

# **Racial inequities in COVID-19 mortality and the contribution of residential segregation in Brazil**

**Joanna MN Guimarães, Amelia AL Friche, Ana V Diez-Roux, Anne D Slovic, Edna Araujo, Gervasio Santos, Leticia O Cardoso, Nelson Gouvea, Sharrelle Barber, Usama Bilal, Waleska T Caiiffa**

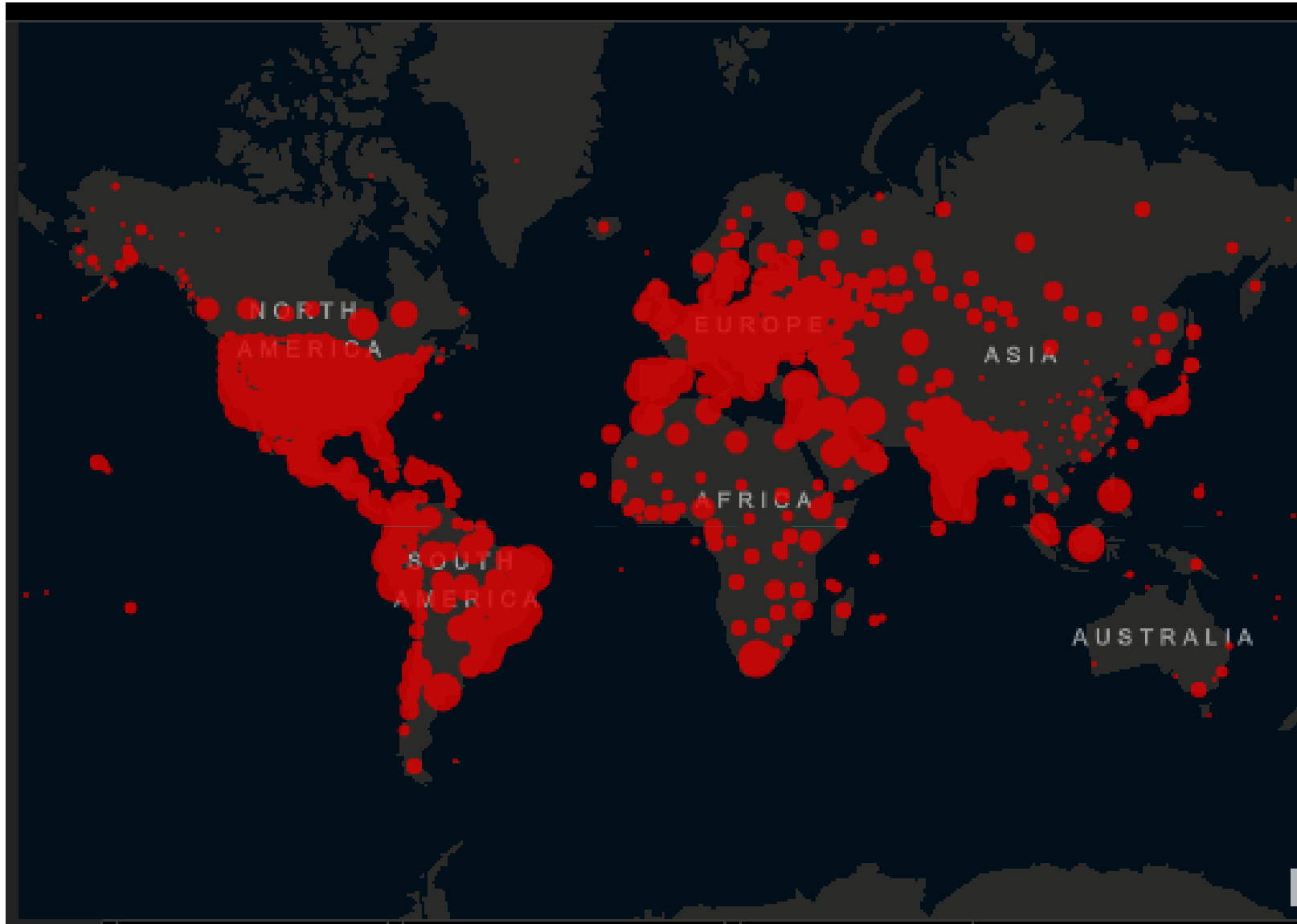
**17<sup>th</sup> International Conference on Urban Health**

