Demographic and socioeconomic characteristics of Brazilian adults and COVID-19: a risk group analysis based on the *Brazilian National Health Survey*, 2013

Aspectos demográficos e socioeconômicos dos adultos brasileiros e a COVID-19: uma análise dos grupos de risco a partir da *Pesquisa Nacional de Saúde*, 2013

Aspectos demográficos y socioeconómicos de los adultos brasileños y la COVID-19: un análisis de los grupos de riesgo a partir de la *Encuesta Nacional de Salud*, 2013

Gabriel Mendes Borges [1]
Claudio Dutra Crespo [1]

Abstract

This study aimed to characterize risk groups for COVID-19 in Brazil and to estimate the number of individuals living in the same household with persons in the risk group. Data were used from the Brazilian National Health Survey (PNS) of 2013. To characterize the risk groups, a binary multiple logistic regression model was adjusted in which the response variable was the presence or absence of at least one condition associated with COVID-19 and the explanatory variables were age, sex, major geographic region, color or race, schooling, and workforce status of the residents interviewed by the study. The results show that age is the principal risk factor for comorbidities associated with COVID-19, but the risk is also greater for persons in more vulnerable categories, such as those with less schooling and blacks and browns. An estimated 68.7% of Brazilians were living with at least one person in the risk group: 30.3% lived with at least one elderly individual and another 38.4% had no elderly individuals in their households, but there was at least one adult resident with preexisting medical conditions. The proportion of persons living in households with at least one resident in the risk group was 50% or greater for all ages and increased from 35 years of age, but there were also high numbers of persons 10 to 25 years of age living with persons in the risk group. The results suggest that due to the difficulties in avoiding close household contact, the exclusive isolation of specific population groups is not a feasible strategy in the Brazilian context, but should be combined with social distancing of the population as a whole.

COVID-19; Risk Groups; Socioeconomic Factors; Social Isolation

Correspondence
G. M. Borges
Instituto Brasileiro de Geografia e Estatística.
Av. Presidente Antonio Carlos 25, sala 803, Rio de Janeiro, RJ
20020-010, Brasil.
gmendesb@hotmail.com

[1] *Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro,*
Brasil.

Introduction

COVID-19, the disease caused by the novel coronavirus SARS-CoV-2, was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 [1]. The first case in Brazil was reported on February 25, 2020, and on June 30, 2020, the country had the world's second most confirmed cases (1,402,041) and deaths (59,594) [2,3].

The COVID-19 pandemic has called the entire world's attention and sparked debates on strategies to deal with the disease, featuring social distancing, closing of schools and jobs, personal hygiene and health, and cancellation of large events, among others [4,5,6,7]. In Brazil, since the latter half of March, social distancing of the population and interruption of non-essential economic activities, proposed by national and global health authorities, were implemented by the majority of subnational governments as a fundamental measure for reducing the pace of the disease's transmission [8]. Such measures have been the object of political debate, particularly after the President of Brazil took a public stance against social distancing [9]. On various occasions, the President called for a "return to normalcy" and suggested the reopening of schools and the resumption of work activities, defending a strategy of "*isolamento vertical*" (vertical isolation) [10]. This term, a translation of the English "vertical interdiction", is not well situated in the scientific literature on the topic and was proposed in an article that discusses such policies in the United States [11]. Although it is not totally clear what the strategy intends to achieve, nor which other measures would be combined with it, the general idea is to propose social isolation only for persons 60 years or older and those with preexisting medical conditions.

The debate on the pandemic's severity and possible measures to deal with it relate to evidence that the novel coronavirus infects persons of all ages, but that two groups run greater risk of severe complications of COVID-19: elderly individuals and those with preexisting medical conditions [1]. The available data thus far point to higher case-fatality from the novel coronavirus in elderly individuals, especially those with comorbid hypertension, heart disease, diabetes, and respiratory disease. Still, although mortality is relatively lower among younger individuals, those with preexisting medical conditions contribute significantly to complications and subsequent hospitalizations from COVID-19 in various countries [12,23,14,15,16], including Brazil [17], generating greater use of finite resources such as healthcare workers and ICU beds and ventilators, which are also unequally distributed in regional and social terms [18].

The political clash stemming from opposing positions on leading the country in the face of the pandemic and thus on the state's role in the population's life raises questions for assessment, based on the available information on this new reality for Brazilians' health.

Studies have reported regional and socioeconomic differences in relation to risk groups for COVID-19 in Brazil, with higher incidence of risk factors among individuals with less schooling [19,20]. Some previous studies have described and characterized risk factors associated with COVID-19, such as hypertension [21,22] and diabetes [23,24]. It is thus important to jointly evaluate these questions and to expand the understanding on how the population's sociodemographic characteristics relate to the odds of belonging to the risk group. Besides, in this context of fighting an infectious disease with high transmissibility [25], the household is considered an important unit of analysis (and for which there is a gap in the literature).

A better understanding of the socioeconomic structure and composition of the households associated with risk groups is essential for fighting the pandemic. To back such discussions, the current study has two main objectives: to describe risk groups for COVID-19 as a function of demographic and socioeconomic characteristics, and based on these estimates, to simulate and characterize the number of individuals living in the same household with persons in the risk group.

Methods

The study uses microdata from the *Brazilian National Health Survey* (PNS). The PNS is a nationwide household survey conducted in 2013 by Brazilian Institute of Geography ans Statistics (IBGE) and the Brazilian Ministry of Health, through a face-to-face interview assisted by a mobile data collection device. The PNS sample was selected via three-stage cluster sampling: (i) census tracts or sets of

tracts; (ii) households; and (iii) residents 18 years or older. The PNS has three questionnaires, the first two with questions on household characteristics, socioeconomic status, and some health questions on all the residents. Specific questions that focused on morbidity and lifestyles were only asked of one resident per household 18 years or older, randomly selected in the sampling's third stage [26,27,28]. Interviews were held in 64,348 households with 205,546 residents, of which 60,202 were 18 years or older and answered the individual questionnaire.

In addition to the demographic and socioeconomic variables, the PNS furnishes important information on chronic noncommunicable diseases, some of which have been identified as important comorbidities associated with COVID-19 [13,29,30,31]. For the one selected resident, weight, height, and blood pressure were also measured, which allows calculating measures of obesity and hypertension.

As the criterion for belonging to the "risk group with preexisting conditions", the current study uses the existence of at least one of the following conditions: self-report of a medical diagnosis of diabetes, heart disease, asthma, lung disease, or chronic renal failure; morbid obesity (BMI greater than $40.0kg/m^2$); hypertension measured in the study as greater than or equal to 140mmHg/90mmHg or current use of antihypertensive medication.

