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Association of workplace and population characteristics with prevalence of hypertension among Brazilian industry workers: a multilevel analysis

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ABSTRACT

Background Exposure to risk factors for hypertension may be influenced by the characteristics of the workplace, where workers spend most of their daily time.

Objectives To evaluate the association between features of the companies, particularly the presence of facilities to provide meals, and of population characteristics and the prevalence of hypertension, taking into account individual risk factors for hypertension.

Material and methods This multilevel analysis was based on a cross-sectional study with individual and company data from the SESI *(Serviço Social da Indústria–Social Service of Industries)* study and population-based data from the national census statistics. Workers aged ≥15 years were randomly selected from small (20–99), medium (100–499) and large (≥500 employees) companies per state using multistage sampling. Logistic regression was used to analyse the association between hypertension and individual, workplace and population variables, with odds ratios (ORs; 95% CI) adjusted for three-level variables.

Results 4818 Workers from 157 companies were interviewed and their blood pressure, weight and height were measured. Overall, 77% were men, aged 35.4 ±10.7 years, with 8.7 ±4.1 years of schooling and mostly worked in companies with a staff canteen (66%). Besides individual characteristics—being male, ageing, low schooling, alcohol abuse and higher BMI—a workplace with no staff canteen (OR=1.28; 95% CI 1.08 to 1.52), small companies (OR=1.31; 95% CI 1.07 to 1.60) and living in cities with higher economic inequality (OR=1.47; 95% CI 1.23 to 1.76) were associated with a higher risk for hypertension.

Conclusion Among Brazilian workers, the prevalence of hypertension is associated with individual risk factors, lack of a canteen at the workplace, small companies and higher economic inequalities of cities. These three-level characteristics help to interpret differences in the prevalence of hypertension between regions or countries.

Strengths and limitation of this study

- Enrolment of a large random sample of industry workers from five regions of Brazil, including urban and rural areas.
- Inclusion of companies of different sizes and characteristics.
- Carrying out a multilevel analysis, including individual, workplace and population characteristics.
- The cross-sectional design of the study has no power to establish causality, particularly regarding the lack of temporality.

BACKGROUND

Hypertension has been a worldwide challenge for public health over the past decades.[1] Although it is possible to prevent, treat and control hypertension, rates of control remain unacceptably low.[2] As a consequence, hypertension continues to have a leading role among risk factors for coronary heart disease, stroke, heart failure and chronic kidney disease.[3] The consequences of hypertension and associated morbidities for the healthcare system increase the costs of providing long-term care and treatment, including hospitalisations and early retirement due to disability. Workplace costs increase owing to the loss or reduction of labour productivity and absenteeism of those who remain in the workforce.[4]

Some risk factors for hypertension are not modifiable, such as ancestry[5] and ageing.[6 7] Many other risk factors, however, can be targeted by interventions—for example stopping smoking,[8] restricting sodium intake,[9] increasing physical activity and intake of fruits, vegetables and whole grains, or losing weight.[10 11] Although individual characteristics are determinants of blood pressure levels, environmental exposures, such as those at the workplace, may mitigate or accentuate risk factors.[12] In addition, the socioeconomic status of individuals,[13 14] which can be measured by variation of income between cities and regions, may influence the prevalence of hypertension.

The effect of socioeconomic differences on the prevalence of hypertension can be analysed for an individual or on a larger scale for those in a workplace,[15] population[16] or even country.[14] Multilevel models allow a network of individual features to be compiled at the same time as context variables of several levels, establishing a hierarchy among them.[13 14] The association between environmental characteristics and blood pressure[14 17] has been shown, but not simultaneously in the workplace and at the population level.[17 18] This study presents the prevalence of hypertension among Brazilian workers and explores the influence of individual characteristics, features of the workplace and of the population where the workers live on the prevalence of hypertension.