**6-8 July 2021**



# Global map, cumulative cases

SALURBAL



## Cases and Deaths

**33.691.590** | **605.304**  
US

**30.458.251** | **400.312**  
India

**18.687.469** | **521.952**  
Brazil

**5.842.612** | **111.297**  
France

**Source:** COVID-19 Dashboard by the CRC - Johns Hopkins Coronavirus Research Center available at <https://coronavirus.jhu.edu/map.html>

# Background & Rationale

- **The experience of Covid-19 is not shared equally across places nor social groups (Berkowitz et al 2020)**
- **Brown, Black and Indigenous people represent historically marginalized social groups**
- **Brazilian blacks and browns have greater Covid-19 mortality than whites (Baqui et al 2020, Caldwell & Araujo 2020)**
- **Blacks and browns in Brazil are more likely to live in spatially segregated neighborhoods (Barber et al 2018)**

# Background & Rationale

- **People and places interact to exacerbate the vulnerability and risk of Covid19 infection and death**
- **Does residential segregation contribute to racial inequities in the burden of Covid-19 mortality in Brazil?**

# Research questions & Hypotheses

1. Are there differences in COVID-19 mortality by race in Brazilian cities?

*H1: Brown, Black and Indigenous people in Brazilian cities have greater COVID-19 mortality than White people*

2. Are there differences in COVID-19 mortality by income residential segregation in Brazilian cities?

*H2: Cities with more income segregation have greater COVID-19 mortality*

3. Does income residential segregation interact with race?

*H3: Cities with more income segregation have larger racial inequities in COVID-19 mortality*

# Methods

## Study population

- 1,009,502 hospitalised individuals from the SIVEP-Gripe (Influenza Epidemiological Surveillance Information System) dataset (Jan 1<sup>st</sup> 2020 to Mar 8<sup>th</sup> 2021)

## Exposures

- Self-declared race/skin color (SIVEP/Gripe): **White, Brown (or Pardo, proxy for Black and White admixture), Black, Asian, Indigenous**
- Income residential segregation – Dissimilarity index (Brazilian 2010 Census), in tertiles **Low, Medium, High**

# Methods – Dissimilarity index

• **Formula:** 
$$\frac{1}{2} \sum_{i=1}^n \left| \frac{a_i}{A_T} - \frac{b_i}{B_T} \right|$$

Where:

.  $n$  is the number of census tracts

.  $A_T$  is the % of households with mean income  $\leq 2$  minimum wages in the city

.  $B_T$  is the % of households with mean income  $> 2$  minimum wages in the city

.  $a_i$  and  $b_i$  are their respective populations in census tract  $i$ .

- Measures evenness and indicates the % of a population group (low-income households) that would have to be relocated in order to achieve complete integration

# Methods

- **Outcome**
  - **COVID-19 in-hospital case fatality, from the SIVEP-Gripe dataset, available at: <https://opendatasus.saude.gov.br/>**
- **Covariates**
  - **Individual age and sex (SIVEP-Gripe)**
  - **City-level Social environment index (Brazilian 2010 Census): Z scores of city features including the % of the pop  $\geq 25$  who completed primary education or above, % of households with access to piped water, % of households with access to a sewage network, % of households with  $>3$  people/room (Bilal et al 2021)**



# Methods – Statistical analysis

- We hypothesized that COVID-19 mortality varies across Brazilian cities thus a 2-level structure was used, for hospitalised individuals nested within cities (N=152)
- Mixed-effects Cox regression survival analysis was performed, Hazard ratios (HR) were estimated
- Package coxme in R

