

# **Closing the Health Gap in Brazil: *Data-Led Infrastructure Expansion***

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*Presented to:*

*Instituto de Estudos para Políticas de Saúde*

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# Outline

1

Brief overview of current health status and infrastructure

2

Identify the disease burden at the municipality level

Predict subjective health conditions at the municipality level

Construct the Municipal Public Health Index (MPHI)

3

Analyze relationship b/w MPHI and health infrastructure

4

Policy recommendation



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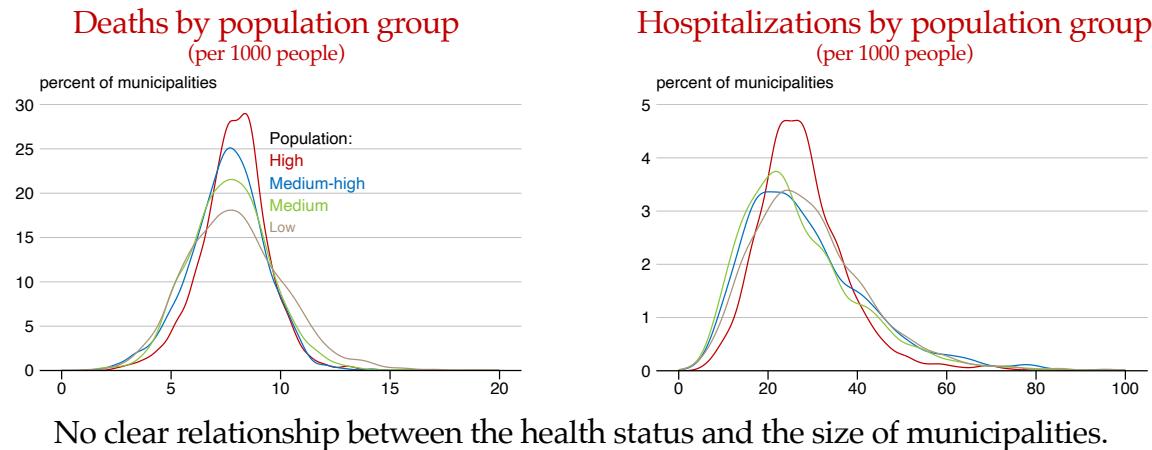
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## Deaths and hospitalizations by population size



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Note: "High": >75 percentile; "Medium-high": 50–75 percentile; "Medium": 25–50 percentile; "Low": <25 percentile.  
Sources: Ministry of Health; Instituto Brasileiro de Geografia e Estatística.

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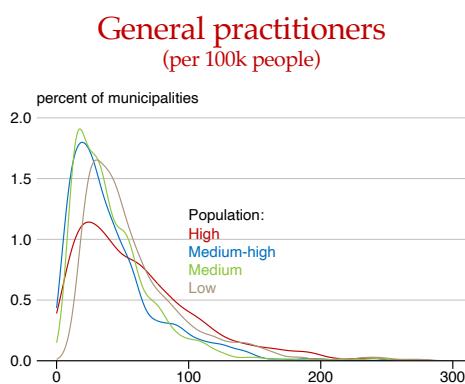
Over the past several decades, Brazil has made tremendous improvements in terms of life expectancy and infant mortality, outpacing the world and Latin America (Chart 1). This is a stark achievement to develop a robust healthcare system to address the needs of its population.

Not all Brazilians, however, have equal access to high quality medical services. Some pieces of evidence can be found in the distributions of the number of deaths and hospitalization relative to population across municipalities (Chart 2)

We divide the municipalities into four groups by quartile of population to see whether the difference in the number of deaths or hospitalizations across municipalities comes from urban and rural settings (Chart 3). The distributions do not differ substantially

across population groups, although we can observe some slight differences which include that the share of municipalities with more than 10 deaths per 1,000 people is higher in the low population group and that the share of municipalities with more than 40 hospitalizations per 1,000 people is higher in bottom three population groups.

## Medical infrastructure by population size



The pattern quite differs between the numbers of general practitioners and hospitals.