MATERIAL AND METHODS

This multilevel analysis used data from a cross-sectional study: the SESI (Serviço Social da Indústria; Social Service of Industries) study, and the demographic census data available at the Brazilian Institute of Geography and Statistics (IBGE). Employees aged ≥15 years who worked in industries or companies listed in the Annual Social Information List (RAIS) of the Ministry of Labour and Employment were eligible. The RAIS consists of a national registry of Brazilian public and private companies, with data on administration and employers registered with the National Institute of Social Security, regularly updated by regulatory agencies of each state. In each region, a state was randomly chosen to represent the region and, subsequently, cities, companies and workers were selected at random. Workers who were absent on the days of enrolment were not included. Workers selected from each company were invited to participate and those who agreed signed a consent form. The institutional review board and ethics committee of the Universidade Federal do Rio Grande do Sul, which is accredited by the Office of Human Research Protections as an institutional review board, approved the protocol.

Sampling and sample size calculation

Workers were randomly selected through multistage sampling. The first stage used simple random sampling to select one state for each region. Alagoas, Mato Grosso do Sul, Tocantins, Rio de Janeiro and Rio Grande do Sul were selected to represent the northeastern, central-west, north, southeast and south regions, respectively. The second stage was conducted in a stratified random sample using the size of the companies listed in the RAIS, comprising small (20-99), medium (100–499) and large (≥500 employees) companies in each state. The number of small, medium and large companies selected by state was established in proportion to the size of the stratum. The companies, sorted by city, were subsequently selected by systematic random sampling in each stratum. Before the data collection, the companies were visited by the supervisors to inform managers about the project, obtain the consent of the participating company and verify the structure of the company in order to generate a systematic random sample of workers. In each company, random systematic sampling was used to select workers. An epidemiologist and a statistician developed all sampling procedures and protocols for data collection. Two supervisors oversaw the fieldwork.

The sample size calculation was based on 5 453 439 workers registered in the RAIS, assuming a prevalence of hypertension ranging between 5% and 50%, with a sampling error of 5%. The prevalence ratio was calculated by the prevalence rate of hypertension among workers with a low level of schooling divided by the prevalence rate among workers with high level of schooling, for example. Using estimates[16] of 12% prevalence of risk factors among those unexposed to low socioeconomic status and 18% among those exposed, with a ratio of 3:1, respectively, 2028 workers would be necessary to detect a prevalence ratio of at least 1.5, with 90% power and 5% significance level (two-tailed). Since we had information about 4818 workers, we carried out the analysis on the full sample. The Statcalc module, of the EPINFO 2000 (Centres for Disease Control and Prevention, Atlanta, USA), version 3.3.2, was used in the sample size calculation.

Study implementation

Individual-level variables

Participants at the workplace were interviewed using a standardised questionnaire with 92 questions, which included assessment of demographic, socioeconomic, lifestyle, food intake and other characteristics. The questions have been previously tested.[16 19–21] In addition, a pilot study with 291 workers was carried out in one state, in order to verify whether the wording of the questionnaire was appropriate. The individual-level details included variables such as gender, age, years at school, current smoking, abusive alcohol consumption, physical activity and body mass index (BMI; weight (kg)/height (m^2)) in the analysis. Age was categorised into 10-year-intervals. Formal education was categorised as 0–4, 5–8, 9–11, ≥12 years completed at school. Physical activity was evaluated using the short form of the International Physical Activity Questionnaire (IPAQ), and categorised as high, moderate or low physical activity, according to the protocol.[22] Alcohol consumption was investigated using a standardised questionnaire about type, frequency and amount of each beverage consumed in the 2 weeks before the interview. Abusive alcohol was determined as daily intake ≥30 g of ethanol, by men and ≥15 g by women.[23] Interviews were carried out and patients were reassured about confidentiality.

With the subject in light clothing and barefoot, weight (kg) was measured to the nearest 100 g with an electronic scale (Plenna, model Mea – 07400) and height (cm) to the nearest 0.1 cm using a stadiometer (Tonelli, vertical model). Blood pressure measurements were carried out with an automatic oscillometric device (OMRON, model HEM-705 CP) using standardised techniques, which include previous resting for 5 min with the participant seated, feet straight on the ground and the arm over a surface with the antecubital fossa at the level of the heart.[24] Hypertension was defined by the average of two blood pressure measurements ≥140/90 mm Hg or use of blood pressure lowering medication.[25]

Company-level variables

One hundred and fifty-seven companies in several cities of each state were selected and 93.1% agreed to participate. The presence of a canteen in the workplace and the size of the company were the variables of the company included in this analysis.