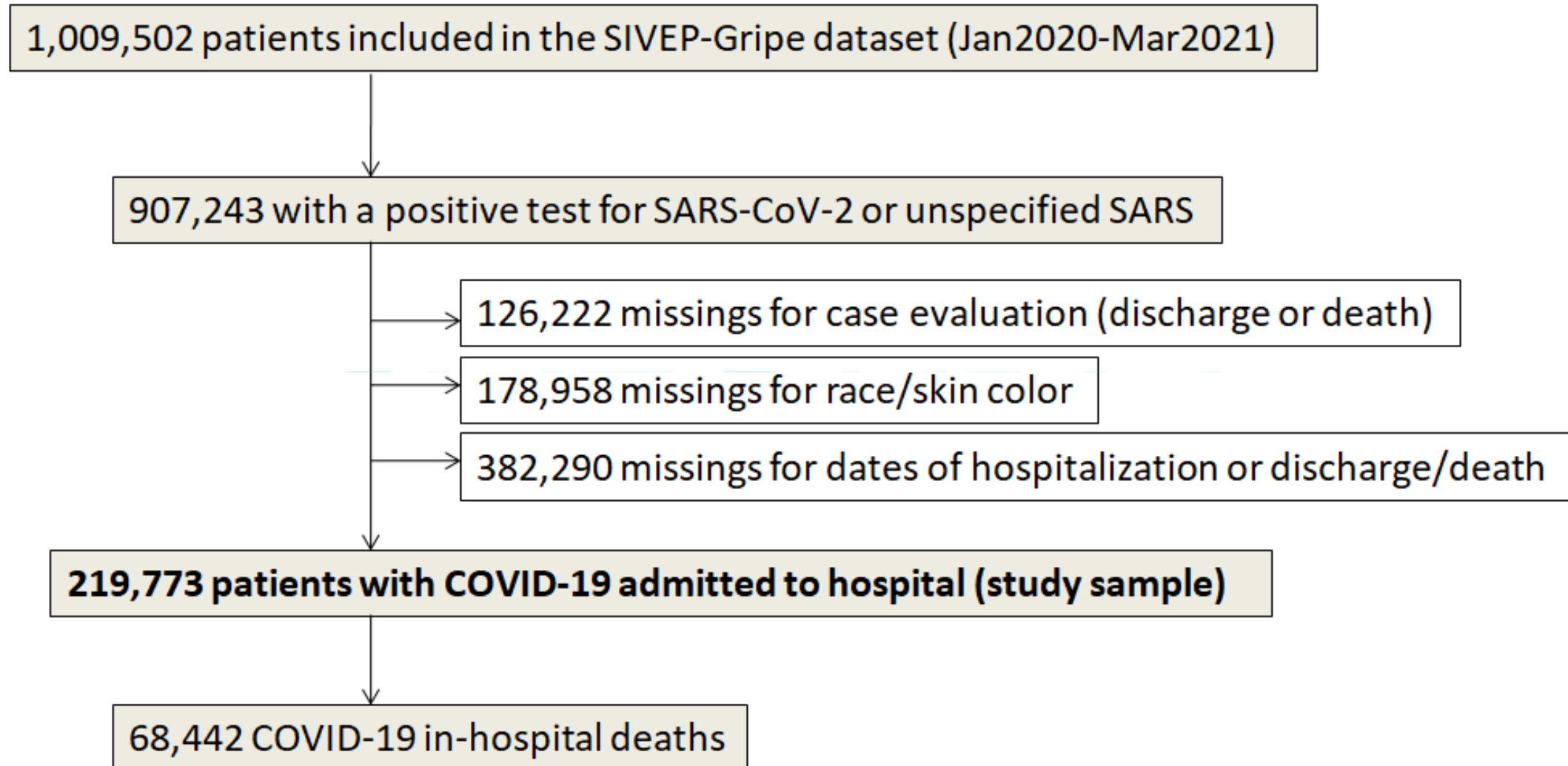
# Methods – Statistical analysis

- **Research questions 1 and 2:**
  - to examine whether race and residential segregation were associated with COVID-19 mortality, a random effect at the city level was included (**Model 1**, age and sex adjusted)
  - the model was additionally adjusted for SEI (**Model 2**) and residential segregation (**Model 3**)
- **Research question 3:**
  - an interaction term race\*residential segregation was added (**Model 4**)
  - if the interaction term was significant ( $p < 0.05$ ), combined effects of race and segregation were estimated

# Results



**Figure 1. Flowchart for SIVEP-Gripe patients included in this study. Brazil, 2020-2021**



**Table 1. Demographic characteristics of the sample by COVID-19 in-hospital case fatality. SIVEP-Gripe 2020-2021, Brazil. N=219,773**