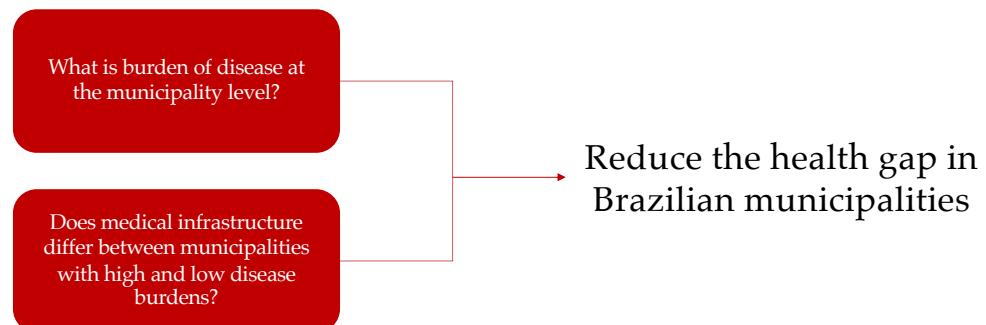
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Note: "High": >75 percentile; "Medium-high": 50–75 percentile; "Medium": 25–50 percentile; "Low": <25 percentile.

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Finally, we compare existing health care infrastructure by municipality group (the same classification as in Chart 3). We do not observe a clear relationship between the number of professionals and the size of the municipalities, although the number of hospitals appears to be greater for larger ones (Chart 5). We will examine whether this mismatch has anything to do with the health gap.

## Devising an investment strategy



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We need to answer these two questions in order to effectively reduce the health gap in municipalities across Brazil.

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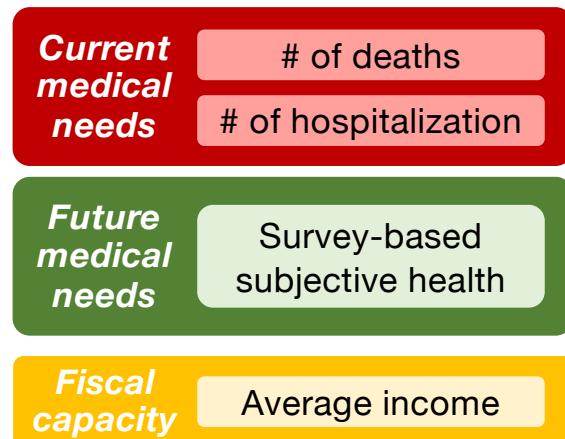
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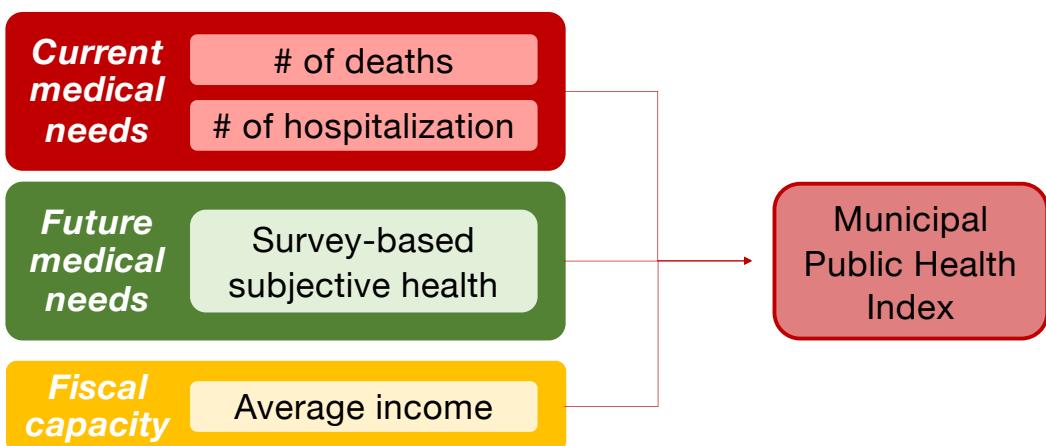
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## Defining burden of disease



