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The Interrelation of Urban Health Indicators and COVID-19: A Study of Passo Fundo/RS

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Abstract: The COVID-19 (Coronavirus Disease 19) pandemic has demonstrated that cities are at the center of major contemporary events. The epidemiological crisis has highlighted the importance of the urban environment, challenging public managers on managing cities. An initiative that aims to assist in this management process is the concept of Smart Cities, which uses ICT (Information and Communication Technology) as tools for transforming urban dynamics, and through urban indicators, measures information about cities. Thus, the research aimed to analyze the health indicators of Passo Fundo/RS, seeking to analyze the interrelationship of these indicators with the epidemiological data from COVID-19. In the methodology, multi-method procedures were applied, using the indicators of the Connected Smart Cities Ranking as reference, as well as a regional selection of medium-sized cities in the southern region of Brazil. The results show that the health indices of Passo Fundo are, for the most part, lower than those of the analyzed cities, with the indicator related to Population Coverage of the Family Health team as the main weakness. However, it also presents satisfactory indices as is the case of the indicator of Beds/1,000 inhabitants. Regarding the epidemiological picture of COVID-19, Passo Fundo had a high lethality rate when compared to the other analyzed cities.

Key words: Smart cities, COVID-19, urban health indicators, resilience.

1. Introduction

The most recent crisis triggered by the expansion of COVID-19 (Coronavirus Disease 19) has shown that cities are at the center of major contemporary events, playing an essential role in the control and displacement within space [1]. In this context, Laughland and Zanolli [2] note that people's individual actions and behaviors play an important role in health, but the environments in which they live and the policies adopted to shape opportunities are what actually dictate the choices they make.

Thus, in the current scenario, governments play a key role in the management of urban space, making efforts so that the speed of contamination is in line with the capacity of health infrastructure to absorb the demand. Furthermore, governments are responsible for the continuity of basic public services, often provided in contexts of scarcity of human, technical and financial resources [1].

Initiatives that seek to help build more sustainable and resilient cities have emerged prominently, such as the concept of Smart Cities [3]. This new paradigm is characterized by using ICT (Information and Communication Technology) as a transformation tool in cities, in order to optimize urban dynamics and all the demands that may arise from this situation.

Given the epidemiological framework of COVID-19 which was established in cities, it is considered that data are the weapon to fight the crisis, increasing resilience, as they begin to equip government officials with the necessary tools to manage their cities effectively [1]. In this sense, the application of Smart Cities initiatives and measurements through indicators can be allies in fighting the pandemic.

The term Smart City was coined in the mid-nineties, aiming to conceptualize the phenomenon of urban

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development dependent on technology, innovation and globalization. However, despite the various initiatives on the subject, it is noteworthy that the concept does not have a single or consensual definition, having been approached in various ways [4].

Nam and Pardo [5] emphasize that creating Smart Cities is not about a revolution or a particularly localized phenomenon, on the contrary, it is about evolution, socioeconomic development and it is a global phenomenon. In this sense, the management of a Smart City can be considered the core reason for the transformation of services and innovations in that city, significantly changing the management principles of the urban environment [6].

The management tools and initiatives arising from Smart Cities are mainly evidenced by indicators and rankings. According to IBGE [7] the objectives of urban indicators are to identify variations, processes and trends, as they allow constant monitoring, establishing comparisons, and facilitating the public's understanding of the topic. In this way, the indicators serve as a subsidy for measuring and understanding the status quo of a territory [4].

In Brazil, since 2015, Urban System has annually released the Connected Smart Cities Ranking [8] which ranks the hundred smartest cities in the country. The ranking takes place according to the analysis of 11 main areas or axes, which are composed of a total of 70 indicators.

Currently, the world is living the greatest epidemiological crisis of the century: the pandemic generated by COVID-19. The easy contamination causes the virus to spread exponentially in the urban environment, leaving consequences all along the way.

It is in this context that ICTs, the use of open data, networked systems, and artificial intelligence [9] come into play. The idea is to establish strategies to strengthen protective measures, assess situations of vulnerability, analyze the different groups that may be affected, combat dissemination, and also combine the data with forecasting methods. Furthermore, technological infrastructures must be thought of from the perspective of resilience, as they are decisive not only for the crisis, but also for activities on returning to normality [1].