The PNS shows results for prevalence of hypertension that are similar for self-reported versus directly measured data [21]. This study adopted the latter criterion, but the results were replicated by adopting the criterion that considers self-reported hypertension and are available in supplementary material in the GitHub repository (https://github.com/gmendesb/PNS-COVID).

In order to identify the demographic and socioeconomic characteristics associated with increased risk of COVID-19, we adjusted a binary multiple logistic regression model as follows:

$$\text{logito}\,(p_i) = \ln\left(\frac{p_i}{1 - p_i}\right) = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \cdots + \beta_k X_{k,i}$$

where p_i represents the probability of belonging to the risk group with preexisting conditions in each individual i, the variables $X_0 X_{1,i} X_{2,i}...X_{k,i}$ indicate the characteristics in each individual considered in the final model, and $\beta_0 \beta_1 \beta_2...\beta_k$ represent the estimated coefficients.

The logistic regression coefficients, when they do not refer to variables that enter the model in interaction terms, are interpreted as a function of the odds ratio (OR) for each of the analytical categories in relation to a reference category. The multiple regression approach to analyze the phenomenon in question is important for minimizing the confounding effects of explanatory variables in relation to the response variable, when the sample size is not sufficiently large to stratify all the target variables [32].

As explanatory variables, we tested the answers given in the interviews referring to: five-year age groups (except for the 18-24-year group), sex, major geographic region, household location (urban versus rural), color or race, schooling, employment status (employed versus unemployed), workforce status (in versus not in the workforce), and possession of a private health plan. We also tested the interaction between the sex and age variables, as a function of the association between these two attributes in relation to the response variable, as shown in the *Results* section.

The parameters' significance was assessed with the Wald test, testing the hypothesis $H_0:\beta_j = 0$ versus $H_1:\beta_j \neq 0$ for each coefficient β_j inserted in the model referring to the inclusion of the variable (or interaction between variables) in the order listed previously [32]. The variables and interactions with p-values less than 0.05 were kept in the model. All the variables and interactions in the final model were significant with p-value less than 0.002. The variables "household location" (p-value = 0.21), "employment status" (p-value = 0.85), and "private health plan" (p-value = 0.70) were not significant for the model and were thus not included. The final model presents pseudo-R^2 (McFadden [33]) of 0.17.

The results of the regression's fit allow estimating the probability of an individual belonging to the risk group with preexisting conditions, taking various demographic and socioeconomic characteristics into account simultaneously.

Since the specific questions on diseases were only collected for one resident 18 years or older per household, it is not possible to directly extract all the residents' characteristics from the study and thus to know which households have persons with such characteristics. We thus used the coefficient resulting from the final adjusted logistic regression model to estimate the probability of each individual 18 to 59 years of age belonging to the risk group, according to his or her individual attributes. Based on these probabilities, we used Bernoulli distribution to estimate belonging (versus not belonging) to the

risk group for each individual 18 to 59 years of age. Since no information was collected on diseases for the population under 18 years of age, these individuals were considered outside the risk group. Elderly individuals 60 years or older were defined as belonging to the risk group, as suggested by the available evidence on COVID-19 [1,29,31].

Data were analyzed with the R statistical software (version 3.6.2) (http://www.r-project.org). The survey library was employed to consider the effects of the study's complex sampling. The scripts used and the supplementary material are publicly available in the GitHub repository (https://github.com/gmendesb/PNS-COVID), which allows reproducibility of all the article's results and reuse of the codes by other researchers.

Results

The results of PNS 2013 show that 39.4% (95% confidence interval – 95%CI: 38.5; 40.4) of males and 40.4% (95%CI: 39.5; 41.2) of females 18 years or older had at least one condition associated with severe complications of COVID-19 (risk group based on preexisting conditions).

The last column in Table 1 presents the prevalence of at least one preexisting condition associated with severe complications of COVID-19 by sex and age group, as well as the confidence intervals. Prevalence increases with age, reaching 75% and 73.1%, for men and women over 60 years, respectively. Although prevalence is higher among older individuals, such preexisting conditions also significantly affect younger persons. For the population 55 to 59 years of age, more than 60% present some comorbidity, while in the population 50 to 54 years of age the prevalence exceeds 50%. Among the younger groups analyzed, the prevalence of a condition associated with complications from COVID-19 reaches 12.2% of women and 15.7% of men in the 18-24-year age group. In the 25-29-year group, the proportions are 14.5% for men and 21% for women, respectively. As for differences by sex, among young people up to 29 years, prevalence is higher in men, while among elderly individuals the prevalence is slightly higher in women.

The most prevalent comorbidity in persons 18 years or older is hypertension, reaching 33% (95%CI: 32.1; 34.0) of men and 31.7% (95%CI: 30.9; 32.5) of women, followed by diabetes with 5.4% (95%CI: 4.8; 5.9) of men and 7.1% (95%CI: 6.7; 7.6) of women.

Table 1 also shows the prevalence of each of the preexisting conditions associated with COVID-19 according to sex and age group. Hypertension and diabetes are more prevalent in middle-aged and elderly individuals, and their prevalence rates increase consistently with age. Prevalence of heart disease is also significantly higher in older individuals, particularly over 55 years. For the population under 40 years, asthma shows high prevalence, around 5%.

Table 2 shows the size of the sample of residents 18 years or older who answered the individual questionnaire, as well as the estimated population considering the study's sampling design according to the selected analytical categories. We call attention to the small numbers of residents who self-identified with the census categories "yellow" or Asian-descendant (533) and "indigenous" (417). Table 2 also shows the prevalence of at least one preexisting condition related to COVID-19 and the confidence intervals for the respective categories. There was an evident increase in prevalence with increasing age, similar prevalence rates for both sexes, and higher prevalence in individuals with no schooling or incomplete primary, namely, 52.6% (95%CI: 51.6; 53.7), and those not in the workforce, at 52.5% (95%CI: 51.4; 53.6).

Table 3 presents the exponential for the estimated coefficients for each category of each variable selected for the final model. For the variables that do not enter the model with interaction (major geographic region, color or race, schooling, and workforce status), the indicators listed in the table refer to the OR of belonging to the risk group with preexisting conditions for these variables, comparing each category to the reference category. For variables that enter the model through interactions, interpretation of the coefficients should consider both variables jointly.

The coefficients for the age variable indicate the OR by age for men and confirm the results seen in Table 1, that the odds of belonging to the risk group with preexisting conditions increase with age in men. The odds of a man 45 to 49 years belonging to the risk group with preexisting conditions are four times the odds of a man 18 to 24 years of age. When the reference group is compared to the

Table 1

Prevalence (%) and 95% confidence intervals (95%CI) for preexisting conditions and risk factors associated with COVID-19 by age groups. Brazil, 2013.

