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Healthcare system capacity of the municipalities in the State of Rio de Janeiro: infrastructure to confront COVID-19

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Considering the growing number of cases requiring emergency care as a result of SARS-CoV-2 in the Brazilian State of Rio de Janeiro, this study focuses on mapping the health infrastructure of the municipalities of the state, comparing the Structure Efficiency Index (IEE) before (2016) and after the COVID-19 pandemic. The article fills a gap in the academic literature, informing public health policies specialists and technicians, as well as policy and decision-makers, about the capacity of municipalities to face the problem. We calculated the Structure Efficiency Index (IEE) of the states' 92 municipalities and positioned them on the pandemic curve. It was possible to verify that the government of the State of Rio de Janeiro needs to start acting to suppress COVID-19, maintaining the policy of providing more hospital beds, and purchasing equipment. However, it is also necessary to consider the particularities and deficiencies of each region, as the policy to transfer patients to places with available beds can contribute to the spread of the disease.
Keywords: COVID-19; pandemic curve; healthcare system capacity; structure efficiency index (IEE); municipalities of the State of Rio de Janeiro.

Capacidade do sistema de saúde nos municípios do Rio de Janeiro: infraestrutura para enfrentar a COVID-19

Considerando um número crescente de casos de atendimento de emergência, provenientes do SARS-CoV-2, no Estado do Rio de Janeiro, o presente estudo se concentra no mapeamento da infraestrutura de saúde nos municípios do Estado, comparando o Índice de Eficiência em Estrutura antes (2016) e após a pandemia da COVID-19. O artigo preenche uma lacuna acadêmica ao informar aos especialistas, técnicos, formuladores e tomadores de decisão de políticas públicas de saúde, sobre a capacidade de cada localidade para enfrentar o problema. Para isso, calculamos o Índice de Eficiência da Estrutura (IEE), alocando os 92 municípios do Estado na curva de pandemia. Foi possível verificar que o Governo do Estado do Rio de Janeiro precisa começar a atuar na supressão da COVID-19, mantendo a política de abertura, ou reabertura, de leitos e aquisição de equipamentos. No entanto, também é necessário considerar as particularidades e deficiências de cada região, pois a política de transferência dos acamados para outras regiões com leitos disponíveis pode espalhar a doença.
Palavras-chave: COVID-19; curva de pandemia; capacidade do sistema de saúde; Índice de Eficiência em Estrutura (IEE); cidades do estado do Rio de Janeiro.

Capacidad del sistema de salud en los municipios del estado de Río de Janeiro: infraestructura para enfrentar la COVID-19

Considerando el número creciente de casos de atención de emergencia procedentes del SARS-CoV-2, en el estado de Río de Janeiro, este estudio se centra en el mapeo de la infraestructura de salud en los municipios de dicho estado, con el fin de informar a los especialistas, técnicos, formuladores y tomadores de decisiones de políticas de salud pública sobre la capacidad de cada localidad para enfrentar el problema. Para esto, calculamos el índice de eficiencia de estructura (IEE) colocando los 92 municipios del estado en la curva de la pandemia. Se pudo verificar que el Gobierno del Estado de Río de Janeiro debe comenzar a actuar para suprimir la COVID-19 manteniendo la política de apertura o reapertura de camas y adquisición de equipos. Sin embargo, también se deben considerar las particularidades y deficiencias de cada región, ya que la política de traslado de pacientes postrados a otras regiones con camas disponibles puede propagar la enfermedad.
Palabras clave: COVID-19; curva pandémica; capacidad del sistema de salud; índice de eficiencia de estructura (IEE); ciudades del estado de Río de Janeiro.

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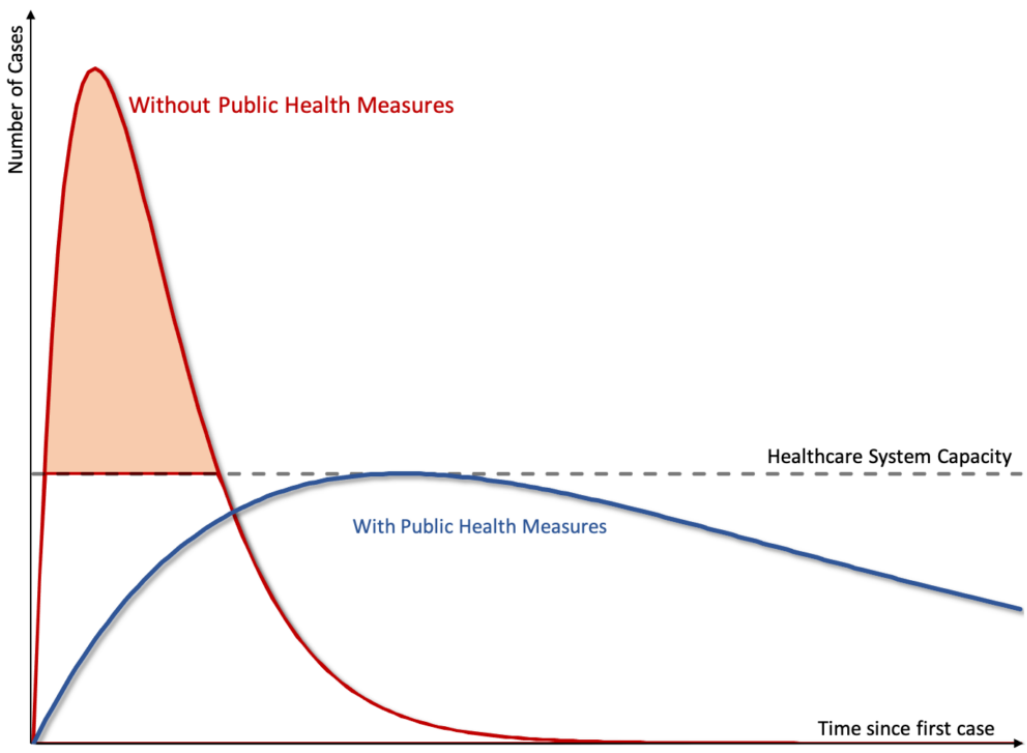
1. INTRODUCTION