The idea of future strategies is also defended by Harari [10] who believes that the monitoring of citizens by the government during the pandemic through cameras, drones and algorithms can set a precedent for governments to monitor the health of each individual in order to avoid situations similar to the COVID-19 outbreak. In this sense, monitoring this information and indicators is remarkably important.

Given the scenario presented, from the perspective of Smart Cities, the research aimed to carry out an analysis of urban health indicators in the city of Passo Fundo/RS, using the indicators of medium-sized cities best classified in the Connected Smart Cities Ranking as a reference [8]. In addition, an attempt was made to interrelate these indicators with the epidemiological data resulting from the COVID-19 pandemic.

2. Method and Materials

This work was based on a case study, as it seeks to analyze the context of health indicators in the city of Passo Fundo/RS, using the Connected Smart Cities Ranking as reference [8] along with the interrelationship of these indicators with data from COVID-19. From the main objective proposed in this research, compliance with specific procedures was adopted, resulting in the four steps shown in Fig. 1.

As shown in Fig. 1, steps two and three of the methodology were based on data from the COVID-19 Portal [11] and on the indicators of the Connected Smart Cities Ranking [8].

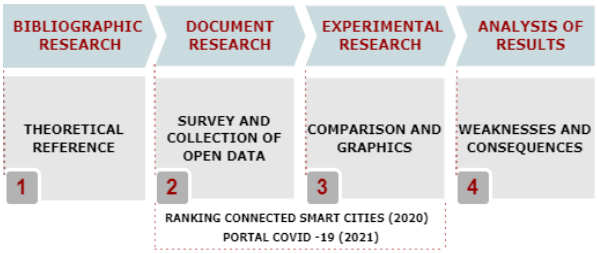

Fig. 1 Steps of the methodological processes.
Source: elaborated by the authors.

Table 1 Health axis indicators RCSC 2020.

Axle	Indicators	Unity	Source
Health	Beds/1,000 inhabitants	#/1,000 inhabitants	Ministry of Health
	Doctors per 100,000 inhabitants	#/100 thousand inhabitants	RAIS (Annual Social Information List)
	Cob. Pop from the Family Health Team	%	Ministry of Health
	Expenses paid for health	R$/Habits	Siconf
	Deaths/thousand live births	#/1,000 live births	Ministry of Health

Source: prepared by the authors based on RCSC 2020.

To apply the methodology, the open data used were collected and collected from official platforms and databases. Table 1 presents the indicators that make up the health axis of the Connected Smart Cities Ranking [8] as well as the measurement unit of each indicator, and the source where open data are collected.

As shown in Table 1, the health axis is composed of 5 indicators. The choice of axis is due to the current epidemiological crisis of COVID-19 that has devastated the world, in order to better understand the context of cities and indicators in this moment of fragility and insecurity.

2.1 Study Object

Located in the northern part of Rio Grande do Sul (RS), Passo Fundo is the main city in the northwest of Rio Grande do Sul. Passo Fundo is a medium-sized city, recognized as an important economic, medical and educational center.

The proposal to use Passo Fundo as the object of the study was made with the aim of verifying at what level the city is in relation to some of the main Smart Cities in the country, according to the Connected Smart Cities Ranking [8]. For this purpose, the four medium-sized cities located in the southern region of Brazil, best classified in the 2020 Ranking, were selected, respectively: Florianópolis, Balneário Camboriú, Itajaí and Blumenau. Table 2 presents the cities, number of inhabitants and the position in the 2020 Connected Smart Cities Ranking.

Table 2 Medium-sized cities in the south region best classified in the RCSC 2020.

	City	Number of inhabitants	Position in RCSC 2020
RCSC 2020	Florianópolis-SC	492,977	2nd
	Blumenau-SC	352,460	19th
	Itajaí-SC	215,895	18th
	Balneário Camboriú-SC	138,792	16th
	Passo Fundo-RS	201,767	-

Source: prepared by the authors based on RCSC 2020.