Sex/Age (years)	Morbid obesity	Hypertension, measured and by use of medication	Diabetes	Heart disease	Asthma	Lung disease	Chronic renal disease	At least one preexisting
Women								
18-24	0.9 (0.4; 1.3)	3.0 (2.2; 3.8)	0.7 (0.2; 1.10)	0.8 (0.4; 1.3)	5.9 (4.6; 7.2)	1.7 (1.0; 2.4)	0.2 (0.1; 0.3)	12.2 (10.4; 13.9)
25-29	2.3 (1.5; 3.1)	6.8 (5.5; 8.0)	0.4 (0.2; 0.60)	1.3 (0.5; 2.1)	4.5 (3.6; 5.4)	0.9 (0.5; 1.3)	0.7 (0.3; 1.1)	14.5 (12.7; 16.2)
30-34	2.2 (1.5; 3.0)	14.9 (13.0; 16.8)	1.3 (0.7; 1.80)	2.1 (1.2; 3.0)	5.3 (4.1; 6.5)	1.6 (0.9; 2.2)	0.5 (0.2; 0.8)	23.3 (21.0; 25.6)
35-39	3.7 (2.2; 5.1)	19.0 (16.9; 21.1)	2.3 (1.6; 3.00)	2.1 (1.1; 3.1)	4.4 (3.2; 5.6)	0.9 (0.5; 1.3)	0.7 (0.3; 1.2)	27.7 (25.2; 30.2)
40-44	2.5 (1.6; 3.4)	25.9 (23.4; 28.40)	4.5 (3.2; 5.80)	3.8 (2.6; 5.0)	5.3 (3.9; 6.7)	1.6 (0.7; 2.4)	1.2 (0.4; 2.0)	37.5 (34.7; 40.2)
45-49	3.2 (2.1; 4.2)	37.3 (34.4; 40.2)	6.5 (5.0; 8.00)	3.3 (1.9; 4.7)	6.3 (4.7; 7.8)	1.6 (0.8; 2.5)	1.1 (0.5; 1.7)	46.6 (43.5; 49.6)
50-54	3.3 (2.0; 4.5)	44.0 (40.6; 47.40)	8.2 (6.7; 9.70)	3.8 (2.9; 4.8)	4.1 (3.0; 5.3)	1.4 (0.8; 2.0)	1.2 (0.6; 1.9)	52.1 (48.7; 55.5)
55-59	2.6 (1.6; 3.5)	54.4 (51.1; 57.8)	13.5 (11.1; 15.90)	8.7 (6.3; 11.1)	4.1 (2.7; 5.4)	1.7 (0.9; 2.6)	1.1 (0.5; 1.7)	62.2 (58.9; 65.4)
60+	2.2 (1.5; 2.9)	67.0 (65.0; 69.0)	19.7 (18.0; 21.40)	10.7 (9.5; 12.0)	5.2 (4.3; 6.1)	3.6 (2.8; 4.4)	1.1 (0.7; 1.5)	75.0 (73.2; 76.8)
Men								
18-24	0.5 (0.1; 0.9)	9.7 (7.7; 11.7)	0.4 (0.1; 0.70)	0.8 (0.2; 1.5)	4.7 (3.7; 5.8)	1.5 (0.7; 2.3)	0.1 (0.0; 0.2)	15.7 (13.5; 18.0)
25-29	0.9 (0.4; 1.4)	15.2 (12.7; 17.6)	1.0 90.3; 1.7)	0.6 (0.2; 1.0)	3.4 (2.2; 4.5)	1.8 (0.9; 2.7)	0.3 (0.1; 0.6)	21.0 (18.4; 23.6)
30-34	0.8 (0.3; 1.3)	18.2 (15.6; 20.8)	0.6 (0.2; 1.00)	0.7 (0.2; 1.2)	3.2 (2.0; 4.3)	0.6 (0.3; 0.9)	0.2 (0.0; 0.5)	22.7 (19.9; 25.4)
35-39	1.0 (0.5; 1.4)	24.0 (21.3; 26.6)	2.0 (0.8; 3.2)	2.2 (1.2; 3.1)	4.8 (3.3; 6.4)	0.6 (0.3; 1.0)	0.4 (0.1; 0.7)	31.4 (28.6; 34.2)
40-44	0.7 (0.2; 1.1)	33.1 (29.9; 36.3)	3.2 (2.1; 4.3)	1.8 (0.9; 2.7)	1.7 (1.1; 2.3)	1.7 (0.9; 2.6)	0.3 (0.1; 0.4)	37.2 (34.0; 40.5)
45-49	1.0 (0.2; 1.8)	36.6 (33.4; 39.8)	4.1 (2.7; 5.40)	3.4 (2.3; 4.6)	3.6 (2.4; 4.8)	1.0 (0.4; 1.5)	1.1 (0.5; 1.7)	43.0 (39.7; 46.3)
50-54	1.2 (0.5; 1.9)	47.9 (44.2; 51.7)	7.4 (5.6; 9.2)	4.6 (3.0; 6.2)	2.9 (1.9; 3.9)	1.5 (0.8; 2.2)	1.7 (0.6; 2.8)	54.6 (50.9; 58.3)
55-59	1.1 (0.4; 1.8)	52.8 (48.8; 56.8)	12.1 (8.6; 15.6)	6.5 (4.5; 8.4)	2.2 (1.3; 3.0)	1.3 (0.7; 2.0)	1.3 (0.6; 2.0)	60.6 (56.6; 64.6)
60+	0.7 (0.2; 1.2)	64.8 (62.6; 67.0)	16.1 (14.1; 18.1)	12.3 (10.3; 14.2)	4.2 (3.1; 5.2)	4.2 (3.1; 5.3)	2.1 (1.3; 2.9)	73.1 (71.2; 75.1)

Source: *Brazilian National Health Survey*, 2013 (Brazilian Institute of Geography and Statistics [26]).

group of persons 60 years or older, elderly men have 12.5 higher odds of belonging to the risk group of preexisting conditions. The OR for the sex variable indicates 25% lower odds for women in the reference age category (18-24 years). However, since the sex and age variables interact, the relationship between the odds according to sex depend on age. The exponential of the coefficients for the interaction term age groups versus sex measures the ratio between the odds ratios for women and men for each age group, indicating lower odds in women 45-49 years of age and lower in the 25-29-year group compared to the OR for these same age groups in men.

Compared to Southeast Brazil, residents of the South have slightly higher odds of belonging to the risk group with preexisting conditions – 1.06 (95%CI: 0.96; 1.17) – while the OR are lower in the Central, Northeast, and North of Brazil, with 0.86 (95%CI: 0.78; 0.94), 0.70 (95%CI: 0.65; 0.76), and 0.55 (95%CI: 0.50; 0.61), respectively.