The availability of on-site canteens was investigated with administrative staff and confirmed with workers during data collection. The standardised questionnaire asked 'Does the company have a canteen?', 'Do you bring food from home?', 'Are meals served at work prepared by a food company?' and 'Does the company have a kitchen and cooks to prepare meals?". A staff canteen aims to provide healthy meals, reducing unhealthy dietary preferences. The potential effect of a staff canteen depends on the number of meals received by employees during working time—three meals in an 8-hour period. In this survey, dietary information was collected on food intake outside and at work.[26]

Population-level variables

The nationwide data collection for the census, performed by the IBGE, provided the number of inhabitants and the Gini coefficient. The number of inhabitants was categorised as <100 000 or ≥100 000 inhabitants. The Gini coefficient is an international parameter used to measure inequality in income distribution among countries or regions. The coefficient varies between 0 and 1; values closer to 0 indicate low income inequality in a city and better income distribution. In this analysis, the distribution of the Gini coefficient for the whole sample was categorised as values ≤50th centile or values >50th centile (high income inequality).

Statistical analysis

Data analysis was performed using the Statistical Package for Social Sciences (SPSS. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc, Illinois, USA) and stratified by sex. All analyses were weighted by the sampling design. Logistic regression models were used to analyse the association between the prevalence of hypertension and company and population variables, adjusted for individual variables. This data analysis was conducted using MLwiN 2.19.

We fitted three models. Model I included individual-level variables: sex, age, years at school and body mass index. Model II incorporated model I individual-level variables and company-level variables: on-site staff canteen and company size. Finally, model III was built with the previous variables adjusted for a third level, population-level variables: number of inhabitants and the Gini coefficient. The model parameters were estimated by the penalised quasi-likelihood method, and odds ratios with 95% CI were reported. The analysis was performed with fixed-effects variables entering sequentially, and missing values were excluded.

RESULTS

In total, 4818, out of 5000 workers, from 157 companies were interviewed. The participation rate of companies was 93.1% and that of workers, 96.4%. Non-participation of workers was due to vacations or illnesses. The main reason for the non-participation of companies was the duration of the evaluations, which reduced employees' working hours on the days of data collection. In addition, a few companies listed in RAIS in the previous year had closed. The workers were aged, on average, 35.4 (SD 10.7) years, most were men (76.5%), had completed 8.7 (SD 4.1) years at school, 65.7% worked in companies with an on-site staff canteen and 68.8% lived in cities with ≥100 000 inhabitants (table 1). At the individual level, prevalence of hypertension was higher among men, those aged ≥30 years and who had a BMI between 18.5 and 29.9 kg/m^2. The non-adjusted analysis showed that at the company level, prevalence of hypertension was lower among those with a staff canteen, but it was not associated with the size of the company, and characteristics at the population level (table 1).

Figure 1 shows that prevalence of hypertension varied by the region of Brazil where the companies were situated and between men and women. The northeastern region had the highest prevalence (35.1%) and the central west and south regions had the lowest rates (19.0% and 19.8%, respectively). Prevalence of hypertension was higher among men than women in all regions.

Table 2 presents the results of logistic regression models for variables in the first (individual), second (company) and third (population) level. At the first level, the independent risk of hypertension for male workers was approximately 2.7 times that for women, increased with age and BMI and was higher among those with <9 years of schooling and those who abused alcohol. At the second level, employees of non-canteen companies were at a higher risk of hypertension than those who worked in companies with a staff canteen, regardless of individual characteristics and company size. This company-level variable explained 4.5% of the prevalence of hypertension. For variables of the third level, living in highly populated cities and higher income inequities increased the risk of hypertension, independently of individual and workplace characteristics. The variance of the second level shifted to 1.0%, and the third level explained 3.0% of the prevalence of hypertension. The full model at the third level shows