In the fight against COVID-19, even countries with a high absolute and the relative number of hospital beds in the Intensive Care Unit (ICU), demanded additional beds to meet the peak demand for hospitalization (Baldwin & Di-Mauro, 2020). From a systemic point of view, this circumstance is amplified when it observes a health system that is already depleted by the usual demand, which can indirectly harm patients of other diseases and other forms of ongoing treatment.

Specifically, in Brazil, less than 10% of the municipalities have ICU beds, in addition to internal national inequalities, which aggravates the problem in remote regions (CNES, 2020). The quantification of health infrastructure is relevant in the fight against SARS-CoV-2 because it helps in the decision on the policy of social isolation and the choice of priority economic activities.

The capacity of a health system to deal with the rate of contamination by SARS-CoV-22 in the short term is limited (see the representative line in Figure 1). The necessary resources are finite, like hospital beds, ICU beds, number of qualified health professionals, ventilators, respirators, among others. This situation imposes a limit on the number of patients that can be treated. The rate of transmission of the coronavirus would quickly overload any health system, leaving many infected patients with deteriorating lung conditions without any treatment, hence the need to flatten the contaminated curve by imposing a drastic policy of social distancing (Gourinchas, 2020).

FIGURE 1 FLATTENING PANDEMIC CURVE



Source: Gourinchas (2020).

Much of the necessary structure is presented by the National Register of Health Facilities (CNES). In this area, Mendes (2005) developed a method for calculating the Technical Efficiency Index in Health (IETS), based on the Results Efficiency Index (IER) and the Structure Efficiency Index (IEE), the latter with potential to measure the capacity of the health system in a comparative perspective. In turn, the capacity of the health system needs to be defined in order for appropriate policies to be established.

In this sense, the present study focuses on mapping the health infrastructure at the municipalities of the State of Rio de Janeiro, comparing the Structure Efficiency Index (IEE) before (2016) and after the COVID-19 pandemic. The paper fills an academic gap, because it informs the specialists, technicians, formulators, and decision-makers of public health policies, about the capacity of each location to face the problem. From a comparative perspective, it will locate each city in the State on the pandemic flattening curve, according to their health care conditions.

This research is justified because of the recent declaration of a COVID-19 pandemic condition by the World Health Organization (WHO) on March 11th, with an increasing number of cases of emergency care, coming from SARS-CoV-2, in the State of Rio de Janeiro. Considering that the health infrastructure defines the urgent need for flattening the ascendant curve in the number of cases, the researchers intend to provide data and information for the society.

We partially consolidated the collected data in order to support decision-makers and public policy formulation and to understand the risks of a possible relaxation of social isolation and quarantine measures announced face to the economic crisis, with impact all over the states and municipalities.

2. THEORETICAL SYNTHESIS

There is an acquiescence that state institutions should play some role in the area of public health. It is essential to note that the health system situation is due to a combination of market and government and that the efficiency generated in this segment will depend on how it is financially organized. In turn, it is not possible to assert that there is a model of financial organization to be considered ideal, balancing public and private investments in health. Consequently, we can infer that the private health system will bring greater efficiency while the public health system would be effective, even if only in essential health goods and services. The Brazilian Unified Health System (SUS) is considered a generous and universal proposal, although it faces problems of precarious supply of goods and services in some communities (Farias & Melamed, 2003).

There is a discussion about the positive impacts of public health policy in Brazil-based mainly on the initiative to supply free medicines and its universal form of distribution through pharmacies, both popular and basic. It is also necessary to consider the entire demographic multiplicity of the Brazilian population and the quality standards of health from the distinct regions of the country. With this, it can be stated that SUS and its expansion successfully reduced the number of diseases in the population, overcoming inequalities in Brazil (Souza et al., 2018).

The guiding principles of SUS, and all its legal basis of support, should cause profound changes, as observed in the reduction of the mortality rate and the increase of the life expectancy of the population. However, it is still necessary to improve the state system in a coherent and articulated action to social protection (Souza et al., 2018).

The implementation of SUS is considered the greatest social policy that was created in the country, even though it contained so many difficulties and problems that were not overcome during its three decades of life. These problems persist because there was never a political party or government that took responsibility and adequately resolved the problems mentioned and put SUS in its proper place of prominence (Rizzotto, 2018).