	All	COVID-19 in-hospital case fatality		
		Non-deaths	Deaths	p-value
Number of participants, %	219,773	151,331 (68.9)	68,442 (31.1)	-
Race/skin color, %				
White	52.2	70.7	29.3	< 0.001
Brown	39.7	67.1	32.9	
Black	6.5	64.9	35.1	
Asian	1.4	67.8	32.2	
Indigenous	0.2	76.9	23.1	
City-level residential segregation (in tertiles), %				
Low	32.7	72.2	27.3	< 0.001
Medium	38.9	71.8	28.2	
High	28.4	60.5	39.5	
Sex, %				
Male	53.8	67.9	32.1	< 0.001
Female	46.2	70.0	30.0	
Age, mean	56.7	51.4	68.6	< 0.001

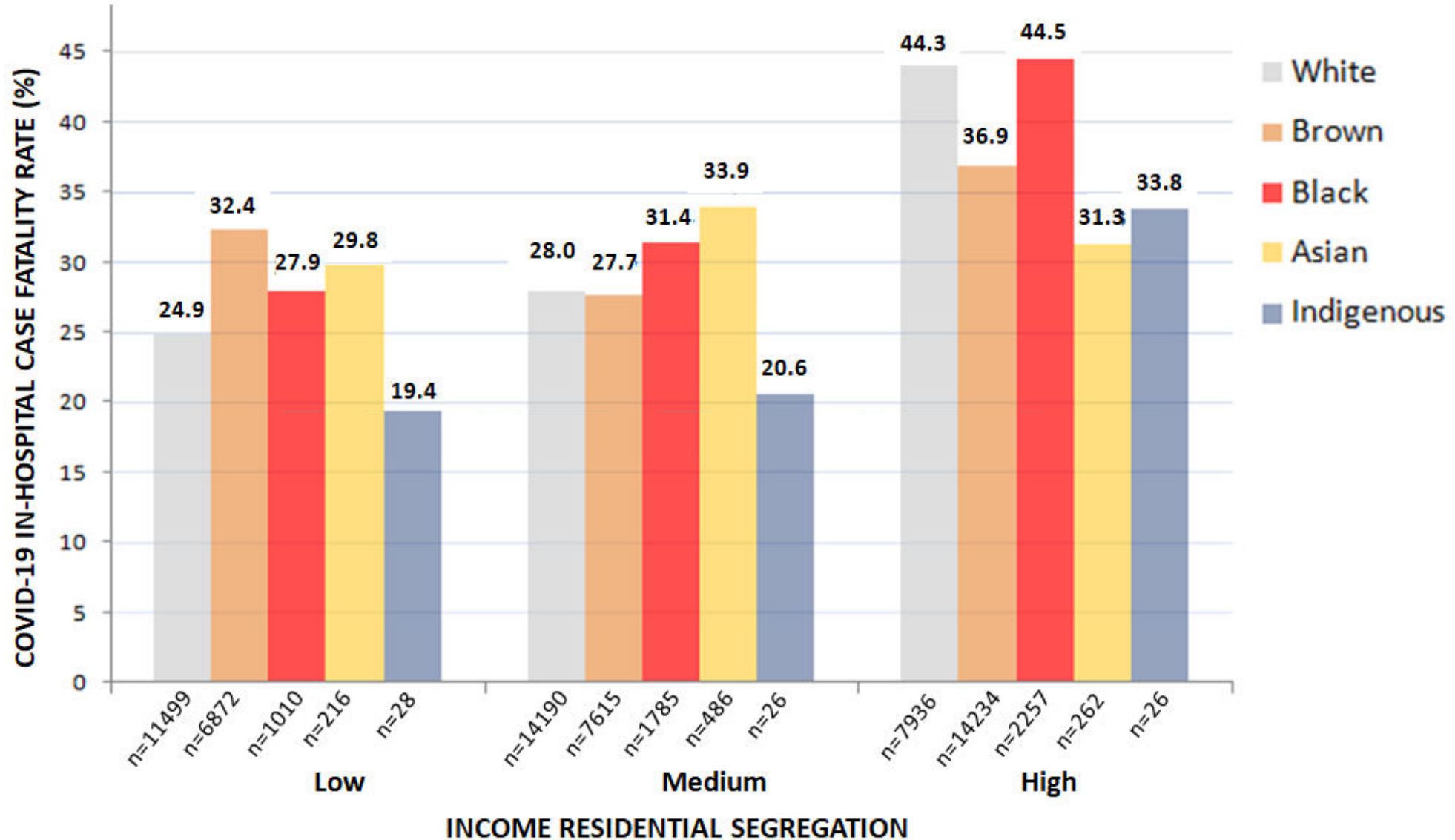
**Table 1. Demographic characteristics of the sample by COVID-19 in-hospital case fatality. SIVEP-Gripe 2020-2021, Brazil. N=219,773**