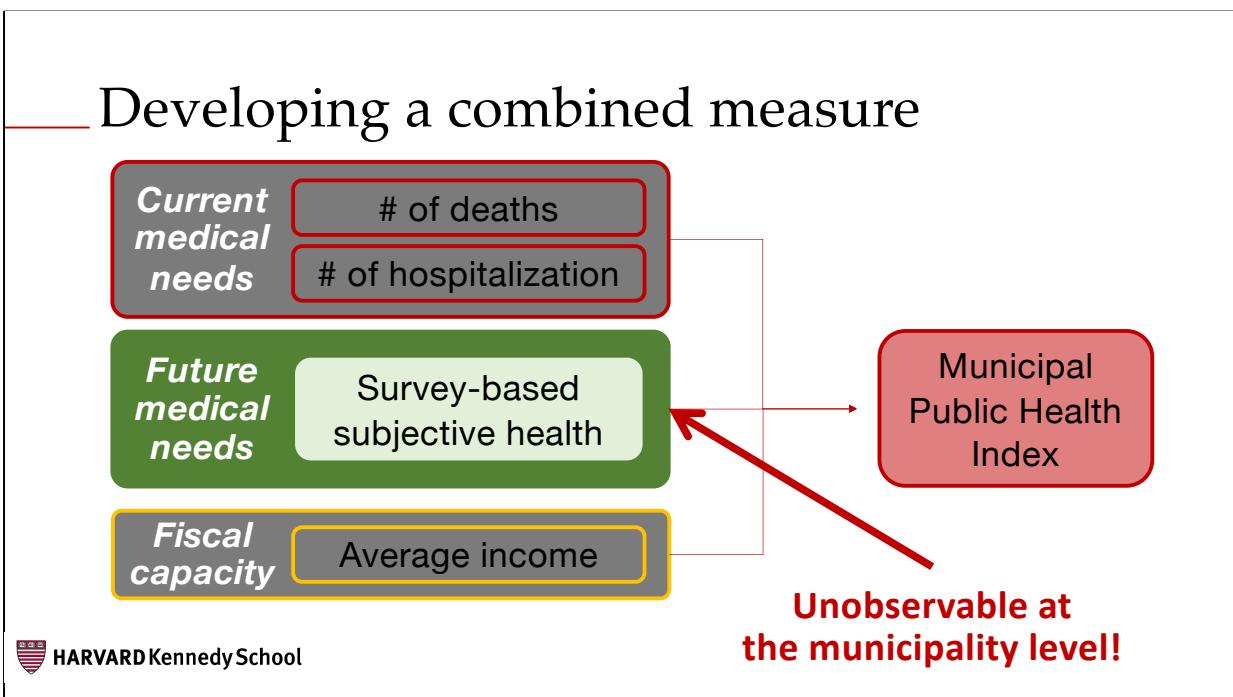
We recognize the burden of disease to be determined by **current and future medical needs as well as fiscal capacity**. We think this way because our ultimate goal is to link the burden of disease with the necessary investment decision, which must be made in a forward-looking way. Every investment decision, however, has to be financed in one way or the other. In this regard, it is also important to take fiscal capacity into account.

## Developing a combined measure



Under this definition, we construct the Municipal Public Health Index (MHPI) by synthesizing the indicators of both current and future medical needs. We use the numbers of deaths and hospitalization per capita as the indicators of current medical needs. We intend to use the subjective health conditions as the indicator of future medical needs. Finally, we use income as a proxy for tax revenue and, hence, fiscal capacity (Chart 6).

## Developing a combined measure



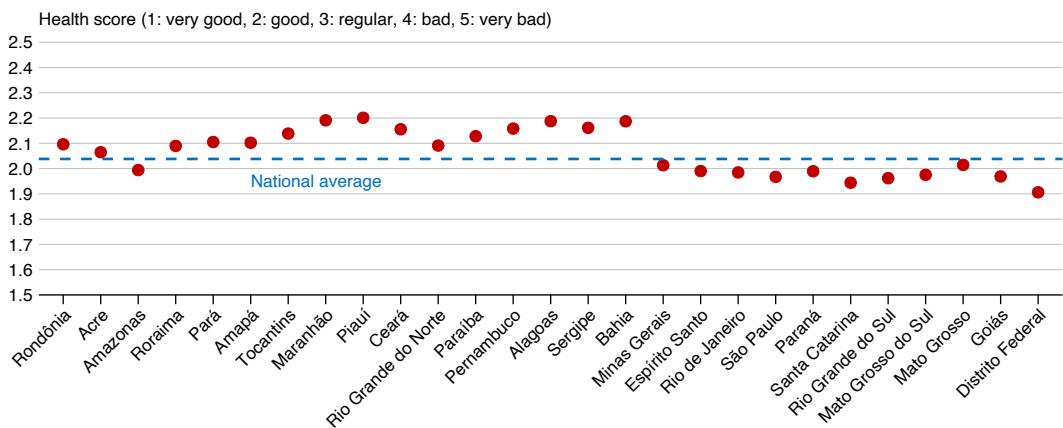
One of the challenges is that the data on the subjective health conditions, which we introduced earlier, is only available at the state level.

