The first hundred days of COVID-19 in PernambucoState, Brazil: epidemiology in historical context

Cem dias de COVID-19 em Pernambuco, Brasil: a epidemiologia em contexto histórico

Cien días de COVID-19 en Pernambuco, Brasil: la epidemiología en contexto histórico

Wayner Vieira de Souza [1]
Celina Maria Turchi Martelli [1]
Amanda Priscila de Santana Cabral Silva [1,2]
Lívia Teixeira de Souza Maia [2]
Maria Cynthia Braga [1]
Luciana Caroline Albuquerque Bezerra [3]
George Santiago Dimech [3]
Ulisses Ramos Montarroyos [4]
Thalia Velho Barreto de Araújo [5]
Demócrito de Barros Miranda-Filho [4]
Ricardo Arraes de Alencar Ximenes [4,5]
Maria de Fátima Pessoa Militão de Albuquerque [1]

Abstract

The timeline of the COVID-19 pandemic began on December 31, 2019, in China, with SARS-CoV-2 identified as the etiological agent. This article aims to describe the COVID-19 epidemic's spatial and temporal dynamics in the first hundred days in the State of Pernambuco, Brazil. We present the evolution in cases and deaths according to epidemiological weeks. We analyzed the series of accumulated daily confirmed COVID-19 cases, with projections for the subsequent 15 days, using the JoinPoint app. This software allows identifying turning points, testing their statistical significance. We also analyze the trend in the spread of COVID-19 to the interior of the state, considering the percent distribution of cases in the state capital, Recife, municipalities in Greater Metropolitan Recife, and the state's interior, by sets of three weeks, constructing thematic maps. The first hundred days of the COVID-19 epidemic resulted in 52,213 cases and 4,235 deaths from March 12, or epidemiological week 11, until June 20, 2020 (epidemiological week 25). The peak in the epidemic curve occurred in epidemiological week 21 (May 23), followed by deceleration in the number of cases. We initially detected the spread of cases from the city center to the periphery of the state capital and Metropolitan Area, followed by rapid spread to the state's interior. There was a decrease in the mean daily growth starting in April, but with an average threshold of more than 6,000 weekly cases of COVID-19. At the end of the period, the state's case series indicates the persistence of SARS-CoV-2 circulation and community transmission. Finally, paraphrasing Gabriel Garcia Marques in One Hundred Years of Solitude, *we ask whether we are facing "a pause in the storm or a sign of redoubled rain".*

COVID-19; Epidemiologic Factors; Time Series Studies

Correspondence
W. V. Souza
Instituto Aggeu Magalhães, Fundação Oswaldo Cruz.
Av. Moraes Rêgo s/n, Recife, PE 50740-465, Brasil.
wayner.vieira@fiocruz.br

[1] *Instituto Aggeu Magalhães, Fundação Oswaldo Cruz, Recife, Brasil.*
[2] *Universidade Federal de Pernambuco, Vitória de Santo Antāo, Brasil.*
[3] *Secretaria de Saúde do Estado de Pernambuco, Recife, Brasil.*
[4] *Universidade de Pernambuco, Recife, Brasil.*
[5] *Universidade Federal de Pernambuco, Recife, Brasil.*

Introduction

The timeline for the COVID-19 pandemic that the world is now experiencing began on December 31, 2019, with the appearance of cases of severe pneumonia with unknown etiology in the city of Wuhan, China. On January 7, 2020, Chinese health authorities identified the etiological agent of this severe acute respiratory infection (SARI) as the novel coronavirus SARS-CoV-2, and the disease was called COVID-19 [1,2] by the World Health Organization (WHO).