As shown in Table 2, the cities have a population between 100,000 and 500,000 inhabitants. The capital of Santa Catarina stands out as the largest in number of inhabitants, reaching almost half a million. The city of Balneário Camboriu has the smallest number of inhabitants, with just over 130 thousand.

2.2 Portal COVID-19

The measurement of the population's health status is a tradition in public health that aims to translate into numbers the quantification of citizens' health information [12]. In June 2020 the COVID-19 Portal was created, in this portal it is possible to check the number of confirmed cases, number of deaths, lethality rate, accumulated cases per day, by city, by region, and the total registered in the country In addition, the COVID-19 Portal is interactive, featuring maps and graphs of the epidemiological data of the pandemic [11].

The COVID-19 Portal is maintained by the Ministry of Health, which publishes daily consolidated data on cases and deaths confirmed by COVID-19 registered by the State and Municipal Health Departments from March 27, 2020 to May 13, 2021.

Thus, after studying the health indicators of the Connected Smart Cities Ranking [8] to be used in this research, the selection of cities to be compared, and the time frame of the COVID-19 Portal data to be analyzed, the second stage of the research, which consisted of collecting and surveying open data from the selected cities, was performed. Subsequently, these data were compared (3rd step) followed by the

analysis of the results (4th step), as shown in the following section.

3. Results and Discussions

The application of the methodology resulted in comparative data that were represented in graphics. Health indicators will be presented subsequently to this section. The first indicators presented are "beds/1,000 inhabitants" and "deaths/1,000 live births" presented in Fig. 1.

The results presented in Fig. 1 show that in the indicator beds/1,000 Passo Fundo is the city with the highest index among the analyzed cities, about a third of this percentage. One of the factors that contributed to this satisfactory index is the consolidation of Passo Fundo as a regional health center, housing several reference hospitals and clinics in the state.

As for the indicator of deaths/1,000 live births, the city of Itajaí has the highest rate, with 10.09 deaths for every 1,000 live births. Passo Fundo has a rate of 6.2, an average value compared to the other cities analyzed, and far below the national average, which is 12.35 deaths/1,000 thousand live births [13]. Highlight for the city of Balneário Camboriú, which has only 2.06 deaths/1,000 live births. Fig. 2 shows the data for the physicians per 100 thousand inhabitants indicator.

When we approach the indicator related to the number of doctors per 100,000 inhabitants, the city of Florianópolis-SC stands out, with a high number of doctors, it stands out when compared to other cities. On the other hand, when we approach the city of Passo Fundo in an isolated way, it appears in an intermediate position in relation to the indices presented by the analyzed cities. This may be due to the fact that, in addition to the city being recognized as a regional health hub, it houses several higher education institutions focused on the area of medicine, attracting students and professionals from different parts of the country. Fig. 3 presents the data for the indicator "health expenditures", considering the amount spent in *Reais* with each inhabitant.

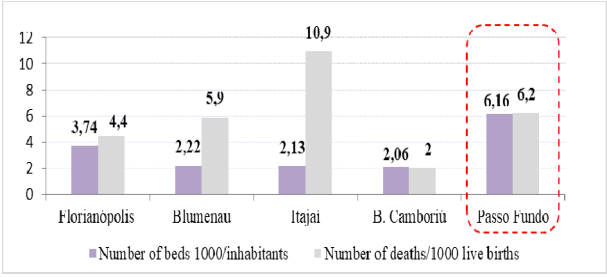

Fig. 1 Data from the indicators "number of beds/1,000 Inhabitants" and "deaths/1,000 live births".
Source: prepared by the authors based on RCSC 2020.

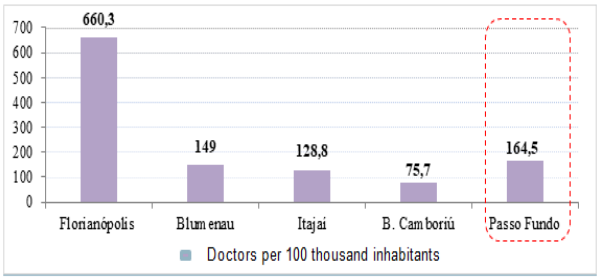

Fig. 2 Data for the indicator "doctors per 100 thousand inhabitants".
Source: prepared by the authors based on RCSC 2020.