However, in times of the Corona Virus disease (COVID-19), it is crucial to reevaluate the health infrastructure over the country by following the World Health Organization (WHO) orientations like the WHO International Health Regulations (WHO IHR MEF), which aims to provide a precise overview at each country. Hence, it is possible to verify capacities to ensure adequate levels of public health. This monitoring is made with a set of components: (1) a mandatory self-reporting of capacity- the State Party Self- Assessment Annual Reporting – SPAR), (2) the Joint External Evaluation, (3) The After-Action Reviews and (4) the Simulation Exercises. It is necessary to say that this measure does not account for other critical indirect components "that might compromise the control of emerging epidemics, such as demographic, environmental, socioeconomic, and political conditions" (Gilbert et al., 2020, p. 873).

The COVID-19 created a Health System crisis around the world, which made all government and private health sectors develop several strategies to support mainly the accelerated expansion in demand of ICU. This ICU demand is particularly scary to the general audience since the ICU is perceived as a place where people go when they are dying, carrying in that way physical and mental stress not only to the patient but also to their family (Paneru, 2020).

Keesara, Jonas, and Schulman (2020) suggest observing three areas: (1) evaluation of clinical care by using (2) reimbursement for new Technological services and (3) an expanded regulatory relief. He also considers that hospital-at-home models would be an alternative for infected but stable patients or an early discharge of admitted patients from COVID-19.

Maves et al. (2020) declares the importance of an efficient triage system to allocate all the available critical care resources as the clinical demands in the surge will largely exceed the provisioned capacity of essential resources. They argue that a triage decision support protocol among infrastructures and personal training is necessary to establish paying attention to legal and regulatory protections. Those factors have to be adequate to three different capacity levels that might occur due to the surge progression: the conventional, the contingency, and the crisis capacity. At conventional capacity, a hospital must be able to expand its critical care capacity. At contingency capacity that occurs during a disaster, it is necessary to expand the Critical care capacity by 100%. If the situation develops to a catastrophic level, which is the tendency because of COVID-19, there will be severe resource restrictions, and the hospital and all mainly affected public should consider a triage protocol.

Another essential strategy to avoid an infrastructure crisis is the home isolation instead of hospital isolation, mainly oriented to patients with mild to moderate symptoms of COVID-19. However, several policymakers like the Chinese, for instance, are against this strategy because it puts the patient's family members at risk, which affects the patient psychologically as well (Chen et al., 2020). Even though, it is necessary to apply strict measures of detection, control, and prevention, including "heightened surveillance and rapid identification of suspected cases, followed by patient transfer and isolation, rapid diagnosis, tracing, and follow-up of potential contacts" (Gilbert et al., 2020, p. 871).

An excellent example of rapid infrastructure adaptation to the COVID-19 outbreak is the Fangcang hospital models implemented in China. The expression Fangcang symbolized the Noah's Ark metaphor and was used primarily at military field hospitals that convert large constructions, like stadiums, for example, in temporary hospitals to attend public health emergencies. Those shelter hospitals have three main characteristics to deal with a crisis like the COVID-19 outbreak: (1) rapid construction as it just adapts other large physical structures; (2) massive scale of the health system since it increases very fast the health care capacity and (3) the low cost of running those installations (Chen et al., 2020).

A highly inefficient example of infrastructure is observed in Nepal, where besides the efforts to expand its overwhelmed ICU beds, there are not enough healthcare workers trained to run the ICU level III demanded by critically ill COVID-19 patients. The Level III ICU I for patients requiring two or more organs support or mechanical ventilation alone, which is staffed by one nurse per patient ideally and a doctor present 24 hours. Even the largest University hospital in Nepal has less than the minimum recommended of 5% of ICU beds of the total available beds. Furthermore, around the country, there are a total of 480 ICU beds and 260 ventilators on both private and public sectors (Paneru, 2020).

At least, WHO is supporting the African countries to improve their diagnostic capacity since they used to have just two referral laboratories to attend almost all the countries there. The main challenge is to provide fast training to improve the personnel to run the tests and to provide a correct stock of materials involved in the tests. This training is crucial to reduce the delivering result time which is essential to health policy planning (Gilbert et al., 2020).

3. METHODS

For this paper, the IEE will be considered the "capacity of the health system," as it covers:

- Municipal spending per capita SUS - impacts on the city's investment conditions in health and emergency demands, purchase of respirators, availability of new beds, among others (2016 and 2020[1]);
- Union transfers per capita SUS - impacts on the city's investment conditions in health and emergency demands, purchase of respirators, availability of new beds, among others (2016 and 2020);
- Hospital Beds per inhabitant - directly impacts service capacity (2016 and 2020);
- Doctors per thousand inhabitants - influence on direct care conditions (2016 and 2020);
- Other health professionals per thousand inhabitants - influence on direct care conditions (2016 and 2020);
- Family Health Teams - influence on health activities reallocation, which is essential to the health system maintenance (2016 and 2020).