We assume that the degree of variation in this measure across states reflects the difference in various socioeconomic and hygiene conditions. They include the average age and the share of households with access to sewage system. They are available at the state and municipality level.

We estimate the subjective health conditions in municipalities using the relationship between subjective health conditions and socioeconomic and hygiene conditions at the state level. To do so, we use a machine learning approach (see Technical Appendix for details).

## Subjective health at the state level

The National Health Survey (PNS) asks respondents to describe their state of health:



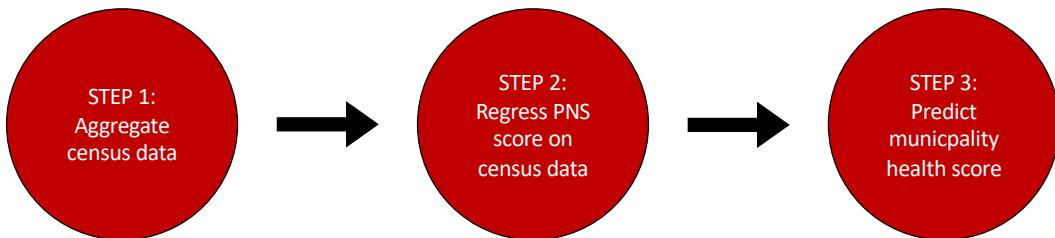
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Source: Instituto Brasileiro de Geografia e Estatística.

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The National Health Survey asks respondents, among other things, to describe their state of health on a five-point scale from “very good” (1) to “very bad” (5). We consider the responses to this question as a measure of the subjective health conditions. Using the publicly available dataset, we can aggregate the subjective health conditions at the state level. Chart 4, which plots the measure for all 27 states, reveals that there is some degree of variation. We will further explore this point in Section 3.2.

## Predicting subjective health in municipalities



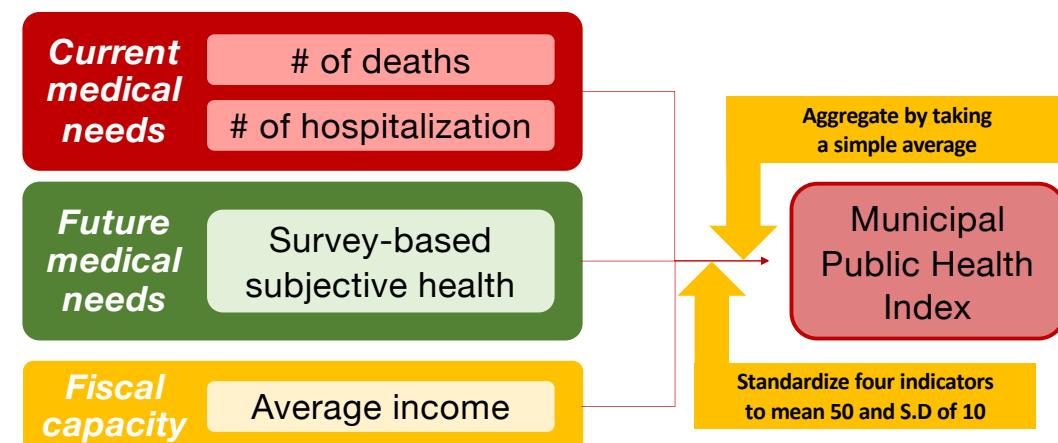
**Step 1 - Aggregate Census Data:** First, we aggregated the data available in the Brazilian Census to understand how variables such as Room Density, Sewage, Water Male ratio Average age, etc. behave at the State level.

**Step 2 - Regress PNS Score on Census Data:** After aggregating the Census data by State, we ran three regression model (i.e. simple OLS, Kitchen-sink, LASSO) using the PNS Health Score as our outcome variable and the parameters in the Brazilian Census as our predictors. This allowed us to analyze what is, on average, the association between a change in the variables on the Brazilian Census and the PNS health score reported at the state level.