As for skin color or race, black and brown Brazilian adults have higher odds of belonging to the risk group with preexisting conditions when compare to whites, with OR of 1.18 (95%CI: 1.05; 1.32) and 1.09 (95%CI: 1.01; 1.17), respectively. The small numbers of other groups of color or race (Asian-descendant and indigenous) resulted in wide confidence intervals and prevented inference concerning their OR.

The OR for schooling show that higher schooling was associated with lower odds of belonging to the risk group with preexisting conditions. Individuals with no schooling or incomplete primary 47% (32%, 65%) present higher odds of belonging to the risk group with preexisting conditions, compared to those with complete university education.

Table 2

Sample size, estimated population, and prevalence of at least one preexisting condition associated with COVID-19. Brazil, 2013.

Variable	Sample (n)	Estimated population (n)	Prevalence of at least one preexisting condition [% (95%CI)]
Age groups (years)			
18-24	7,823	23,306,033	14.1 (12.6; 15.5)
25-29	6,498	14,851,817	18.1 (16.5; 19.7)
30-34	7,425	16,788,072	23.1 (21.4; 24.9)
35-39	6,844	14,855,019	29.6 (27.7; 31.4)
40-44	5,973	13,225,702	37.4 (35.3; 39.4)
45-49	5,432	13,197,422	44.9 (42.7; 47.2)
50-54	4,814	12,402,142	53.3 (50.8; 55.8)
55-59	4,216	11,274,420	61.4 (58.8; 64.0)
60+	11,177	26,407,831	74.2 (72.9; 75.5)
Sex			
Male	25,920	68,916,470	39.4 (38.5; 40.4)
Female	34,282	77,391,988	40.5 (39.7; 41.3)
Major geographic region			
Southeast	14,294	64,074,682	43.5 (42.4; 44.6)
North	12,536	10,885,968	28.2 (26.9; 29.5)
Northeast	18,305	38,947,575	35.8 (34.7; 36.9)
South	7,548	21,624,664	43.8 (42.3; 45.4)
Central	7,519	10,775,569	38.3 (36.9; 39.6)
Color/Race			
White	24,106	69,441,261	41.6 (40.6; 42.6)
Black	5,631	13,454,163	42.8 (40.7; 45.0)
Yellow	533	1,371,822	37.9 (30.6; 45.1)
Brown	29,512	61,418,883	37.7 (36.8; 38.6)
Indigenous	417	619,019	32.6 (24.8; 40.4)
Schooling			
None or incomplete Primary	24,083	56,960,795	52.6 (51.6; 53.7)
Complete Primary or incomplete Secondary	9,215	22,715,539	33.8 (32.1; 35.6)
Complete Secondary or incomplete University	19,149	47,995,480	30.0 (28.8; 31.2)
Superior complete	7,755	18,636,644	34.3 (32.4; 36.1)
Workforce status			
In the workforce	38,420	95,052,182	33.3 (32.4; 34.1)
Not in the workforce	21,782	51,256,276	52.5 (51.4; 53.6)

95%CI: 95% confidence intervals.

Source: *Brazilian National Health Survey*, 2013 (Brazilian Institute of Geography and Statistics [26]).

Individuals not in the workforce (persons not classified as either employed or unemployed) had 19% higher odds of belonging to the risk group with preexisting conditions, compared to those in the workforce (either employed or unemployed).

Based on imputation of the indicator belonging versus not belonging to the risk group with preexisting conditions for all study subjects 18 to 59 years of age allowed estimates of the households' composition and the presence of household members in the risk group with preexisting conditions. As described in the previous section, belonging to the risk group was defined as individuals having at least one preexisting condition or over 60 years of age.

Table 3

Exponential of estimated coefficients, 95% confidence intervals (95%CI), and p-values according to adjusted variables in the logistic regression for preexisting conditions and risk factors associated with COVID-19. Brazil, 2013.

| Variable	Exponential (coefficient)	95%CI	p-value
Intercept	0.16	0.13; 0.19	< 0.001
Age groups (years)			
18-24	-	-	
25-29	1.49	1.17; 1.90	0.001
30-34	1.61	1.29; 2.01	< 0.001
35-39	2.51	2.02; 3.13	< 0.001
40-44	3.17	2.54; 3.97	< 0.001
45-49	4.00	3.21; 4.99	< 0.001
50-54	6.20	4.97; 7.74	< 0.001
55-59	7.66	5.94; 9.87	< 0.001
60+	12.5	10.2; 15.4	< 0.001
Sex			
Male	-	-	
Female	0.75	0.59; 0.96	0.020
Age groups (years) x sex			
25-29 x female	0.86	0.63; 1.19	0.400
30-34 x female	1.38	1.02; 1.86	0.037
35-39 x female	1.09	0.81; 1.48	0.600
40-44 x female	1.33	0.99; 1.79	0.059
45-49 x female	1.47	1.09; 1.98	0.012
50-54 x female	1.14	0.84; 1.56	0.400
55-59 x female	1.37	0.99; 1.90	0.057
60+ x female	1.40	1.06; 1.85	0.017
Major geographic region			
Southeast	-	-	
North	0.55	0.50; 0.61	< 0.001
Northeast	0.70	0.65; 0.76	< 0.001
South	1.06	0.96; 1.17	0.200
Central	0.86	0.78; 0.94	< 0.001
Color or race			
White	-	-	
Black	1.18	1.05; 1.32	0.006
Yellow	0.92	0.67; 1.26	0.600
Brown	1.09	1.01; 1.17	0.022
Indigenous	0.89	0.59; 1.35	0.600
Schooling			
Complete University	-	-	
None or incomplete Primary	1.47	1.32; 1.65	< 0.001
Complete Primary or incomplete Secondary	1.27	1.12; 1.44	< 0.001
Complete Secondary or incomplete University	1.19	1.06; 1.34	0.003
Workforce status			
In the workforce	-	-	
Not n the workforce	1.19	1.10; 1.28	< 0.001

Source: *Brazilian National Health Survey*, 2013 (Brazilian Institute of Geography and Statistics [26]).

According to the results of the PNS survey, 13.2% of the population were 60 years or older, and 30.3% of the households had at least one resident 60 years or older. Defining as the risk group both elderly individuals and persons with comorbidities associated COVID-19, according to the PNS 2013 data, Brazil had 68.5% (95%CI: 67.8; 69.1) of persons living in households with at least one person in the risk group. Figure 1 shows these percentages by state, indicating important regional differences. The values vary from 50% to 60% for states in the North, reaching more than 70% elsewhere in Brazil in the states of Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, and Rio Grande do Sul.