The flattening curves of the number of cases, compared with the capacity of health systems, consider the dispersion pattern of rich countries, attributing an average of 0.5 to the health system's attending

[1] The number of inhabitants in 2020 is calculated on the basis of data for 2019.

capacity, as an intermediate indicator (Walker et al., 2020). In developing countries, the results of the pandemic may be worse than anticipated, given sanitation conditions, water supply, and people agglomerations in communities (Walker et al., 2020). The calculation of the IEE considers the average of six projected indicators, in order to allocate values among the municipalities themselves, where the worst municipality in the State in each indicator has a score of zero in the respective item. In contrast, the better municipality receives a score of 1. The IEE is calculated using the following formula:

$$IEE = 1 - \left(\frac{R\ best - R\ calc}{R\ best - R\ worse}\right)$$

Where: “R best” represents the best result for each variable (such as, for example, Hospital Beds per inhabitant, or Health professionals per inhabitant). “R calc” corresponds to the municipality indicator to be calculated in the variable, and “R worse” refers to the worst result for each variable (Mendes, 2005).

The information available for all of these indicators in the CNES database (source of secondary data) for all municipalities in the State of Rio de Janeiro, is from 2016, which corresponds to a research limitation. However, a few modifications were observed in the scenario. Faced with the coronavirus pandemic, the municipalities had to update the health structure data, since April 2020, because of the rapid expansion in the number of hospital beds and equipment. This circumstance enabled a comparison of the IEE in May 2016, with the current IEE (May 2020), making it possible to assess which municipalities in the state have improved or regressed their respective infrastructures. All ninety-two municipalities in the State of Rio de Janeiro have participated in the research, and the study presents the results of the IEE in each municipality. The analysis and data interpretation uses an explanatory graph based on the conditions of the services for a visual demonstration. In sequence, the explanatory note makes a series of suggestions to the State Government, and as a consequence, to all Municipalities. Estimates of deaths and care needs were based on Walker et al. (2020).

4. RESULTS AND DISCUSSION

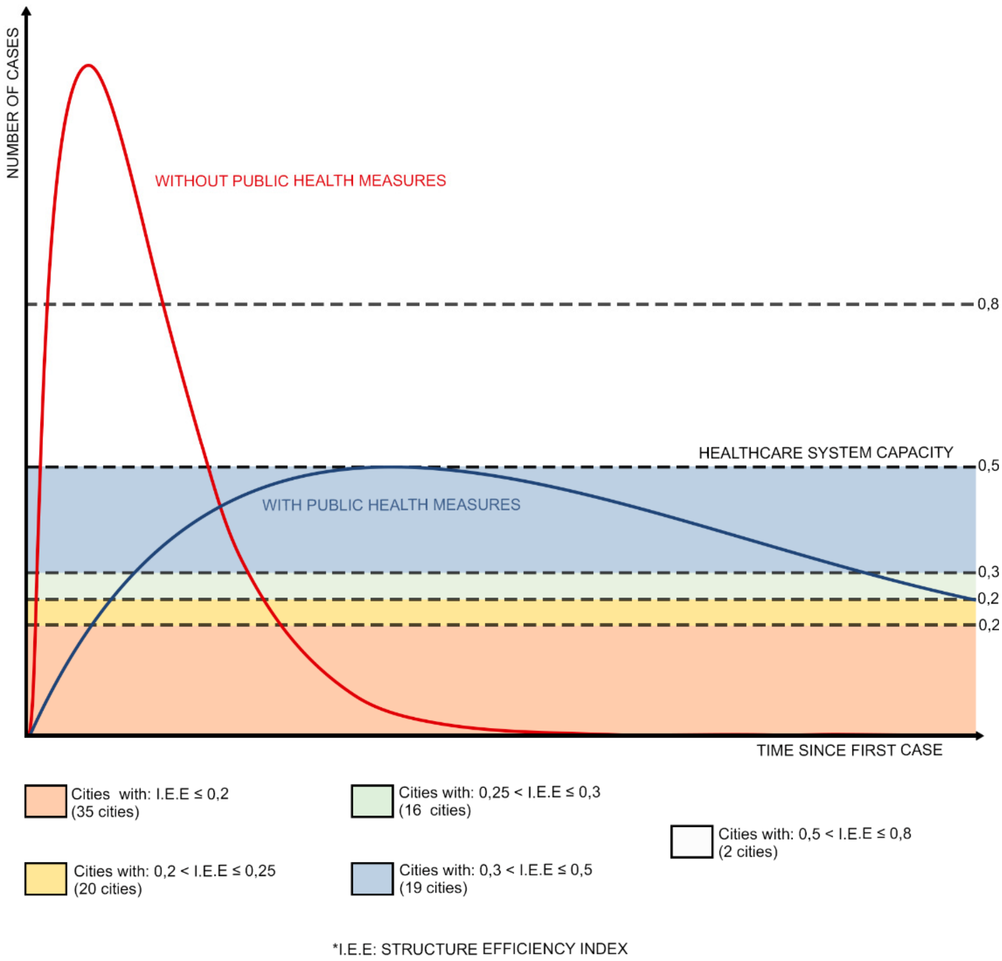
4.1 2016 Results

Thirty-five municipalities in the State (38%) – with IEE between 0.0 and 0.2 - had deplorable health infrastructure conditions to deal with COVID-19 cases. In those places, with the previous structure, cases would need to be treated in other municipalities, or emergency beds should be made available on an urgent basis within one month after the first confirmed case (see Figure 2 and Figure 3).