Parallels can be drawn with the Spanish influenza pandemic just over a century ago. In the space of nearly a year from 1918 to 1919, this pandemic, caused by the 1918 H1N1 strain of the virus, resulted in more than 50 million deaths, more than AIDS in the last 40 years [3]. References to the Spanish influenza pandemic have been frequent as the backdrop to the discussion on the speed, intensity, and sufficiency of control measures adopted by each country in the current global health crisis [4]. Ashton [4] emphasizes that failure to study and learn history's lessons leads us to repeat the same mistakes, given that much of the unpreparedness seen in 1918-1919 has been repeated in the COVID-19 pandemic. Among the mistakes made with Spanish influenza, communication with the population is cited as the main one. As an example, the United States government remained silent on the pandemic with the motto "worry kills more than the disease", repeated ad nauseum [5].

On February 3, 2020, through *Ruling MS n. 188* [6], the Brazilian Ministry of Health declared a Public Health Emergency of National Concern. The ruling also created the Public Health Emergency Operations Center (COE-COVID-19) as the management body at the national level, under the responsibility of the Health Surveillance Secretariat [7]. From then on, a surveillance system was assembled to record COVID-19 cases and deaths, and the reference laboratory network was also organized.

In Brazil, the COVID-19 pandemic was characterized by rapid spread, and the current level of scientific knowledge generates uncertainties as to the strategies for confronting the disease, further aggravated by the country's social inequalities [8]. The WHO and others have recommended that the health sector's responses should be structured in stages according to the surveillance of epidemics: containment, suppression, mitigation, and recovery [2,9].

In this epidemic context, conflicts emerged in the management of the health crisis between leaders at the national and regional levels in Brazil, leading to a ruling by the Supreme Court concerning the jurisdiction of states and municipalities (counties) in formulating measures to confront the novel coronavirus, even in opposition to measures recommended by the Federal Government [10]. From the health management perspective, states and municipalities began to define and implement surveillance and control measures according the epidemiological data from their respective areas. Thus, records of COVID-19 cases and deaths at the state and municipal levels have been the object of epidemiological analyses to understand the dynamics of SARS-CoV-2 transmission in specific populations.

In the State of Pernambuco, the responses to the pandemic followed rapidly after confirmation of the first two imported COVID-19 cases on March 12. Two days later, the state published its first decree [11] banning events with more than 50 persons, following by various other decrees, issued in March and in subsequent months, with various types of social distancing measures. These featured the suspension of activities in cultural venues and fitness gyms, total closure of schools, and suspension of commerce and non-essential services, culminating in the 15-day lockdown in Recife, Olinda, Camaragibe, São Lourenço da Mata, and Jaboatão dos Guararapes, starting on May 16. Pernambuco also led other nonpharmacological interventions by decreeing mandatory mask use by the population on May 16, in keeping with the scientific evidence of mask-wearing's effectiveness in preventing the spread of COVID-19 and other viral respiratory infections [12].

Pernambuco reached the hundredth day of epidemic in the state with 52,213 COVID-19 cases and 4,235 deaths, already under flexibilization of social distancing since June 15, even in the absence of indicators to support this reopening, according to recommendation by the WHO [13].

It is thus necessary to reflect on the transmission of this viral infection in Pernambuco in order to describe (from the social perspective) the COVID-19 epidemic's spatial and temporal dynamics in the state in the first hundred days of the epidemic.

Methodology

The study site was the State of Pernambuco, considering the state capital Recife, Greater Metropolitan Recife, and the state's interior. Administratively, Pernambuco is divided into 185 municipalities (counties) distributed in 12 Regional Health Divisions, grouped in Four Health Macro Regions [14]. According to the last population census, the state had 9,496,294 inhabitants, 1,637,834 of which in the city of Recife according to data from Brazilian Health Informatics (DATASUS) in 2018. Greater Metropolitan Recife consists of 14 municipalities and concentrates 42% of the state's population according to the same projections (DATASUS. População residente em Pernambuco. Estimativa populacional. http://tabnet.datasus.gov.br/cgi/tabcgi.exe?ibge/cnv/poptpe.def).