Figure 2 shows the proportion of persons living with at least one resident in the risk group for COVID-19 by age, as well as the estimated confidence intervals. This percentage is greater than or equal of 50% for all ages, indicating that the number of persons living in households without persons in the risk group is lower than the number of residents in households with persons in the risk group for all ages. This proportion increases with age, particularly from 35 years upwards and is 100% (by definition) after 60 years. The number of persons in the two groups under analysis is closer for children under 5 years and adults 25 to 35 years of age. The proportion of individuals living with at least one person in the risk group is more than 60% for the 10 to 25-year age groups, reaching nearly 70% around 20 years of age.

Figure 1

Prevalence and 95% confidence intervals (95%CI) of at least one preexisting medical condition associated with COVID-19 (%) by states. Brazil, 2013.
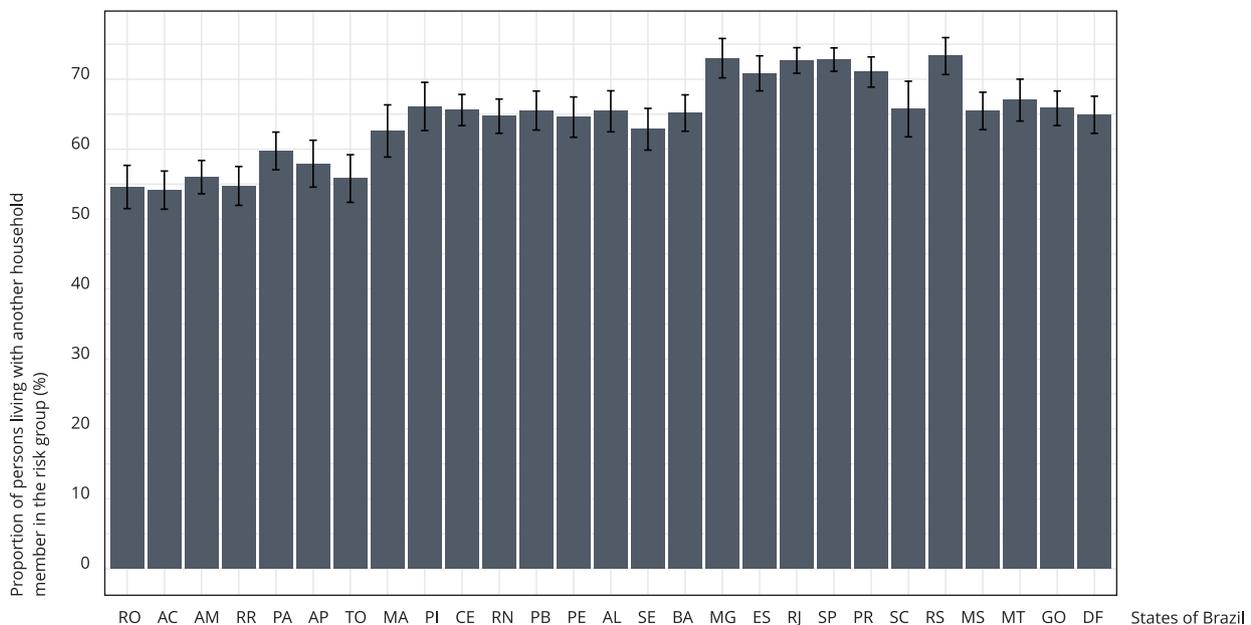
AC: Acre; AL: Alagoas; AM: Amazonas; AP: Amapá; BA: Bahia; CE: Ceará; DF: Distrito Federal; ES: Espírito Santo; GO: Goiás; MA: Maranhão; MG: Minas Gerais; MS: Mato Grosso do Sul; MT: Mato Grosso; PA: Pará; PB: Paraíba; PE: Pernambuco; PI: Piauí; PR: Paraná; RJ: Rio de Janeiro; RN: Rio Grande do Norte; RR: Roraima; RS: Rio Grande do Sul; SC: Santa Catarina; SE: Sergipe; SP: São Paulo; TO: Tocantins.

Figure 2

Prevalence and 95% confidence intervals (95%CI) of at least one preexisting medical condition associated with COVID-19 (%) by age groups. Brazil, 2013.
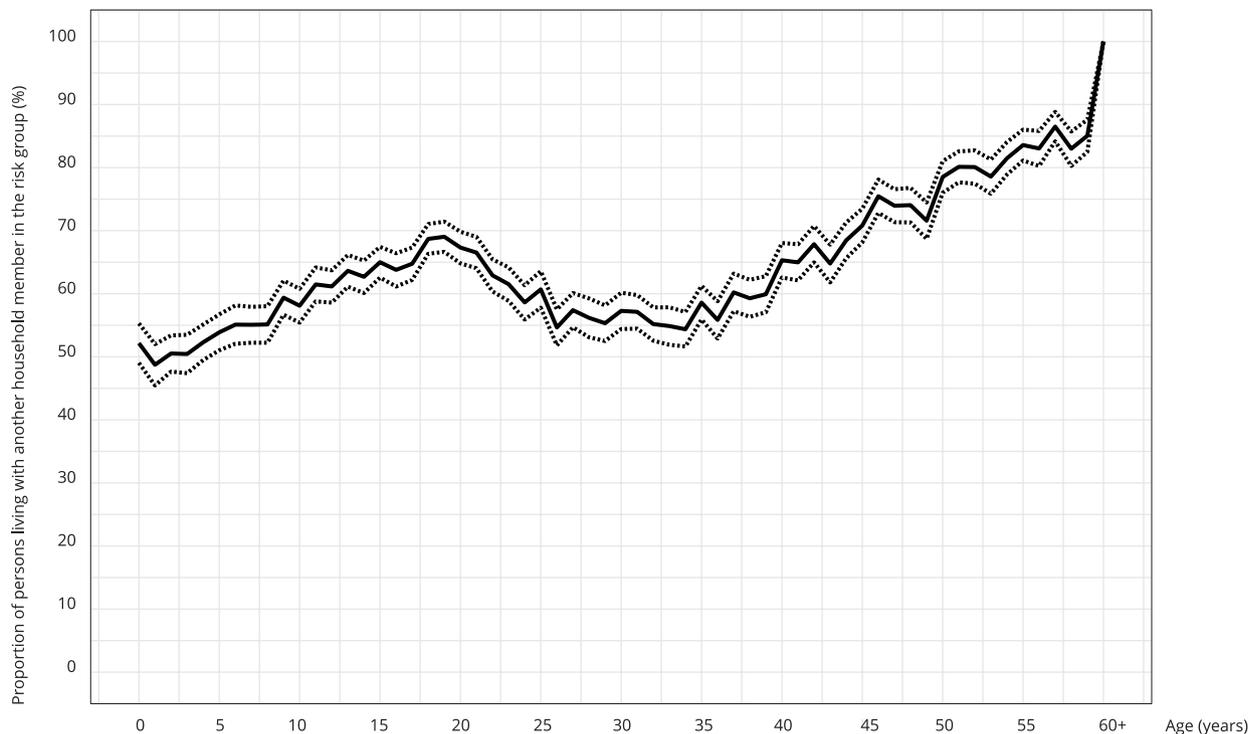
Discussion

The study's results show important demographic and socioeconomic differences associated with the odds of belonging to the risk group for COVID-19 in Brazil. Age is the principal risk factor for comorbidities associated with COVID-19, but sociodemographic variables also have important impacts, generally indicating higher risk for persons in more vulnerable categories, such as those with less schooling and blacks and browns. The results are consistent with those of other studies, pointing to differences in the prevalence of hypertension [21,22], diabetes [23,24], chronic renal disease [34], and asthma [35].