Complementing this alarming number, the state had 20 cities with IEE between 0.2 and 0.25, and poor service conditions, in addition to another 16 municipalities between 0.25 and 0.3, still unsatisfactory, even with the flattening of the curve in the number of cases.

Under normal conditions, only 21 municipalities had initial service capacity (considering 3 months after first case) for the cases of COVID-19, where Niterói (0.51) and Vassouras (0.766) would be the only ones capable of meeting the demand of the city itself within the flat curve, without considering emergency services from neighboring municipalities. The regionalization of emergency beds would need to be intensified according to the study of local conditions, due to the stratification of the data.

FIGURE 2 FLATTENING PANDEMIC CURVE AND HEALTHCARE SYSTEM CAPACITY 2016



Source: Based on Gourinchas (2020).

That being said, it is necessary to discuss that even the current slowing down of the curve towards flattening was not able to mitigate the effects on the health system, according to the methodological criteria. For this reason, the municipalities of Rio de Janeiro would need to expand their service capacity, and by April 2020 capacities were already different, according to item 4.2.

FIGURE 3 IEE 2016 IN THE MUNICIPALITIES OF RIO DE JANEIRO

*I.E.E: STRUCTURE EFFICIENCY INDEX

Cities with: I.E.E ≤ 0,2 - Japeri, São João de Meriti, Seropédica, Belford Roxo, Queimados, São Pedro da Aldeia, Magé, São Gonçalo, São Francisco de Itabapoana, Saquarema, São Fidélis, Maricá, Rio das Ostras, Mesquita, Sumidouro, Guapimirim, Conceição de Macabu, Varre-Sai, Bom Jardim, Teresópolis, Paty dos Alferes, Duas Barras. Nova Iguaçu, Araruama, Mendes, Paraty, São José do Vale do Rio Preto, Barra do Piraí, Cachoeiras de Macacu, Trajano de Moraes, Duque de Caxias, Italva, Miracema, Itaboraí, Tanguá.

Cities with: 0,2 < I.E.E ≤ 0,25 - Santo Antônio de Pádua, Porcíuncula, Pinheiral, Itaocara, Iguaba Grande, Cordeiro, Paracambi, Nova Friburgo, Nilópolis, Cardoso Moreira, Cabo Frio, Cantagalo, Casemiro de Abreu, Areal, Aperibé, Arraial do Cabo, Santa Maria Madalena, Barra Mansa, Silva Jardim, Valença.

Cities with: 0,25 < I.E.E ≤ 0,3 - Itaguaí, Rio Claro, Mangaratiba, Miguel Pereira, Engenheiro Paulo de Frontin, Rio das Flores, Bom Jesus de Itabapoana, São Sebastião do Alto, Volta Redonda, Itatiaia, Paraíba do Sul, Laje do Muriaé, Resende, Sapucaia, Cambuci, Macaé.

Cities with: 0,3 < I.E.E ≤ 0,5 - Rio de Janeiro, Petrópolis, Rio Bonito, Armação dos Búzios, Campos dos Goytacazes, Angra dos Reis, Carmos, Natividade, Carapebus, Três Rios, Piraí, Comendador Levy Gasparian, São José de Ubá, Quissamã, Macuco, São João da Barra, Quatis, Porto Real, Itaperuna.

Cities with: 0,5 < I.E.E ≤ 0,8 - Niterói, Vassouras.

Source: Elaborated by the authors.

4.2 April 2020 Results

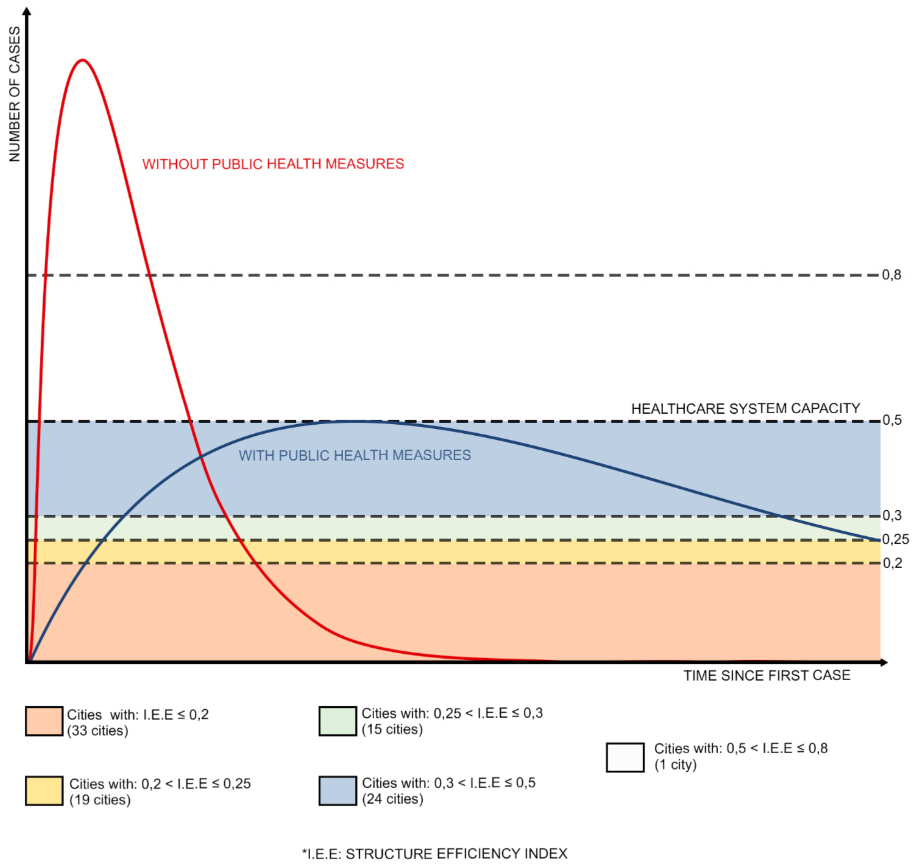
In the view of IEE's characteristics when stablishing a kind of ranking, we are able to observe few changes in the quantitative distribution of municipalities among the groups. Given the current data, thirty-three cities show deplorable health infrastructure (36%) (the number was thirty-five in 2016). We notice that some cities' respective classification gets worse and join this group – having IEE between 0 and 0.2. – as in the case of Pinheiral, Iguaba Grande, Cordeiro, Itaocara, Porciúncula, Nilópolis, Paracambi, Santa Maria Madalena, Sapucaia, Itaguaí e Quatis (see Figures 4 and 5).