The study analyzes the occurrence of COVID-19 in the state from March 12 to June 20, 2020, (the end of epidemiological week 25), corresponding to the epidemic's first hundred days.

The first approach dealt with the presentation of the evolution of cases and deaths by reporting date, according to epidemiological weeks based on analysis of the historical series of the accumulated daily confirmed cases of COVID-19, with projection for the subsequent 15 days. This analysis was made with the JoinPoint app (https://surveillance.cancer.gov/joinpoint/). Briefly, the software analyzes data from historical series seeking to identify turning points in these curves. JoinPoint is initialized with the minimum number of turning points (for example, 0 points, which represents a straight line) and tests whether more turning points are statistically significant and should be added to the model. This allows the user to test whether an apparent change in trend is statistically significant. The tests of significance use the Monte Carlo permutation method. The models can incorporate each point's estimated variation (for example, when the responses are age-adjusted rates), or use a Poisson variation model, which was used in the present analysis. The models can also be linear in the log of the response ($Ln(y) = \beta_0 + \beta_1 t$), as used here to calculate the change in the daily percent rate [15].

We then proceeded to analyze the evolution in the epidemic's temporal and spatial distribution in the state capital's neighborhoods. This analysis revealed the evolution according to neighborhood strata classified according to living conditions, using head-of-family's income as the indicator, as described in Souza et al. [16]. Four different blocks appeared in this stratification, considering head-of-family's income according the IBGE criteria (Brazilian Institute of Geography and Statistics). The two strata with the best socioeconomic conditions (A and B) included 24 neighborhoods of Recife, while the other two strata (C and D) included 70 neighborhoods. The first two had 306,277 inhabitants and the other two had 1,214,302 inhabitants, according to the last Population Census. The evolution of this spatial distribution of accumulated cases in the state capital, as well as in the other municipalities of Greater Metropolitan Recife, was also represented using point pattern maps with four temporal cross-sections (weeks 12, 14, 16, and 18). Week 18 was the last week for which georeferencing was performed, given the high number of weekly cases that already allowed clearly characterizing the distribution.

Finally, we verified the time trend in the spread of COVID-19 to the interior of the state, analyzing the percent distribution of cases in Recife, the other municipalities of Greater Metropolitan Recife, and the municipalities of the interior in five sets of three-week cross-sections, up to week 25. The procedure was also represented by a thematic map.

Results

As of June 20, 2020 (week 25), Pernambuco had accumulated 52,213 confirmed cases of COVID-19 and 4.235 deaths. Figure 1 shows the distribution of these cases and deaths by epidemiological week.

The figure shows a peak in cases in week 21 with a decrease in the three subsequent weeks, then a new increase in week 25 (June 14 to 20), beginning 14 days after loosening of the 15-day lockdown in five municipalities of Greater Metropolitan Recife that started on May 31.

The analysis of the historical series of the accumulated number of cases per day identified five periods with significantly different growths. Figure 2 shows the models' parameters for each stretch and representation of the series with a projection until July 5.
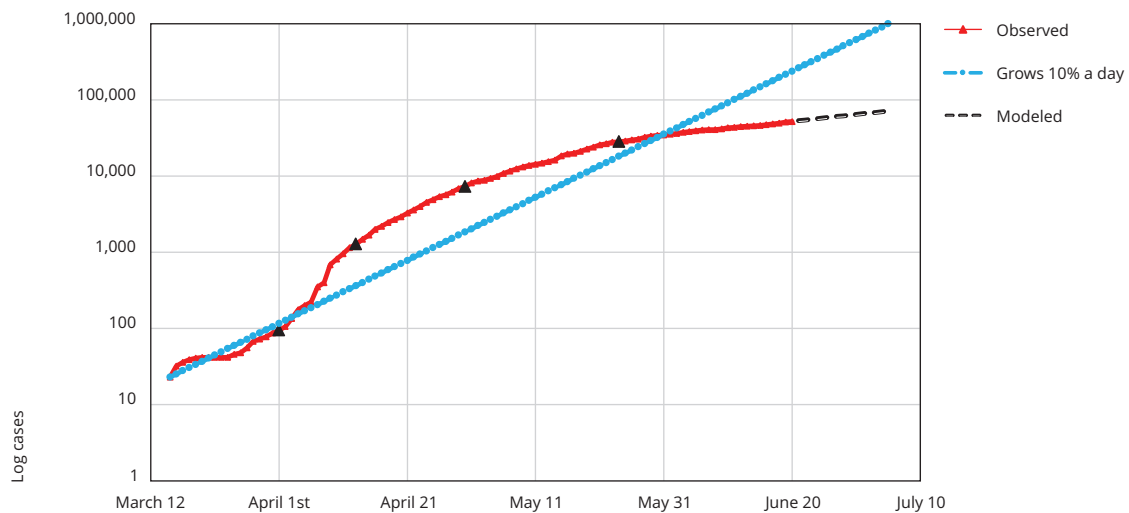
Figure 1