The likelihood of belonging to the risk group with preexisting conditions reflects the prevalence rates for each of these conditions and their association with the target explanatory variables. Prevalence of asthma and diabetes is higher in the female population, while hypertension as defined by use of antihypertensive medication is slightly higher in men. Prevalence of hypertension is high in all ages when compared to prevalence of the other target conditions. For young adults (18-29 years), asthma prevalence makes an important contribution to the likelihood of belonging to the risk group with preexisting conditions. Diabetes and heart disease are more prevalent in the older age groups. Despite this complex interaction, characterization of the risk group with preexisting conditions is largely driven by hypertension, since it is the most prevalent condition.

Studies have reported higher incidence of risk factors for COVID-19 among persons with less schooling [19,20]. This result is expected, since less educated populations are concentrated in more advanced ages, which are the age groups with the highest prevalence of these preexisting conditions. However, the current results show that even after controlling for age, sex, and other variables, the likelihood of belonging to the risk group with preexisting conditions for COVID -19 is higher among

groups with less schooling. According to the estimates, on average, persons with the same characteristics but with less schooling have 47% higher odds of belonging to the risk group for COVID-19, compared to those with university degrees. The higher likelihood that persons with less schooling belong to the risk group for COVID-19 is also consistent with the results of other studies indicating higher prevalence of hypertension [21,22], diabetes [23,24], and chronic renal disease [34] in this population group.

Prevalence of comorbidities associated with COVID-19 is similar in white and black Brazilian adults and slightly lower in individuals self-identified as brown. This result is consistent with other studies using the PNS data, which either did not find a significant difference in the color or race variable in prevalence of risk factors for COVID-19 [19] or found a slight difference in relation to prevalence of diabetes [23] and hypertension [22]. However, after controlling for other variables, color or race is associated with the risk factors, with blacks and browns having higher odds of belonging to the risk group when compared to whites. This result illustrates the importance of treating the phenomenon multidimensionally, since there are complex interactions between different socioeconomic variables. Future studies can further this understanding and assess how the different variables analyzed in the current study, such as sex, schooling, and color or race interact with each other in their association with the target variable, as suggested by the literature on the topic [36].

As for regional differences, preexisting conditions were less prevalent in North and Northeast Brazil. These differences probably result from less diagnostic capacity in these regions due to lower access to health services and thus worse information on persons' health assessment [34,35].

Besides characterizing risk groups for COVID-19 at the individual level, this study also provides estimates of individuals living with at least one household member in the risk group, which can be relevant for prevention and mitigation strategies by considering the possibilities of household transmission.

In 2013, an estimated 68.7% of Brazilians lived with at least one person in the risk group for developing complications associated with COVID-19. In addition to the 30.3% of Brazilians living with at least one elderly individual, another 38.4% did not have elderly individuals in their households but had at least one adult resident with preexisting conditions. The proportion of households with at least one resident in the risk group varies regionally, with higher rates in some states of the South and Southeast, which can be explained by the population's age structure, household composition, and prevalence of comorbidities in each region.

The age distribution of persons living in households with at least one resident in the risk group is generally younger. Still, there is an extremely high number of persons between 10 and 25 years of age living with at least one person in the risk group, mainly parents but also grandparents and other relatives.

The results suggest that so-called "vertical isolation" is not a feasible strategy in the Brazilian context, since it would have to be combined with isolation of all the household members, given that it is practically impossible to avoid close household contact.

Age group analysis provides further elements for discussions on public interventions such as closing of schools and universities. Although children and young people have a relatively low risk of developing complications from the disease, more than 50% of children 0 to 5 years of age live with at least one person in the risk group. This proportion reaches nearly 70% of young people close to 20 years, indicating that the activity of schools and universities may be an important route for transmission of the virus to households with persons at high risk, not to mention the increase in the flows of public transportation involved in schooling.

Note that this analysis only considers household relations, while one should keep in mind that many people belonging to the risk groups, such as elderly individuals, are dependent on their social support networks, including persons that do not necessarily live in the same household. Importantly, the results for the various target comorbidities only refer to individuals that have been diagnosed and that report having knowledge of their conditions, which is one of the study's limitations. One can expect that part of the population has never been diagnosed, which could increase the percentage of persons in the risk group for COVID-19 severity and case-fatality. For example, an estimated one half of persons with diabetes has never been diagnosed [37]. The prevalence rates for morbid obesity, which used weight and height measurements, and hypertension, which was measured both by blood pressure levels and use of medication, also have their limitations. Underestimation of the diagnosis of

these diseases may be particularly important in North and Northeast Brazil, where there are greater problems of access to health services and thus lower capacity for diagnosis and access to medication, in the case of measurement of hypertension [21].

Another limitation to this study is that it used data from 2013, thus outdated by some seven years in relation to the beginning of the pandemic. The data analyzed here can be updated as soon as the results of the PNS of 2019 are available.

Conclusions

This study aimed to contribute elements for a better understanding of the demographic and socio-economic structure associated with risk groups for COVID-19, as well as the contexts, particularly household conditions, in which these more vulnerable groups are living, which involves important analyses for developing strategies to fight the pandemic.

With the spread of COVID-19 in various regions of Brazil, underreporting of cases, uncertainties about actual effective immunity for those who have recovered from the disease, and severe cases in the young adult population, as observed in Brazil, the strategies to control transmission of the disease should draw on risk group analysis to understand the pandemic's progression in the country. Such analyses should also be employed to assess social distancing measures, as well as timeframes, plans, and stages for a comprehensive future resumption of activities, mitigating the risks to people's lives.