Table 1 Risk factors for hypertension at the different levels of assessment

Risk factors	Overall percentage (n=4818)	Hypertension – (%) (n=3549**)	Hypertension + (%) (n=1257**)	p Value
Individual level				
Men	76.5	2561 (72.2)	1116 (88.9)	<0.001
Age (years)				<0.001
15–29	35.0	1468 (41.4)	215 (17.1)	
30–39	29.7	1110 (31.3)	316 (25.2)	
40–49	24.6	763 (21.5)	418 (33.3)	
50–76	10.7	207 (5.8)	308 (24.5)	
Years at school				<0.001
0–4	18.6	576 (16.2)	319 (25.4)	
5–8	31.8	1085 (30.6)	442 (35.2)	
9–11	33.1	1258 (35.4)	332 (26.4)	
>11	16.5	631 (17.8)	164 (13.0)	
Physical activity				0.07
Low	14.4	494 (13.9)	199 (15.8)	
Moderate	34.8	1264 (35.6)	408 (32.5)	
High	50.8	1792 (50.5)	650 (51.7)	
Abusive alcohol consumption	6.7	202 (5.7)	121 (9.6)	<0.001
Current smoking	15.8	524 (14.8)	234 (18.6)	0.001
Body mass index (kg/m^2)				<0.001
<18.5	1.7	74 (2.1)	9 (0.7)	
18.5–24.9	48.4	1950 (54.9)	378 (30.1)	
25.0–29.9	37.9	1216 (34.3)	604 (48.1)	
≥30.0	12.0	309 (8.7)	266 (21.2)	
Company level				
On-site staff canteen	68.3	2344 (70.0)	767 (63.4)	<0.001
Size of company				1.0
Large	32.5	1140 (32.1)	408 (32.5)	
Medium	34.2	1230 (34.7)	430 (34.2)	
Small	33.3	1179 (33.2)	419 (33.4)	
Population level				
Number of inhabitants ≥100 000	68.8	2369 (68.6)	844 (69.4)	0.6
Gini coefficient (>50thP)†	50.0	1673 (47.6)	687 (54.9)	<0.001

*Percentages were obtained in the analysis taking into account the sampling design
†The Gini coefficient is an international parameter used to measure the inequality in income distribution among countries. A Gini coefficient >50th centile means high income inequality.
**Numbers may not add to totals due to weight and rounding, beside missing information for hypertension (n=17), Gini coefficient (n=25), number of inhabitants (n=125), and on-site staff canteen (n=220).

that all individual characteristics, with the exception of smoking and physical activity, remained independently associated with hypertension. The size of company became statistically associated with the prevalence of hypertension after the multivariate analysis, with a risk for hypertension in workers of small size companies.

Differences in food intake according to the presence of an on-site staff canteen were observed in a secondary analysis. In companies with an on-site staff canteen, workers were more likely to consume more vegetables (67.2% vs 62.5%; p=0.002), beans (89.0% vs 86.5%; p=0.002), leafy vegetables (60.6% vs 53.2%; p≤0.001) than red meat (41.8% vs 46.2%; p=0.02), salted meat (2.3% vs 4.6%; p≤0.001) and sausage (7.0% vs 8.8%; p=0.04).

DISCUSSION

This multilevel analysis showed that population and workplace factors are associated with prevalence of

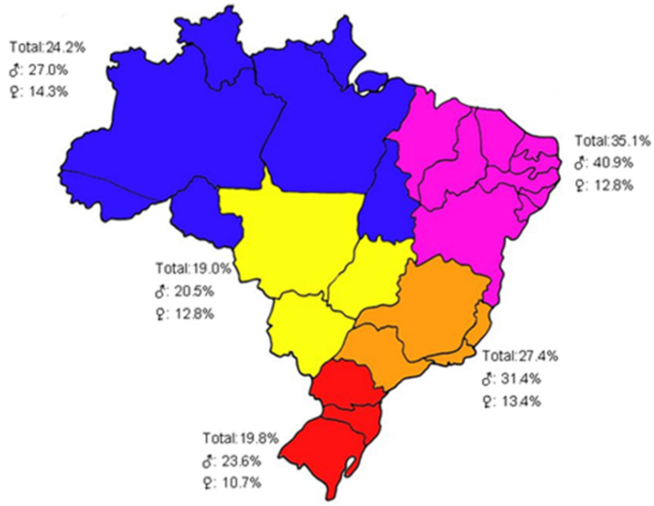

Figure 1 Prevalence of hypertension for men and women by regions of Brazil.