The municipalities which have gotten out of the worst qualifying range are: Itaboraí, Trajano de Moraes, Tanguá, Barra do Piraí, Paty do Alferes, Paraty, Mendes, Teresópolis, Duas Barras, Bom Jardim, São fidélis, Maricá e Sumidouro.

Nineteen municipalities form the second range with poor health service conditions, IEE between 0.2 and 0.25, and other twenty-four cities between 0.25 and 0.3, still under unsatisfactory conditions.

As the set-out criteria arbitrariness foundations in international conditions, and considering the structure's evolution after COVID-19, twenty-six cities would be able to assist the population during the three first months, since they can present the attenuated epidemic curve. In this regard, the municipality of Vassouras is the highlight. Even though the city has a small population, it owns and important university hospital, in addition to specific beds available to cover the COVID demand.

FIGURE 4 FLATTENING PANDEMIC CURVE AND HEALTHCARE SYSTEM CAPACITY 2020



Source: Elaborated by the authors.

FIGURE 5 IEE 2020 IN THE MUNICIPALITIES OF RIO DE JANEIRO

*I.E.E: STRUCTURE EFFICIENCY INDEX

- Cities with: I.E.E ≤ 0,2 - Belford Roxo, Seropédica, São Pedro da Aldeia, Queimados, São João de Meriti, São Francisco de Itabapoana, Japeri, São Gonçalo, Magé, Saquarema, Conceição de Macabu, Itaguaí, Rio das Ostras, Mesquita, Cachoeiras de Macacu, Porciúncula, São José do Vale do Rio Preto, Quatis, Nova Iguaçu, Paracambi, Santa Maria Madalena, Nilópolis, Araruama, Itaocara, Cordeiro, Miracema, Varre-Sai, Sapucaia, Iguaba Grande, Duque de Caxias, Guapimirim, Pinheiral, Italva.
- Cities with: 0,2 < I.E.E ≤ 0,25 - Trajano de Moraes, Paty do Alferes, Barra do Piraí, Arraial do Cabo, Engenheiro Paulo de Frontin, Itaboraí, São Fidélis, Paraty, Tanguá, Mendes, Santo Antônio de Pádua, Silva Jardim, Teresópolis, Casimiro de Abreu, Barra Mansa, Mangaratiba, Bom Jardim, Cabo Frio, Duas Barras.
- Cities with: 0,25 < I.E.E ≤ 0,3 - Itatiaia, São José de Ubá, Nova Friburgo, Rio Bonito, Maricá, Cantagalo, Piraí, Cambuci, Aperibé, Resende, Laje do Muriaé, Volta Redonda, Paraíba do Sul, Bom Jesus do Itabapoana, Rio de Janeiro.
- Cities with: 0,3 < I.E.E ≤ 0,5 - Rio das Flores, Valença, Areal, Carapebus, Três Rios, Sumidouro, Campos dos Goytacazes, Cardoso Moreira, Macaé, Itaperuna, Comendador Levy Gasparian, Natividade, Carmo, São João da Barra, Angra dos Reis, São Sebastião do Alto, Miguel Pereira, Armação dos Búzios, Petrópolis, Macuco, Rio Claro, Porto Real, Niterói, Quissamã.
- Cities with: 0,5 < I.E.E ≤ 0,8 - Vassouras.

Source: Elaborated by the authors.

4.3 Discussions and reflections

IEE cannot be considered an instrument to measure service structure for the complications coming specifically from COVID-19. However, it brings the ability of explaining health system structure, given the fact that it gathers the network articulation capacity as a whole, staff, possibility of resources application and beds. The introduction of an indicator with these characteristics becomes meaningful because facing coronavirus minimizes the service capacity related to other diseases, building a system-wide problem.