COVID-19 cases and deaths by epidemiological week. Pernambuco State, Braszil, 2020.
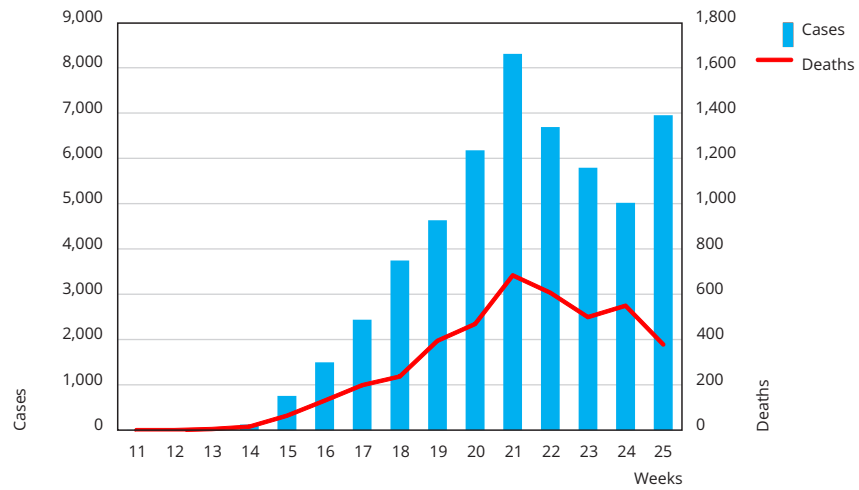
Source: prepared by the authors from data by the Pernambuco State Health Surveillance Division.

Figure 2

Growth models and respective parameters from the Historical Series of accumulated cases per day in Pernambuco State, Brazil, per periods with projection up to July 5.

Period	Intercept	Daily growth % (β)	Standard error	95%CI	p-value
March 15-April 1st	3.3206	6.68	0.0196	2.8-11.2	0.001
April 1st-April 13	0.4249	23.72	0.0145	23.2-30.5	< 0.001
April 13-April 30	4.4963	9.68	0.0026	9.6-10.7	< 0.001
April 30-May 24	6.3497	5.65	0.0007	5.7-6.0	< 0.001
May 24-June 20	8.8381	2.09	0.0003	2.0-2.2	< 0.001

In the early days of the epidemic, the growth curve is aligned with a mean growth pattern of about 10% per day, which represented approximately doubling the number of cases each week. However, the growth in the month of April greatly exceeded that threshold, at a highly worrisome pace in several senses, especially in relation to the installed capacity of hospital beds. Starting in late May, this growth slowed down to a level well below the daily 10% threshold, the parameter used as the reference. As of June 20, Pernambuco had accumulated 52,213 cases, while the model had predicted approximately 48,000 to 58,000 cases. For the end of the projection period, on July 5, the model projected slightly more than 71,000 cases, ranging between 64,000 and 81,000. Thus, by way of updating beyond the hundred days, as of this date, the state had seen more than 65,000 cases, within the range predicted by the model and experiencing a mean threshold of 450 deaths and more than 6,000 cases in the following two epidemiological weeks (weeks 26 and 27).