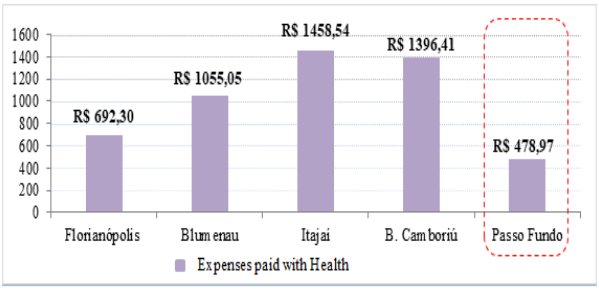

Fig. 3 Data for the indicator "health expenditures".
Source: Prepared by the authors based on RCSC 2020.

According to Fig. 3, when comparing the Smart Cities indexes used as a reference, from the RCSC, with the Passo Fundo index, it is observed that the amount of expenses paid with health per inhabitant in the city of Rio Grande do Sul is lower than the values of the cities of Santa Catarina. The data indicate that there has been a low investment in public health by the municipality. It is observed that the amount paid for health care is about half of the investment in most analyzed cities. It is noteworthy that these expenses cover various sectors of health, from access to drugs, treatments and provision of health services. In the sequence, Fig. 4 is presented.

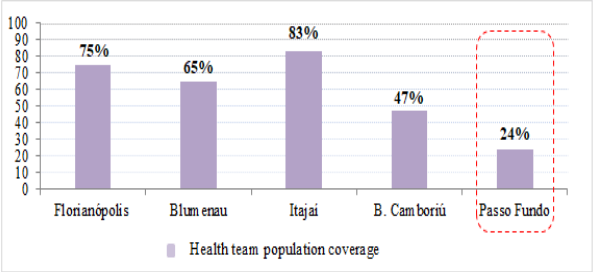

Fig. 4 Data for the indicator "population coverage of the family health team".
Source: prepared by the authors based on RCSC 2020.

According to the Ministry of Health, this indicator is mainly related to the Basic Health Care Program. This program presents actions guided by the principles of universality, accessibility, bond, continuity of care, comprehensive care, equity and social participation [14]. As seen, the coverage of the program in the city of Passo Fundo reaches a level of 24%, a much percentage lower than in the other analyzed cities.

Monitoring by the municipal health team is extremely important, mainly because it allows direct monitoring of patients, following up, giving attention and enabling to strategically act in the early stages of any pathology, avoiding problems and future treatments. In addition, the program aims to democratize access to information, passing on guidance and care, mainly related to health and well-being.

After the presentation and analysis of the health indicators of the Connected Smart Cities Ranking, it was possible to verify that most of Passo Fundo's indices are lower than those of the analyzed cities. The main deficit points shown by the results were in relation to the Population Coverage of the Family Health Team, and in relation to the expenses paid with health per inhabitant.

Following, after measuring and analyzing the health indicators of the Connected Smart Cities Ranking used as a reference, the interrelationship of these indicators with data from COVID-19 will be presented. Table 3 shows the relationship of the number of cases, number of deaths, and the mortality rate of COVID-19 in the same cities compared above.

Table 3 Data from the COVID-19 PORTAL.

DATASUS data—period from 03/27/2020 to 05/13/2021			
City	Total number of contaminated	Number of deaths	Mortality rate
Florianópolis	73,918	960	1.30%
Blumenau	45,087	508	1.12%
Itajaí	25,572	582	2.27%
B. Camboriú	22,323	327	1.46%
Passo Fundo	27,232	464	1.70%
City	Number contaminated 100 thousand inhabitants	Number of deaths 100 thousand inhabitants	Lethal rate 100 thousand inhabitants
Florianópolis	14,755	192	1.30%
Blumenau	12,622	142	1.12%
Itajaí	11,648	265	2.27%
B. Camboriú	15,688	230	1.46%
Passo Fundo	13,397	228	1.70%

Source: prepared by the authors based on the COVID-19 Portal.