hypertension over and above individual-level characteristics, such as age, sex, years at school, smoking, physical activity and BMI. The presence of a canteen in the workplace may be associated with availability, variety and quality of healthy meals. The size of the company and, at the level of the population, the number of inhabitants of the city and the index of income inequalities, probably reflect other risks for hypertension not identified at the individual level.

Among workers, the analysis of individual-level risk factors confirmed higher prevalence[27 28] and risk of hypertension among men, elderly workers, with less than middle school education[29] and obese.[30] Even though, this multilevel analysis showed a further influence of the macro-environment level on blood pressure. The presence of a staff canteen is part of Brazilian regulatory policy for companies with 300 or more employees and consequently, the workers do not take homemade meals to the workplace. In Brazil, canteens usually have nutritionists who supervise the preparation and provision of meals. The availability of canteens providing healthy meals in the workplace is not common in all countries.[31] In addition, the presence of canteens also seems to reduce the consumption of snacks and drinks sold in vending machines.[32 33] However, the availability of healthy food did not ensure its consumption.[34]

In this study, living in a city with greater number of inhabitants accounted for higher risk of hypertension, which persisted after controlling for individual, company characteristics and population economic inequalities. The number of inhabitants was used a proxy for the size of the city, which might account for the exposure to social, cultural, economic and regulatory policies. These features are likely to differ between large and small cities. Our results are in accordance with previous findings for population characteristics associated with individual systolic blood pressure.[14] At the population level, physical activity, smoking, dietary practices and environmental pollution are some of the mechanisms linking urbanisation to the development of non-communicable diseases.[35]

Workplaces are the perfect setting for health promotion initiatives.[36–38] Given that most of the adult population is employed and spends 8 or more hours a day in the workplace, it is a natural setting for promoting healthy habits aiming to reduce the prevalence of non-communicable disease.[36] Thus, the workplace is a captive environment in which people can be contacted for recruitment and programme implementation. Strategies to prevent hypertension could include intervention at the company level, enabling staff canteens, even in small and medium-sized companies, health promotion programmes[39] and dietary modification interventions.[40] At the individual level, strategies could include interventions to control alcohol abuse and education about healthy eating.[41] The implementation of joint interventions would probably be more effective,[40] particularly if targeting a well-defined population. In addition, the increasing availability of fruits and vegetables in the workplace is possible when environmental changes and connections between employers and workers are developed.[42]

Our findings have some limitations. The cross-sectional design does not establish temporality and the possibility of reverse causality cannot be disregarded. Moreover, workplace-specific characteristics such as psychosocial work environment, physical factors and work task are potential sources of morbidity, which were not examined and should be investigated in further studies. The measurement of BP twice on 1 day to diagnose hypertension is a limitation, but it is unlikely that this potential error is unequally distributed among groups defined by different exposures. Moreover, definition of hypertension in observational studies is often based on two or three BP measurements,[25] which differs from the recommendations for diagnosing hypertension.[24]

The strengths of our study includes a large random sample of workers, from five regions of Brazil, including urban and rural areas, and companies of small, medium and large size of a wide variety of industries, including, but not limited to, manufacturing, upstream and downstream industries and extractive industries, construction and service industries. This large representative sample of Brazilian workers was investigated to provide information on a poorly investigated spectrum of characteristics at the workplace level.

In conclusion, Brazilian workers have higher risks for hypertension when living in cities with a higher index of economic inequalities, working in small companies and without a canteen at the workplace. These risks were independent of ageing, sex, schooling, consumption of alcohol and body mass index. These findings help to explain the differences in hypertension by companies and regions of the country.