	All	COVID-19 in-hospital case fatality		
		Non-deaths	Deaths	p-value
Number of participants, %	219,773	151,331 (68.9)	68,442 (31.1)	-
Race/skin color, %				
White	52.2	70.7	29.3	< 0.001
Brown	39.7	67.1	32.9	
Black	6.5	64.9	35.1	
Asian	1.4	67.8	32.2	
Indigenous	0.2	76.9	23.1	
City-level residential segregation (in tertiles), %				
Low	32.7	72.2	27.3	< 0.001
Medium	38.9	71.8	28.2	
High	28.4	60.5	39.5	
Sex, %				
Male	53.8	67.9	32.1	< 0.001
Female	46.2	70.0	30.0	
Age, mean	56.7	51.4	68.6	< 0.001

**Table 1. Demographic characteristics of the sample by COVID-19 in-hospital case fatality. SIVEP-Gripe 2020-2021, Brazil. N=219,773**

	All	COVID-19 in-hospital case fatality		
		Non-deaths	Deaths	p-value
<b>Education, %</b>				
No education	7.5	58.8	41.2	< 0.001
Elementary I	27.1	60.0	40.0	
Elementary II	19.1	63.8	36.2	
Secondary	31.2	72.9	27.1	
University	15.2	78.8	21.2	
<b>Brazilian macroregions, %</b>				
North	6.5	53.8	46.2	< 0.001
Northeast	12.9	61.7	38.3	
Central-west	4.7	72.0	28.0	
Southeast	59.2	70.4	29.6	
South	16.7	73.8	26.2	
City-level social environment index*	0.21	0.23	0.16	< 0.001
* Higher score indicates better social environment				

**Figure 2. COVID-19 in-hospital case fatality rates (%) by race and residential segregation tertiles. SIVEP-Gripe 2020-2021, Brazil. N=219,773.**





**Table 3. Hazard ratios of Covid-19 in-hospital case fatality associated with race and income residential segregation. SIVEP-Gripe 2020-2021, Brazil. N=219,773.**

	M1: + age and sex	M2: + Social env index	M3: + resid segreg
<b>Individual-level</b>			
Brown (vs White)	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>
Black (vs White)	<b>1.24 (1.21,1.28)</b>	<b>1.24 (1.20,1.28)</b>	<b>1.24 (1.20,1.28)</b>
Asian (vs White)	0.97 (0.91,1.03)	0.97 (0.91,1.03)	0.97 (0.91,1.03)
Indigenous (vs White)	0.87 (0.70,1.09)	0.87 (0.70,1.08)	0.87 (0.70,1.08)
<b>City-level</b>			
Residential segregation, Medium (vs Low)			1.08 (0.94,1.24)
Residential segregation, High (vs Low)			<b>1.18 (1.03,1.36)</b>
Brown*Residential segregation Medium			
Black*Residential segregation Medium			
Asian*Residential segregation Medium			
Indigenous*Residential segregation Medium			
Brown*Residential segregation High			
Black*Residential segregation High			
Asian*Residential segregation High			
Indigenous*Residential segregation High			
<b>Variance</b>			
Random intercept	0.122	0.099	0.095

**Table 3. Hazard ratios of Covid-19 in-hospital case fatality associated with race and income residential segregation. SIVEP-Gripe 2020-2021, Brazil. N=219,773.**