We ultimately decided to use LASSO because it had a better performance than both the Simple OLS and the Kitchen-Sink model in terms of out-of-sample RMSE. The table below summarizes the performance of each of the three models:

**Step 3 - Predict health score based on the relationship at the state level:** Finally we used our most efficient regression model (LASSO) to predict the PNS Health Score for each municipality based on their respective Census data

## Developing a combined measure

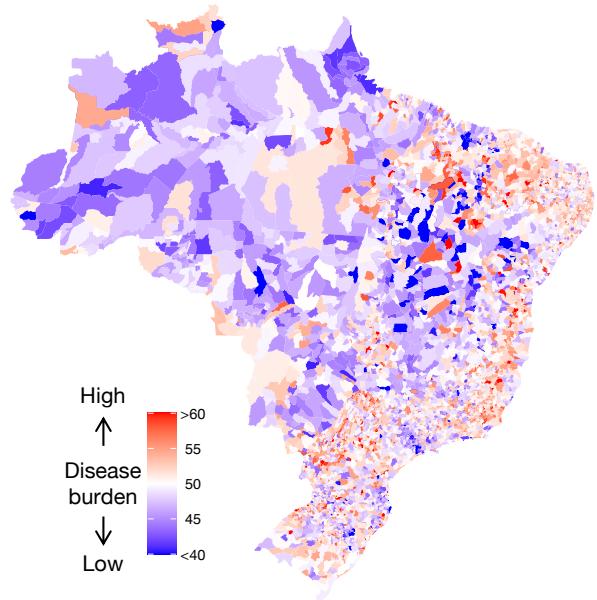


We calculate the MPHI in the following two steps. First, we standardize all four indicators: deaths per capita; hospitalizations per capita; the subjective health conditions; and average income (inverted). A higher value implies a greater burden of disease for that municipality. This first step is necessary to make the indicators measured in different units comparable.

Second, we aggregate the three (standardized) indicators by taking a simple average.

Through these steps, we obtain the MPHI as shown in Chart 7. According to this analysis, the burden of disease is identified to be higher in municipalities that are located in the north-east region or in the coastal region.

## MPHI at glance



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# MPHI and the health infrastructure

## “Frontier Municipalities”

- Groups of municipalities with low burden of disease
- MPHI below the 25th percentile
- More health professionals, more medical equipment, less hospitals

## “Catch-up Municipalities”

- Groups of municipalities with high burden of disease
- MPHI above the 75th percentile
- Fewer health professionals, less medical equipment, more hospitals

Municipalities	Medical professionals				Medical facilities				Medical equipment	
	Pharmacist	General practitioner	Nurse	Family physician	Health center	General hospital	Speciality care clinic	Health management	X-ray	Ultrasound
Frontier (Low burden)	24	58	110	17	28	4	22	7	36	22
Catching-up (High burden)	16	30	94	15	42	7	13	10	17	13

\*per 100k people



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We compare the medical capital stock between the groups of municipalities with low burden of disease (frontier municipalities) and those with high burden of disease (catching-up municipalities). The former group is municipalities whose MPHIs are equal to or higher than the 75<sup>th</sup> percentile, and the latter is equal to or lower than the 25<sup>th</sup> percentile.

We notice that catching-up municipalities generally have fewer health professionals (general practitioners and nurses) and lower amount of medical equipment (X-ray and ultrasound), whereas the number of general hospitals is higher (Chart 8).

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# Policy Recommendation

- **FOCUS:**

- Addressing needs in catch-up municipalities

- **RECOMMENDATION:**

- Increase the number of all types of health care workers in catch-up municipalities
- Increase the amount of medical equipment in catch-up municipalities
- Begin collecting data at the municipality level and expand MPHI measure

- **GOAL:**

- Promote full utilization of existing facilities (many in catch-up municipalities)
- Reduce the future number of deaths and hospitalizations
- Develop a procedure to regularly evaluate and address health needs across Brazil



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Based on the above, we recommend the government increase the number of medical workers and the amount of medical equipment in municipalities with high burden of disease as identified by our MPHI, so as to promote the full utilization of existing medical facilities and, hence, reduce the numbers of deaths and hospitalization.

## Limitations and Opportunities

- **Causes** of deaths and hospitalizations may vary across municipalities
  - May need a more elaborate measure of disease burden that includes cause
  - Can work on expanding the MPHI measure
- Unclear whether investing in each municipality or in a **group** of municipalities is more cost effective
  - May be more effective to develop infrastructure to supply a region (group of municipalities)
  - Unclear how health care investments will be administered based on this analysis



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*Major causes of deaths or hospitalizations vary a lot among municipalities. This might imply that municipalities have different medical needs, and such needs are better met with a tailormade strategy for health infrastructure expansion.*

*Worth considering whether expanding infrastructure in each municipality will be effective, or it is more cost effective if the government makes a major investment in regional hubs across the country. While the availability of data does not allow us to do a deep dive into developing an investment plan that incorporates this aspect, we think this is an interesting avenue for future analysis.*



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# Thank You