We can't argue against the increase of infrastructure in health recently utilized, from the logic that the new structure may be idle right after the end of coronavirus outbreak. On the contrary, the health system will need to supply the demand represented related to other diseases. It's been detected, in many countries, an increase of cardiovascular and psychiatric disorders, not to mention the situation of elective surgeries temporarily cancelled (Linschoten & Asselbergs, 2020; Shigemura et al., 2020; Zheng, Boni, & Fingerhut, 2020). All listed circumstances, if observed together, indicate that during a long time, there will be a bigger demand for health service after the pandemic period.

As a result of the referred context, the policy of opening beds, initiated by the State Government at Zilda Arns Hospital, Anchieta Hospital, and at the Brain Institute needs to be intensified, with the regional distribution. Therefore, it is necessary to map provisional, permanent or unused infrastructure with the municipalities. It is possible to formulate a short-term action based on information exchange. The stratification of IEE data can contribute to the formulation of this decision.

A mobilisation of the health structure in a decentralized way, contemplating regional inequalities is urgent needed. The patients transfer procedure inside of the hospital units is already a risk reason, consequently, when considering carrying patients over between cities, the risk is high. This is explained because the virus has a high propagation potential, even in hospitals and among health professionals (Brindle & Gawande, 2020). If badly led, a public policy from this nature may spread the outbreak to less affected cities.

Observing the evolution of IEE between the years of 2016 and 2020, both cities, Maricá and Sumidouro, moved up more than one position on the ranking range. Other cities that have leveraged their indexes in more than 0,1 can be highlighted as well: Rio Claro, Miguel Pereira, Cardoso Moreira and Quissamã. Whereas, the cities of Itaguaí, Itaperuna, São José de Ubá and Quatis, showed decrease up to 0,1 in IEE (Table 1).

TABLE 1 IEE EVOLUTION – WORST INDICATORS

Group	Cities	I.E.E. 2016	I.E.E. 2020	Increase or decrease
4	Duas Barras	0.161	0.248	0.087
	Cabo Frio	0.224	0.248	0.024
	Bom Jardim	0.150	0.242	0.093
	Mangaratiba	0.254	0.242	-0.012
	Barra Mansa	0.242	0.241	-0.001
	Casimiro de Abreu	0.238	0.240	0.002
	Teresópolis	0.158	0.233	0.075
	Silva Jardim	0.244	0.233	-0.011
	Santo Antônio de Pádua	0.201	0.228	0.027
	Mendes	0.169	0.226	0.057
	Tanguá	0.199	0.226	0.028
	Paraty	0.173	0.226	0.053
	São Fidélis	0.111	0.213	0.102
	Itaboraí	0.196	0.212	0.017
	Engenheiro Paulo de Frontin	0.259	0.212	-0.046
	Arraial do Cabo	0.241	0.211	-0.029
	Barra do Piraí	0.181	0.211	0.030
	Paty do Alferes	0.159	0.211	0.052
	Trajano de Moraes	0.190	0.210	0.020
5	Italva	0.194	0.198	0.004
	Pinheiral	0.205	0.197	-0.008
	Guapimirim	0.134	0.197	0.063
	Duque de Caxias	0.190	0.196	0.006
	Iguaba Grande	0.210	0.194	-0.016
	Sapucaia	0.279	0.194	-0.085
	Varre-Sai	0.144	0.192	0.048
	Miracema	0.195	0.192	-0.003
	Cordeiro	0.211	0.191	-0.019
	Itaocara	0.209	0.189	-0.020
	Araruama	0.167	0.181	0.014
	Nilópolis	0.217	0.179	-0.039

Continue

Group	Cities	I.E.E. 2016	I.E.E. 2020	Increase or decrease
	Santa Maria Madalena	0.241	0.175	-0.066
	Paracambi	0.213	0.173	-0.040
	Nova Iguaçu	0.165	0.172	0.008
	Quatis	0.429	0.170	-0.259
	São José do Vale do Rio Preto	0.176	0.168	-0.008
	Porciúncula	0.201	0.167	-0.034
	Cachoeiras de Macacu	0.189	0.156	-0.033
	Mesquita	0.125	0.155	0.030
	Rio das Ostras	0.122	0.150	0.029
	Itaguaí	0.251	0.143	-0.109
	Conceição de Macabu	0.141	0.131	-0.009
	Saquarema	0.108	0.113	0.005
	Magé	0.082	0.112	0.030
	São Gonçalo	0.082	0.106	0.024
	Japeri	0.040	0.091	0.051
	São Francisco de Itabapoana	0.092	0.090	-0.001
	São João de Meriti	0.043	0.090	0.048
	Queimados	0.064	0.077	0.013
	São Pedro da Aldeia	0.070	0.064	-0.006
	Seropédica	0.051	0.056	0.005
	Belford Roxo	0.054	0.055	0.001

Source: Elaborated by the authors.

About the calculation of the IEE in all fluminense municipalities, when a case of COVID-19 is reported, it's recommended that no localities with an index lower than 0,25 (Table 1), hypothesizes a relaxation of distance provisions. This analysis is able to help the public formulators in decisions similar to the ones established by Decree 47.025 (2020), authorizing mayors to release commercial activities in municipalities without any notifications.