Data from COVID-19 presented in Table 3 show Florianópolis as the city with the highest number of infected people with 73,918 cases, and also with the highest number of deaths resulting from COVID-19. Regarding the mortality rate, Itajaí is the city with the highest number of deaths from confirmed cases of the disease. On the other hand, Blumenau presents the lowest mortality rate with 1.12%.

Data from cities were also compared using the ratio of 100,000 inhabitants as a reference. For this purpose, the same data obtained by DATASUS were used and the simple rule of three was applied.

As shown in Table 4, when applying the ratio of the number of contaminated cases, the city of Balneário Camboriú has more cases in a universe of 100,000 inhabitants, reaching a level of 15,688 contaminated. The largest number of deaths is in the city of Itajaí, with 265 deaths. Furthermore, Itajaí also has the highest mortality rate, reaching a level of 2.27%. The city of Passo Fundo had a high number of infected people and deaths, in terms of the mortality rate; the city was second only to Itajaí, with a rate of 1.70%.

From the results presented in the graphs, and from the analyses carried out, it is possible to see the interrelationship of the Smart Cities indicators with

the epidemiological framework of COVID-19. The four cities in the South Region that are best ranked in the RCSC analyzed in this research have presented better health indicators and a lower fatality rate.

Knowledge of information and data is extremely important for planning and managing Public Health, especially in times of crisis, where strategies and alternatives that can help in this process are sought. Furthermore, knowledge of this information provides subsidies for making more assertive and mitigating decisions.

Another important point to be highlighted is the communication channel that Smart Cities tools and initiatives can provide, bringing the public administration and the community closer together, enabling the provision of guidance and information more efficiently. In this sense, programs such as the Family Health Team's Population Coverage are extremely important for monitoring the municipal scenario.

4. Conclusions

This article analyzed the urban health indicators in the city of Passo Fundo. The study used the indicators of the Connected Smart Cities Ranking [8] as a reference, as well as the indexes of the four medium-sized cities in the south region, best classified in this ranking. After this analysis, it was possible to observe that the health indices of Passo Fundo are, for the most part, lower than those of the medium-sized analyzed cities (Florianópolis-SC, Blumenau-SC, Itajaí-SC, Balneário Camboriú-SC), still far from the values needed for it to become a smarter and more resilient city.

The main weakness shown by the results, with regard to the city of Passo Fundo, is the issue related to the Population Coverage of the Family Health Team, not reaching even a quarter of the city's population. This indicator is extremely important, as it allows the monitoring of pathologies, and especially in the issue related to Primary Health Care, which concerns the primary care of patients, as a form of early intervention in the development of diseases.

In a second phase of this research, health indicators were contrasted with data from the current epidemiological crisis at COVID-19. Again, the city of Passo Fundo had negative numbers, with a high mortality rate among the analyzed cities, reaching a level of 1.70%, an index still below the national average, but high when compared to those of the cities classified in the Connected Smart Cities Ranking [1].

Through these results, it was possible to verify that the cities that present better indicators and have Smart City initiatives had a better performance in facing the COVID-19 pandemic. In this sense, the active monitoring of indicators and the use of ICTs can be a great ally in the management and planning of urban spaces, helping to make more assertive decisions and the development of smarter, resilient and sustainable cities.

It is noteworthy that the incorporation of ICTs and open data provide a range of subsidies for better management and planning of cities. Initiatives such as real-time monitoring, integrated network systems, communication channels, applications, smart meters are some of the Smart Cities tools that help consolidate cities with a better quality of life for their citizens.

The application of methodological processes made it possible to compare the health indicators of the cities analyzed in a clear and objective way. Furthermore, the use of open data collected from public bodies facilitates access to this information, while ensuring its veracity. As a limitation of the methodology applied, it appears that, considering that the indicators evaluated are measured quantitatively, often the data collected did not fully reflect the quality of infrastructure/services in the cities. In this sense, the context and variables of the local reality must be considered so that a more reliable reading of urban indicators can be carried out.

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