	M1: + age and sex	M2: + Social env index	M3: + resid segreg
<b>Individual-level</b>			
Brown (vs White)	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>
Black (vs White)	<b>1.24 (1.21,1.28)</b>	<b>1.24 (1.20,1.28)</b>	<b>1.24 (1.20,1.28)</b>
Asian (vs White)	0.97 (0.91,1.03)	0.97 (0.91,1.03)	0.97 (0.91,1.03)
Indigenous (vs White)	0.87 (0.70,1.09)	0.87 (0.70,1.08)	0.87 (0.70,1.08)
<b>City-level</b>			
Residential segregation, Medium (vs Low)			1.08 (0.94,1.24)
Residential segregation, High (vs Low)			<b>1.18 (1.03,1.36)</b>
Brown*Residential segregation Medium			
Black*Residential segregation Medium			
Asian*Residential segregation Medium			
Indigenous*Residential segregation Medium			
Brown*Residential segregation High			
Black*Residential segregation High			
Asian*Residential segregation High			
Indigenous*Residential segregation High			
<b>Variance</b>			
Random intercept	0.122	0.099	0.095

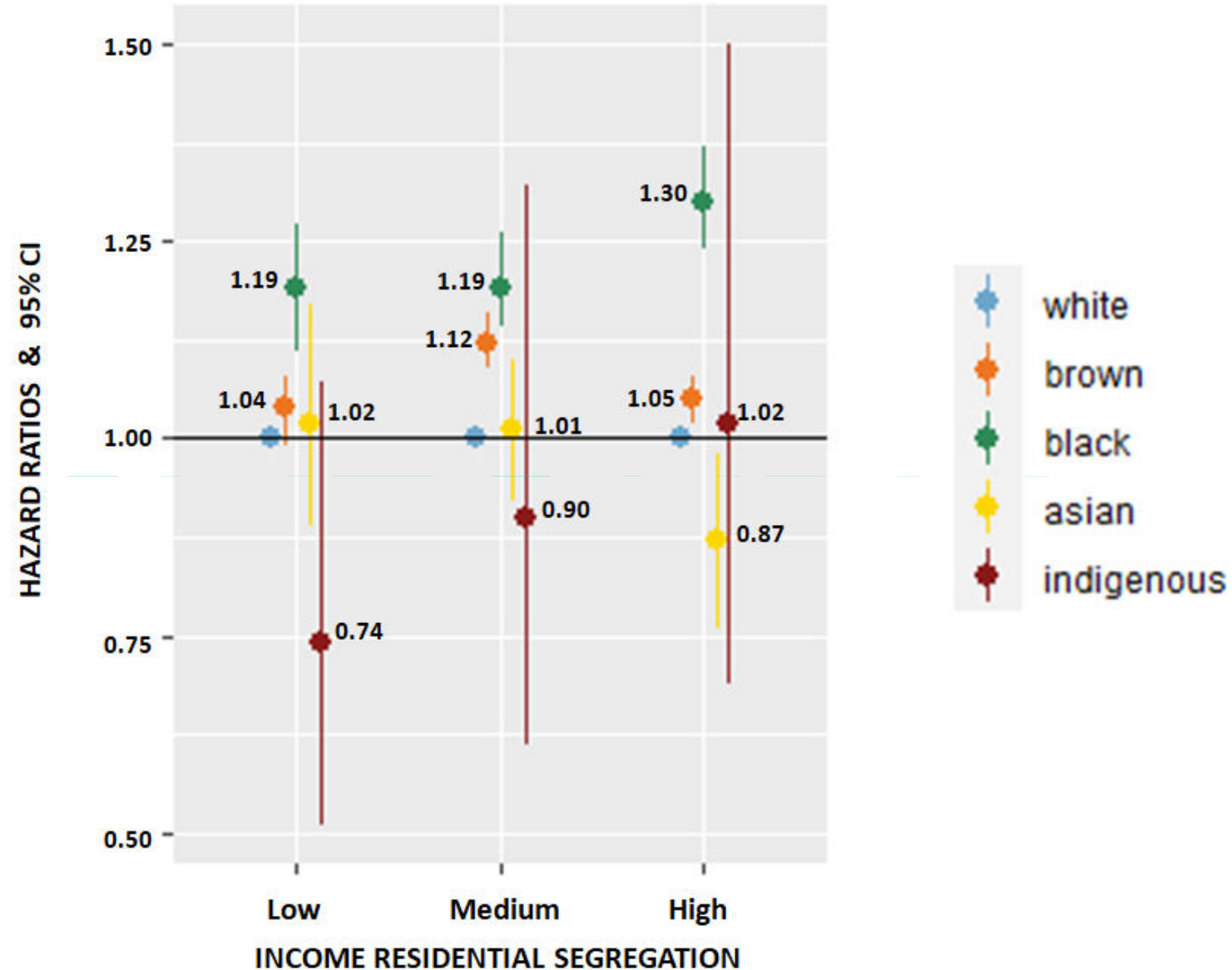
**Table 3. Hazard ratios of Covid-19 in-hospital case fatality associated with race and income residential segregation. SIVEP-Gripe 2020-2021, Brazil. N=219,773.**