What is known thus far is that the most vulnerable population groups, such as elderly individuals and persons with preexisting medical conditions, do indeed merit special attention, while exclusive isolation of this group appears not to be an effective strategy, due to the health and socioeconomic characteristics, forms of social relations, and household composition. The study's results corroborate evidence that suppression strategies, including social distancing of the entire population, are the most adequate at the moment, since they are the ones that allow flattening the transmission curve, avoiding an even greater crisis in the public health system. The information is also important for planning the follow-up time for the social distancing strategy in the entire population. The effectiveness of full social distancing requires solid federative relations for implementing rapid and coordinated actions by the various levels of government, in defense of the lowest possible case fatality and reduction of socioeconomic harms.

The current situation includes the lack of both a vaccine to immunize the population and provenly effective medicines to treat the disease, deficiencies in the public health system, expressed as shortage of healthcare workers, insufficient personal protective equipment for these workers, and scarcity of ICU resource such as respirators/mechanical ventilators. These social factors are relevant for the survival of COVID-19 patients, especially given the enormous inequality between the portion of the population that has access to private services through health plans and those who depend exclusively on the public Brazilian Unified National Health System (SUS).

Importantly, COVID-19 is a new disease with huge uncertainties on the horizon of needs for strategies to deal with it and measures to contain the pandemic's spread, healthcare, social protection, and emergency economic aid considering diverse scenarios. Thus, the current study's results and possible spinoffs are relevant, not only for the debate on public health interventions, but also to plan actions for other dimensions of social life such as schooling and work activities, the rules for sharing public spaces, and others. Such actions may minimize new health system collapses and peaks in transmission and deaths when interventions such as social distancing are relaxed.

Beyond the measures applied in the period of the pandemic's emergence, the results further confirm that the sociodemographic profile and the prevalence of chronic noncommunicable diseases in a large share of the Brazilian population are factors to be observed for measures in structuring the public health system, without which the daily situations or those aggravated by health emergencies, the economy, and other dimensions of social life are negatively impacted.

Contributors

The authors participated equally in the production of this article.

Additional informations

ORCID: Gabriel Mendes Borges (0000-0002-8840-328X); Claudio Dutra Crespo (0000-0003-4273-3053).

Acknowledgments

References

1. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report-51. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200311-sitrep-51-covid-19.pdf?sfvrsn=1ba62e57_10 (accessed on 30/Jun/2020).

2. Johns Hopkins University. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6 (accessed on 30/Jun/2020).

3. Rodriguez-Morales AJ, Gallego V, Escalera-Antezana JP, Méndez CA, Zambrano LI, Franco-Paredes C, et al. COVID-19 in Latin America: the implications of the first confirmed case in Brazil. Travel Med Infect Dis 2020; 35:101613.

4. Kupferschmidt K, Cohen J. China's aggressive measures have slowed the coronavirus. They may not work in other countries. Science 2020; 02 mar. https://www.sciencemag.org/news/2020/03/china-s-aggressive-measures-have-slowed-coronavirus-they-may-not-work-other-countries.

5. Viner R, Russell S, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid narrative systematic review. Social Science Research Network 2020; 27 mar. https://papers.ssrn.com/abstract=3556648.

6. Koo JR, Cook AR, Park M, Sun Y, Sun H, Lim JT, et al. Interventions to mitigate early spread of SARS-CoV-2 in Singapore: a modelling study. Lancet Infect Dis 2020; 20:678-88.

7. Ferguson N, Laydon D, Nedjati Gilani G, Imai N, Ainslie K, Baguelin M, et al. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand. http://spiral.imperial.ac.uk/handle/10044/1/77482 (accessed on 03/Apr/2020).

8. Agência Brasil. Veja as medidas que cada estado está adotando para combater a covid-19. Agência Brasil 2020; 28 mar. https://agenciabrasil.ebc.com.br/saude/noticia/2020-03/veja-medidas-que-cada-estado-esta-adotando-para-combater-covid-19.

9. COVID-19 in Brazil: "so what?" Lancet 2020; 395:1461.

10. Rocha C. O isolamento vertical defendido por Bolsonaro sob análise. Nexo Jornal 2020; 25 mar. https://www.nexojornal.com.br/expresso/2020/03/25/O-isolamento-vertical-defendido-por-Bolsonaro-sob-an%C3%A1lise.

11. Katz D. Is our fight against coronavirus worse than the disease? The New York Times 2020; 20 mar. https://www.nytimes.com/2020/03/20/opinion/coronavirus-pandemic-social-distancing.html.

12. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 2020; 395:507-13.

13. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020; 395:1054-62.

14. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020; 395:497-506.

15. Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? Lancet Respir Med 2020; 8:e21.

16. Red Nacional de Vigilância Epidemiológica. Informe sobre la situación de COVID-19 em España. https://www.isciii.es/QueHacemos/Servicios/VigilanciaSaludPublicaRENAVE/EnfermedadesTransmisibles/Documents/INFORMES/Informes%20COVID-19/Informe%20n%C2%BA%2020.%20Situaci%C3%B3n%20de%20COVID-19%20en%20Espa%C3%B1a%20a%203%20de%20abril%20de%202020.pdf (accessed on 04/Apr/2020).

17. Prazeres L, Mariz R, Souza A. Coronavírus: Brasil tem 2.915 casos confirmados e 77 mortes. O Globo 2020; 26 mar. https://oglobo.globo.com/sociedade/coronavirus/coronavirus-brasil-tem-2915-casos-confirmados-77-mortes-1-24330514.

18. Rache B, Rocha R, Nunes L, Spinola P, Malik AM, Massuda A. Necessidades de infraestrutura do SUS em preparo à COVID-19: leitos de UTI, respiradores e ocupação hospitalar. São Paulo: Instituto de Estudos de Políticas de Saúde; 2020. (Nota Técnica 3).

19. Rezende LFM, Thome B, Schveitzer MC, Souza-Júnior PRB, Szwarcwald CL. Adults at high-risk of severe coronavirus disease-2019 (Covid-19) in Brazil. Rev Saúde Pública 2020; 54:50.

20. Carvalho L, Nassif Pires L, Lima Xavier L. COVID-19 e desigualdade: a distribuição dos fatores de risco no Brasil. https://www.researchgate.net/publication/340452851_COVID-19_e_Desigualdade_no_Brasil (accessed on 04/Apr/2020).

21. Malta DC, Gonçalves RPF, Machado IE, Freitas MIF, Azeredo C, Szwarcwald CL. Prevalência da hipertensão arterial segundo diferentes critérios diagnósticos, Pesquisa Nacional de Saúde. Rev Bras Epidemiol 2018; 21:e180021.

22. Andrade SSA, Stopa SR, Brito AS, Chueri PS, Szwarcwald CL, Malta DC. Prevalência de hipertensão arterial autorreferida na população brasileira: análise da Pesquisa Nacional de Saúde, 2013. Epidemiol Serv Saúde 2015; 24:297-304.