Table 2 Adjusted multilevel analysis of characteristics associated with hypertension (OR (95% CI))

Characteristics	Individual level*	Individual + company level†	Individual + company + population level‡
Gender			
Women	1.00	1.00	1.00
Men	2.68 (2.18 to 3.29)	2.71 (2.19 to 3.35)	2.78 (2.24 to 3.46)
p Value	<0.001	<0.001	<0.001
Age (years)			
15–29	1.00	1.00	1.00
30–39	1.61 (1.32 to 1.96)	1.75 (1.42 to 2.14)	1.71 (1.38 to 2.11)
40–49	2.80 (2.30 to 3.42)	2.98 (2.43 to 3.66)	2.93 (2.38 to 3.62)
50–76	7.20 (5.65 to 9.17)	8.31 (6.47 to 10.69)	8.24 (6.37 to 10.65)
p Value	<0.001	<0.001	<0.001
Years at school			
0–4	1.51 (1.18 to 1.94)	1.51 (1.16 to 1.96)	1.48 (1.13 to 1.93)
5–8	1.58 (1.25 to 1.98)	1.45 (1.14 to 1.84)	1.43 (1.12 to 1.82)
9–11	1.16 (0.92 to 1.46)	1.17 (0.92 to 1.48)	1.12 (0.88 to 1.43)
>11	1.00	1.00	1.00
p Value	<0.001	0.003	0.004
Physical activity			
Low	1.11 (0.90 to 1.38)	1.09 (0.88 to 1.36)	1.07 (0.85 to 1.34)
Moderate	0.96 (0.82 to 1.13)	0.94 (0.80 to 1.11)	0.95 (0.810 to 1.13)
High	1.00	1.00	1.00
p Value	0.5	0.4	0.6
Abusive alcohol consumption			
No	1.00	1.00	1.00
Yes	1.58 (1.22 to 2.06)	1.54 (1.17 to 2.02)	1.62 (1.22 to 2.16)
p Value	0.001	0.002	0.001
Current smoking			
No	1.00	1.00	1.00
Yes	1.13 (0.94 to 1.37)	1.08 (0.89 to 1.32)	1.06 (0.87 to 1.29)
p Value	0.19	0.4	0.6
Body mass index (kg/m^2)			
<18.5	1.00	1.00	1.00
18.5–24.9	1.49 (0.67 to 2.32)	1.46 (0.68 to 3.13)	1.48 (0.69 to 3.19)
25.0–29.9	3.19 (2.37 to 4.02)	3.13 (1.46 to 6.69)	3.26 (1.52 to 7.02)
≥30.0	6.01 (5.18 to 6.85)	5.83 (2.69 to 12.65)	5.76 (2.63 to 12.59)
p Value	<0.001	<0.001	<0.001
On-site staff canteen			
Yes	–	1.00	1.00
No	–	1.31 (1.11 to 1.54)	1.28 (1.08 to 1.52)
p Value		0.001	0.004
Size of company			
Small	–	1.19 (0.99 to 1.44)	1.31 (1.07 to 1.60)
Medium	–	1.12 (0.94 to 1.34)	1.06 (0.88 to 1.28)
Large	–	1.00	1.00
p Value		0.17	0.02

Continued

Table 2 Continued

Characteristics	Individual level*	Individual + company level†	Individual + company + population level‡
Number of inhabitants			
<100.000	–	–	1.00
≥100.000	–	–	1.22 (1.01 to 1.47)
p Value			0.04
Gini coefficient			
≤P50	–	–	1.00
>P50			1.47 (1.23 to 1.76)
p Value			0.001

*OR adjusted for gender, age, years at school and body mass index (BMI).
†OR adjusted for gender, age, years at school, BMI, size of company and on-site canteen.
‡OR adjusted for gender, age, years at school, BMI, on-site canteen, size of company, number of inhabitants Gini coefficient above 50th centile.

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Competing interests None declared.

Patient consent Obtained.

Ethics approval Research ethics committee of the Universidade Federal do Rio Grande do Sul.

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Data sharing statement The additional data report from the study is available to researchers at: http://vidasaudavelempresa.sesi.org.br/portal/lumis/portal/file/fileDownload.jsp?fileId=FF8080812B3B9D27012B3F0989CA1B9C

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