In the accumulated cases notified as of May 22 with onset of symptoms up to week 18 in the city of Recife, 8,891 COVID-19 cases were confirmed. Based on the above-mentioned stratification of the city's neighborhoods, we found that at the beginning of the epidemic, some 40% of the cases were concentrated in socioeconomic strata C and D, which represent 80% of the population. While in the last two weeks of the target period, only six weeks since the intra-urban spread of SARS-CoV-2, 70% of cases were already concentrated in residents of these socioeconomic strata, with greater social vulnerability, revealing the accelerated spread of SARS-CoV-2 transmission to the city's periphery, as shown in Figure 3.

The epidemic's spread to the state's interior is another fact that appears over the course of the period, characterized by spread to the capital's periphery and its metropolitan area, with progressive spread to all the state's municipalities. At the end of the period, only one municipality in the state had not recorded any cases, but it reported cases just the following week. Figure 4 illustrates this territorial process.

Table 1 shows in three-week strata the evolution, in quantitative terms, of this spread to the state's interior, highlighting that in the last three weeks the municipalities of the state's interior already accounted for more than half of the reported cases, and that when added to the other municipalities in Greater Metropolitan Recife, that accounted for 76% of the cases in the period.

Figure 3

Evolution in the distribution of cases according to periods in neighborhood strata in Recife with onset of symptoms up to epidemiological week 18.
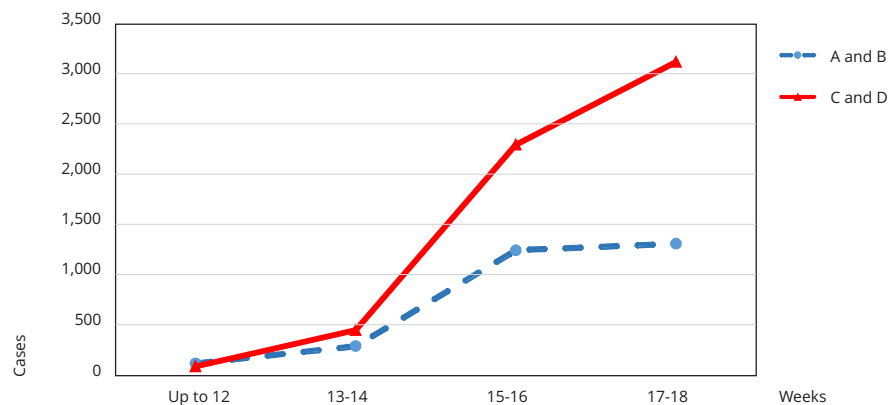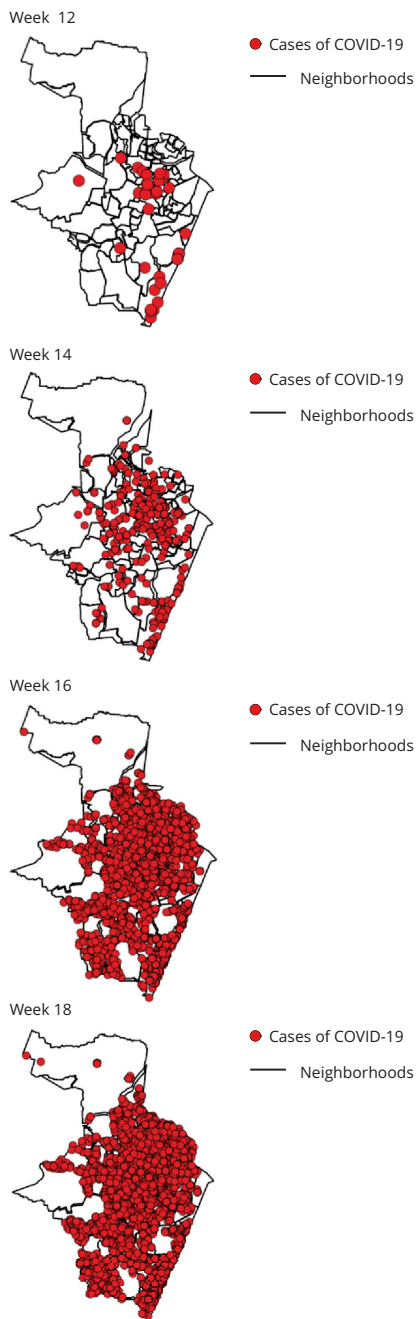