In absolute terms, the efficiency indicators point out Vassouras, Quissamã, Niterói, Porto Real and Rio Claro, as cities with good capacity of the structure's mobilisation (Table 2). It is important to mention that these indicators do not portray effectiveness to deal with coronavirus outbreak, but the capacity of mobilisation. Notwithstanding, Niterói and Vassouras keep Intensive Care Units in particular for patients affected by COVID-19, with the state's government support, as the capital. It is interesting to observe the municipality of Volta Redonda, which is contemplated by the state system too, it does not occupy a prominence position.

TABLE 2 IEE EVOLUTION – BEST INDICATORS

Group	Cities	I.E.E. 2016	I.E.E. 2020	Increase or decrease
1	Vassouras	0.766	0.720	-0.046
2	Quissamã	0.400	0.500	0.100
	Niterói	0.510	0.458	-0.052
	Porto Real	0.434	0.436	0.002
	Rio Claro	0.253	0.380	0.127
	Macuco	0.409	0.377	-0.031
	Petrópolis	0.318	0.370	0.052
	Armação dos Búzios	0.321	0.370	0.049
	Miguel Pereira	0.256	0.365	0.109
	São Sebastião do Alto	0.270	0.352	0.081
	Angra dos reis	0.329	0.351	0.023
	São João da Barra	0.416	0.350	-0.065
	Carmo	0.346	0.344	-0.002
	Natividade	0.363	0.344	-0.019
	Comendador Levy Gasparian	0.379	0.339	-0.040
	Itaperuna	0.450	0.336	-0.113
	Macaé	0.297	0.336	0.039
	Cardoso Moreira	0.222	0.323	0.101
	Campos dos Goytacazes	0.325	0.320	-0.004
	Sumidouro	0.128	0.319	0.191
	Três Rios	0.368	0.312	-0.056
	Carapebus	0.366	0.312	-0.054
	Areal	0.240	0.306	0.066
	Valença	0.248	0.305	0.057
	Rio das Flores	0.260	0.305	0.045
3	Rio de Janeiro	0.315	0.298	-0.017
	Bom Jesus do Itabapoana	0.263	0.297	0.033
	Paraíba do Sul	0.277	0.296	0.019
	Volta Redonda	0.272	0.296	0.024
	Laje do Muriaé	0.278	0.294	0.016
	Resende	0.278	0.285	0.006

Continue

Group	Cities	I.E.E. 2016	I.E.E. 2020	Increase or decrease
3	Aperibé	0.240	0.281	0.041
	Cambuci	0.282	0.279	-0.003
	Piraí	0.368	0.278	-0.090
	Cantagalo	0.233	0.267	0.034
	Maricá	0.114	0.265	0.151
	Rio Bonito	0.319	0.264	-0.055
	Nova Friburgo	0.216	0.257	0.041
	São José de Ubá	0.383	0.255	-0.128
	Itatiaia	0.272	0.254	-0.018

Source: Elaborated by the authors.

5. CONCLUSIONS AND SUGGESTIONS TO MANAGERS

The mapping of IEE in all municipalities in the state of Rio de Janeiro came out as a fruitful ranking tool. The notes exhibit the mobilisation capacity of health structure, allowing better precision when it comes to decision-making. Especially, about the necessity of a regional focus for solving health system infrastructure problems.

When we compared indicators between the years of 2016 and 2020, we were able to verify cities with positive and negative highlights, however, there was a low mobility among the established groups. The fact can be well explained given the fact that the seek for structure expansion, substantiated by field hospitals and respirators was governed by the Union, with various municipalities effort. Since IEE is a ranking indicator inside of the own sample, formed by six different data types, we noticed a mobilisation limitation, in other words, the difficulty for a municipality to go up – or down – in many ranking positions.

Considering the municipal and state efforts for beds opening, we cannot forget to point out the necessity of mapping existent and under reactivation possibility beds. As if the shortage of resources and scarce investments scenario weren't enough, there are traces of possible irregular purchases in the health sector, what may deepen infrastructure issues.

Thus far the preparation of the present research report, the social distancing measures in the State are in the range of 0.3 and 0.6 according to the standards of Walker et al. (2020), and the contamination can reach more than one hundred thousand quickly infected in the State and about 10,000 deaths, in less than six months after the first case being confirmed. Calculation of social distancing is not considering disobedience to current decrees. It considers the currently system's capacity (the number can be mitigated, with the immediate expansion of capacity, an action already initiated by the State Government). In this regard, the loosening of measures, without due care is not indicated, which can double the number of deaths.

The most appropriate would be to intensify the mitigation measures and acquire COVID-19 tests in order to start acting in the suppression. That means, the need to test suspected cases more quickly, and consequently isolate confirmed cases, with the possibility of testing the social groups in contact with all those confirmed contaminated cases. Also, the State Government should aim to break the path of the virus transmission, maintaining the social distancing imposition. Even short-term economic needs cannot overcome the problem. Evidence from Correia, Luck, and Verner (2020) demonstrate that during the 1918 flu pandemic, some locations opted for a more lenient policy of isolation and others less. The areas, with the lowest social distancing had persistently higher rates of sickness and worse economic results. At the same time, cities that acted earlier and more aggressively began to grow faster after the end of the pandemic.

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