23. Iser BPM, Stopa SR, Chueiri PS, Szwarcwald CL, Malta DC, Monteiro HOC, et al. Prevalência de diabetes autorreferido no Brasil: resultados da Pesquisa Nacional de Saúde 2013. Epidemiol Serv Saúde 2015; 24:305-14.

24. Iser BPM, Malta DC, Duncan BB, de Moura L, Vigo Á, Schmidt MI. Prevalence, correlates, and description of self-reported diabetes in Brazilian capitals – results from a telephone survey. PLoS One 2014; 9:e108044.

25. Freitas ARR, Napimoga M, Donalisio MR. Análise da gravidade da pandemia de Covid-19. Epidemiol Serv Saúde 2020; 29:e2020119.

26. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde 2013. https://www.ibge.gov.br/estatisticas/sociais/saude/9160-pesquisa-nacional-de-saude.html (accessed on 04/Apr/2020).

27. Szwarcwald CL, Malta DC, Pereira CA, Vieira MLFP, Conde WL, Souza Junior PRB, et al. Pesquisa Nacional de Saúde no Brasil: concepção e metodologia de aplicação. Ciênc Saúde Colet 2014; 19:333-42.

28. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde 2013: percepção do estado de saúde, estilos de vida e doenças crônicas. https://biblioteca.ibge.gov.br/visualizacao/livros/liv91110.pdf (accessed on 04/Apr/2020).

29. Wu C, Chen X, Cai Y, Xia J, Zhou X, Xu S, et al. Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA Intern Med 2020; 180:1-11.

30. COVID-19 Surveillance Group. Characteristics of COVID-19 patients dying in Italy: report based on available data on March 20th, 2020. https://www.epicentro.iss.it/coronavirus/bollettino/Report-COVID-2019_20_marzo_eng.pdf (accessed on 04/Apr/2020).

31. Chow N, Fleming-Dutra K, Gierke R, Hall A, Hughes M, Pilishvili T, et al. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019 – United States. MMWR Morb Mortal Wkly Rep 2020; 69:382-6.

32. Jewell NP. Statistics for epidemiology. London: Chapman and Hall; 2003.

33. McFadden D. Conditional logit analysis of qualitative choice behavior. Berkeley: University of California; 1973.

34. Moura L, Andrade SSCA, Malta DC, Pereira CA, Passos JEF. Prevalência de autorrelato de diagnóstico médico de doença renal crônica no Brasil: Pesquisa Nacional de Saúde, 2013. Rev Bras Epidemiol 2015; 18:181-91.

35. Menezes AMB, Wehrmeister FC, Horta B, Szwarcwald CL, Vieira ML, Malta DC. Prevalência de diagnóstico médico de asma em adultos brasileiros: Pesquisa Nacional de Saúde, 2013. Rev Bras Epidemiol 2015; 18:204-13.

36. Alves RFS, Faerstein E. Educational inequalities in hypertension: complex patterns in intersections with gender and race in Brazil. Int J Equity Health 2016; 15:146.

37. International Diabetes Federation. IDF diabetes atlas. 9th Ed. https://www.diabetesatlas.org (accessed on 15/Apr/2019).

Resumo

Os objetivos deste trabalho são caracterizar os grupos de risco para COVID-19 no Brasil, bem como estimar o número de indivíduos convivendo no mesmo domicílio com pessoas no grupo de risco. Para tal, utiliza-se dados da Pesquisa Nacional de Saúde *2013. Para caracterizar os grupos de risco, ajustou-se um modelo de regressão logística binária múltipla tendo como variável a resposta à existência ou não de pelo menos uma condição associada à COVID-19 e como variáveis explicativas a idade, sexo, grande região, cor ou raça, nível de escolaridade e condição em relação à força de trabalho dos moradores entrevistados pela pesquisa. Os resultados mostram que a idade é o principal fator de risco para comorbidades associadas à COVID-19, mas há também maior risco para pessoas em categorias mais vulneráveis, como os menos escolarizados e pretos e pardos. Estima-se que 68,7% dos brasileiros viviam com pelo menos uma pessoa no grupo de risco – 30,3% viviam com pelo menos um idoso e outros 38,4% não tinham idosos em seus domicílios, mas havia pelo menos um morador adulto com condições médicas preexistentes. A proporção de pessoas vivendo em domicílios com pelo menos um morador no grupo de risco era maior ou igual a 50% para todas as idades, sendo crescente a partir dos 35 anos, mas havia também um alto número de pessoas com idades entre 10 e 25 anos convivendo com pessoas no grupo de risco. Tais resultados sugerem que, em função das dificuldades em se evitar contato próximo intradomiciliar, o isolamento exclusivo de grupos populacionais específicos não se configura uma estratégia possível no contexto brasileiro, devendo ser combinado com o isolamento do conjunto da população.*

COVID-19; Grupos de Risco; Fatores Socioeconômico; Isolamento Social

Resumen

Los objetivos de este trabajo son caracterizar los grupos de riesgo para COVID-19 en Brasil, así como estimar el número de individuos conviviendo en el mismo domicilio con personas en el grupo de riesgo. Para ello, se utilizan datos de la Encuesta Nacional de Salud *2013. Para caracterizar los grupos de riesgo, se ajustó un modelo de regresión logística binaria múltiple, teniendo como variable respuesta la existencia o no de por lo menos una condición asociada a la COVID-19 y como variables explicativas, la edad, sexo, gran región, color o raza, nivel de escolaridad y condición, en relación a la fuerza de trabajo de los habitantes entrevistados por la encuesta. Los resultados muestran que la edad es el principal factor de riesgo para comorbilidades asociadas a la COVID-19, pero existe también un mayor riesgo para personas en categorías más vulnerables, como los menos escolarizados y negros y mulatos/mestizos. Se estima que un 68,7% de los brasileños vivían con por lo menos una persona en el grupo de riesgo – un 30,3% vivían con por lo menos un anciano y otros un 38,4% no vivían con ancianos en sus domicilios, pero tenían por lo menos un residente adulto con condiciones médicas preexistentes. La proporción de personas viviendo en domicilios, con por lo menos un residente en el grupo de riesgo, era mayor o igual a un 50% para todas las edades, siendo creciente a partir de los 35 años, pero había también un alto número de personas con edad entre 10 y 25 años conviviendo con personas en el grupo de riesgo. Tales resultados sugieren que, en función de las dificultades para evitar el contacto cercano intradomiciliario, el aislamiento exclusivo de grupos poblacionales específicos no se configura en una estrategia posible en el contexto brasileño, debiendo ser combinado con el aislamiento del conjunto de la población.*

COVID-19; Grupos de Riesgos; Factores Sociecómicos; Aislamiento Social