Source: prepared by the authors from data by the Pernambuco State Health Surveillance Division.

Figure 4

Spatial and temporal distribution of COVID-19 cases in the city of Recife, Greater Metropolitan Recife, and State of Pernambuco, Brazil.

4a) Evolution of COVID-19 according to neighborhoods of Recife

4b) Evolution of COVID-19 according to municipalities of Greater Metropolitan Recife
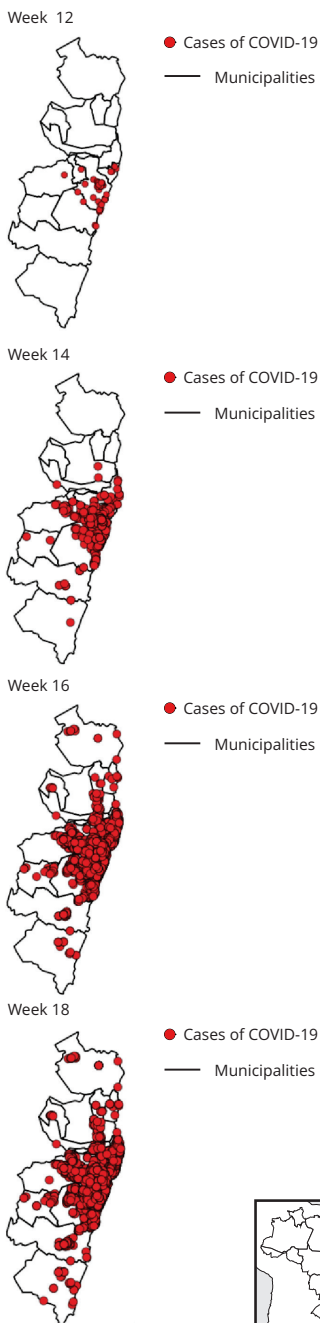
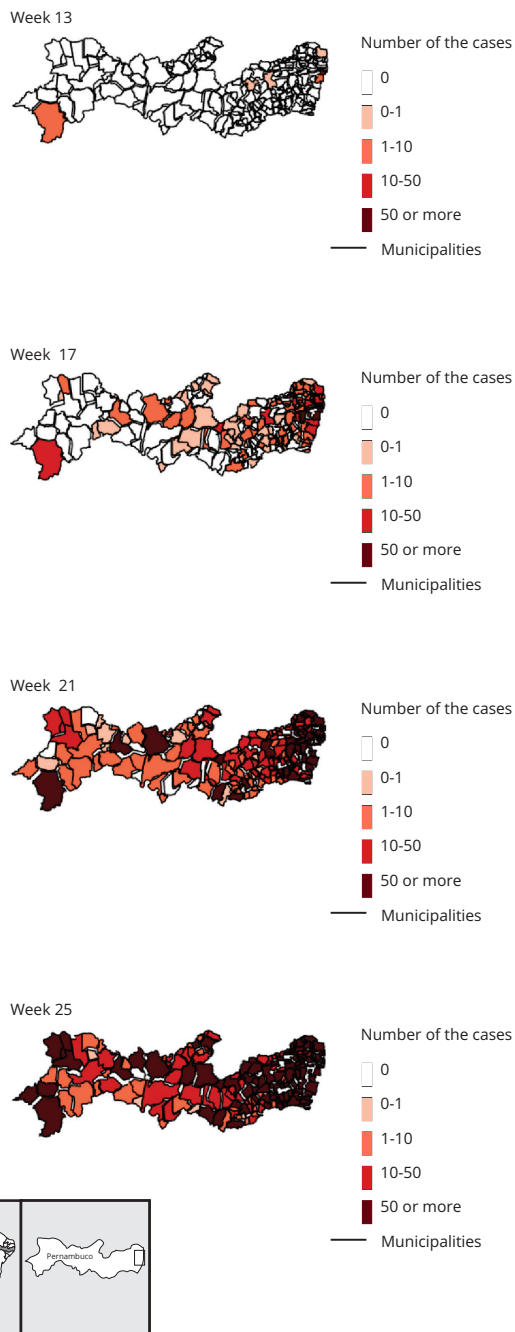4c) Evolution of COVID-19 according to municipalities of state of Pernambuco