	M1: + age and sex	M2: + Social env index	M3: + resid segreg
<b>Individual-level</b>			
Brown (vs White)	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>
Black (vs White)	<b>1.24 (1.21,1.28)</b>	<b>1.24 (1.20,1.28)</b>	<b>1.24 (1.20,1.28)</b>
Asian (vs White)	0.97 (0.91,1.03)	0.97 (0.91,1.03)	0.97 (0.91,1.03)
Indigenous (vs White)	0.87 (0.70,1.09)	0.87 (0.70,1.08)	0.87 (0.70,1.08)
<b>City-level</b>			
Residential segregation, Medium (vs Low)			1.08 (0.94,1.24)
Residential segregation, High (vs Low)			<b>1.18 (1.03,1.36)</b>
Brown*Residential segregation Medium			
Black*Residential segregation Medium			
Asian*Residential segregation Medium			
Indigenous*Residential segregation Medium			
Brown*Residential segregation High			
Black*Residential segregation High			
Asian*Residential segregation High			
Indigenous*Residential segregation High			
<b>Variance</b>			
Random intercept	0.122	0.099	0.095

**Table 3. Hazard ratios of Covid-19 in-hospital case fatality associated with race and income residential segregation. SIVEP-Gripe 2020-2021, Brazil. N=219,773.**

	M1: + age and sex	M2: + Social env index	M3: + resid segreg	M4: + race*resid segreg
<b>Individual-level</b>				
Brown (vs White)	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>	<b>1.07 (1.05,1.09)</b>	1.04 (0.99,1.08)
Black (vs White)	<b>1.24 (1.21,1.28)</b>	<b>1.24 (1.20,1.28)</b>	<b>1.24 (1.20,1.28)</b>	<b>1.19 (1.11,1.27)</b>
Asian (vs White)	0.97 (0.91,1.03)	0.97 (0.91,1.03)	0.97 (0.91,1.03)	1.02 (0.89,1.17)
Indigenous (vs White)	0.87 (0.70,1.09)	0.87 (0.70,1.08)	0.87 (0.70,1.08)	0.74 (0.51,1.07)
<b>City-level</b>				
Residential segregation, Medium (vs Low)			1.08 (0.94,1.24)	1.04 (0.90,1.20)
Residential segregation, High (vs Low)			<b>1.18 (1.03,1.36)</b>	<b>1.18 (1.03,1.36)</b>
Brown*Residential segregation Medium				<b>1.09 (1.03,1.14)</b>
Black*Residential segregation Medium				1.00 (0.93,1.09)
Asian*Residential segregation Medium				0.99 (0.84,1.16)
Indigenous*Residential segregation Medium				1.22 (0.71,2.09)
Brown*Residential segregation High				1.01 (0.96,1.06)
Black*Residential segregation High				<b>1.09 (1.01,1.19)</b>
Asian*Residential segregation High				0.85 (0.71,1.02)
Indigenous*Residential segregation High				1.38 (0.81,2.37)
<b>Variance</b>				
Random intercept	0.122	0.099	0.095	0.095

**Fig 3. Combined effects of race and income segregation on COVID-19 in-hospital case fatality (HR, 95%CI). SIVEP-Gripe 2020-2021, Brazil. N=219,773.**



# Final remarks

- **Black and Brown people admitted to hospital had risk of COVID-19 mortality 24% and 7% higher than White people, respectively**
- **Highly income segregated cities showed greater risk of COVID-19 in-hospital mortality**
- **Income residential segregation interacted with race, such that racial inequities in COVID-19 in-hospital mortality were larger in more segregated cities (for Black vs White people)**

# LEARN MORE AND CONTACT US



*LACURBANHEALTH.ORG*  
*SALURBAL@DREXEL.EDU*

**FOLLOW US**

*@LACURBANHEALTH*

