.5)
Physical inactivity	1.4 (1.2-1.7)	36.7%	58.6%	12.8% (11.7-13.9)	4.5% (3.8-5.2)
Diabetes	1.5 (1.3-1.8)	19.7%	41.8%	9.0% (8.1-10.0)	3.1% (2.6-3.7)
Air pollution	1.1 (1.1-1.1)	83.5%	60.7%	7.7% (6.8-8.6)	2.7% (2.2-3.3)
Overall				**77.6% (76.8-78.4)**	**48.2% (47.2-49.2)**

Table 2. Population attributable fraction (PAF) for 12 dementia risk factors in poor and rich Brazilian regions (n=9,412)

	Risk factor prevalence (%)		Communality (%)		PAF (%)		Weighted PAF (%)	
	Poor	**Rich**	**Poor**	**Rich**	**Poor**	**Rich**	**Poor**	**Rich**
Less education	52.2	46.1	57.2	60.7	23.9 (22.6-25.2)	21.7 (21.2-22.2)	9.6 (8.7-10.5)	7.7 (7.4-8.0)
Hypertension	45.1	47.1	42.9	53.9	21.3 (20.1-22.6)	22.0 (20.9-23.1)	8.5 (7.7-9.4)	7.8 (7.1-8.6)
Obesity	27.5	33.5	33.7	51.1	14.2 (13.2-15.3)	16.7 (15.7-17.7)	5.7 (5.0-6.4)	5.9 (5.3-6.6)
Hearing loss	30.0	24.6	32.7	41.9	21.3 (20.1-22.6)	18.1 (17.1-19.2)	8.5 (7.7-9.4)	6.4 (5.8-7.1)
TBI	12.1	12.1	43.2	52.7	8.8 (8.0-9.7)	8.8 (8.0-9.6)	3.5 (3.0-4.1)	3.1 (2.6-3.6)
Alcohol	4.2	4.3	40.5	60.9	0.8 (0.6-1.1)	0.9 (0.7-1.2)	0.3 (0.2-0.5)	0.3 (0.2-0.5)
Smoking	11.2	10.2	50.2	61.0	6.3 (5.1-7.6)	5.8 (5.0-6.7)	2.5 (1.8-3.4)	2.0 (1.6-2.5)
Depression	11.5	18.2	58.5	63.1	9.4 (8.0-10.9)	14.1 (12.9-15.3)	3.8 (2.9-4.9)	5.0 (4.3-5.8)
Social isolation	2.0	1.4	14.3	36.9	1.2 (0.8-1.9)	0.8 (0.5-1.1)	0.5 (0.2-1.0)	0.3 (0.1-0.5)
Physical inactivity	36.4	36.8	48.8	47.8	12.7 (11.1-14.4)	12.8 (11.7-14.0)	5.1 (4.1-6.3)	4.5 (3.8-5.3)
Diabetes	17.8	20.8	45.2	41.7	8.2 (6.9-9.6)	9.4 (8.4-10.5)	3.3 (2.5-4.3)	3.3 (2.7-4.0)
Air pollution	72.9	89.7	50.6	61.1	6.8 (5.6-8.1)	8.2 (7.3-9.2)	2.7 (2.0-3.6)	2.9 (2.3-3.5)
Overall					**77.0 (75.7-78.3)**	**78.1 (77.6-78.6)**	**54.0 (52.5-55.5)**	**49.2 (47.9-50.7)**

Poor regions: North, Northeast, and Midwest (n=4,212)
Rich regions: South and Southeast (n=5,200)

Table 3. Population attributable fraction (PAF) for 12 dementia risk factors by race (n=8,760)

	Risk factor prevalence (%)		Communality (%)		PAF (%)		Weighted PAF (%)	
	White	**Black**	**White**	**Black**	**White**	**Black**	**White**	**Black**
Less education	39.4	52.9	59.1	63.7	19.1 (17.8-20.4)	24.1 (22.9-25.3)	6.8 (6.0-7.7)	8.2 (7.5-9.0)
Hypertension	42.7	48.7	50.1	57.4	20.4 (18.7-22.2)	22.6 (21.2-24.0)	7.3 (6.3-8.5)	7.7 (6.8-8.6)
Obesity	31.5	30.9	48.8	50.4	15.9 (14.4-17.5)	15.6 (14.4-16.9)	5.7 (4.7-6.7)	5.3 (4.6-6.1)
Hearing loss	26.3	26.9	46.7	44.8	19.1 (17.5-20.8)	19.5 (18.2-20.9)	6.8 (5.8-8.0)	6.6 (5.8-7.5)
TBI	12.1	12.1	52.8	52.0	8.8 (7.6-10.0)	8.8 (7.9-9.8)	3.1 (2.4-3.9)	3.0 (2.4-3.6)
Alcohol	3.8	4.7	55.4	52.6	0.8 (0.4-1.2)	0.9 (0.6-1.3)	0.3 (0.1-0.7)	0.3 (0.1-0.6)
Smoking	10.1	10.5	64.0	60.7	5.7 (4.5-7.0)	5.9 (4.9-7.1)	2.0 (1.3-2.9)	2.0 (1.4-2.8)
Depression	18.0	14.0	64.1	73.9	13.9 (12.1-15.8)	11.2 (9.8-12.7)	5.0 (3.9-6.2)	3.8 (3.0-4.8)
Social isolation	1.4	1.6	36.1	13.8	0.8 (0.4-1.4)	1.0 (0.6-1.5)	0.3 (0.1-0.7)	0.3 (0.1-0.7)
Physical inactivity	35.3	37.5	55.6	54.1	12.4 (10.7-14.2)	13.0 (11.5-14.6)	4.4 (3.4-5.6)	4.4 (3.5-5.4)
Diabetes	20.8	18.0	41.5	41.2	9.4 (7.9-11.0)	8.3 (7.1-10.0)	3.4 (2.5-4.5)	2.8 (2.1-3.6)
Air pollution	86.5	80.3	59.3	59.7	8.0 (6.6-9.5)	7.4 (6.2-8.7)	2.8 (2.0-3.8)	2.5 (1.8-3.33)
Overall					**76.7 (75.3-78.1)**	**78.0 (76.9-79.1)**	**47.9 (46.3-49.6)**	**46.9 (45.5-48.3)**

White (n=3,590)
Black (n=5,170)

Research in Context

1. Systematic review: We reviewed the literature using the PubMed database and references from retrieved articles. Twelve risk factors account for 40% of dementia cases according to data mostly from high-income countries.

2. Interpretation: Using a nationally-representative study from Brazil, the largest country in Latin America, we estimated that 48% of dementia cases were attributable to 12 modifiable risk factors. Overall and individual population attributable fractions (PAF) varied between rich and poor macro-regions. Although the overall PAF was similar by race, education was the most important factor among Blacks, while hypertension was the most important in Whites.

3. Future directions: This study suggests that it is important to tailor public health interventions to adequately prevent dementia based on the local context, considering regional differences in race and socioeconomic level.