Table 1

Distribution of COVID-19 cases in the state of Pernambuco State, Brazil, according to epidemiological week.

Epidemiological weeks	Recife		Greater Metropolitan Recife		Interior		Pernambuco State (N)
	n	%	n	%	n	%	
Up to 13	46	**73.0**	11	17.5	6	**9.5**	63
14-16	1,209	**57.1**	708	33.4	202	**9.5**	2.119
17-19	5,326	53.4	3,369	33.8	1.274	12.8	9,969
20-22	8,584	40.4	6,612	31.2	6,026	28.4	21,222
23-25	4,214	**23.9**	4,062	23.0	9,354	**53.1**	17,630
Total	19,379	38.0	14,762	28.9	16,862	33.1	51,003

Source: prepared by the authors from data by the Pernambuco State Health Surveillance Division.

The same phenomenon was also true of deaths. As of April 18 (week 16), there were 216 deaths, 100 of which (46%) in residents of Recife. In the next nine weeks (17 to 25), there were 3,992 deaths, 2,429 of which (61%) in residents of the state's other municipalities.

Discussion

The first hundred days of COVID-19 in Pernambuco resulted in 52,213 confirmed cases and 4,235 deaths from the disease. Starting on March 12 (epidemiological week 11), the confirmed COVID-19 cases in Pernambuco accumulated, reaching a peak in the curve in the 21st week (which ended on May 23), when the growth began to decelerate and the number of cases per epidemiological week began to decrease, although there was an increase in the number of cases in the last week, ending on June 20. During the period, we first observed the spread of cases to the periphery of the capital and Metropolitan Area, then spreading quickly to the state's interior, reaching nearly all of the state's municipalities.

In Northeast Brazil, the states of Maranhão, Ceará, and Pernambuco were the epidemic's first epicenters. However, this is only an analysis of a short time period, thus subject to changes in the middle and long term, depending on social interactions and adherence to control measures.

Matos [17], offers observations a hundred years after the Spanish influenza pandemic, raising the question of whether we are prepared for this new pandemic. He concludes by warning of the cyclical pattern of influenza pandemics and that despite the high uncertainty, we should always keep in mind that some predictability and that some teachings based on previous experiences are indispensable, such as lessons from pandemics in the last century.

The references for experience with the COVID-19 pandemic may be the Spanish flu (1918-1919), Asian flu (1957), Hong Kong flu (1968), and swine flu (2009) pandemics. Despite the magnitude and transcendence of all these pandemics, the Spanish influenza, called the mother of all pandemics by Honigsbaum [3], provides indispensable elements for our reflection. The Spanish influenza infected half of the world population and took close to 50 million lives. The spread occurred in waves with approximately six-month intervals. The first was in the second quarter of 1918 (spring in the Northern hemisphere), the second was reported as the most severe, in the third trimester (autumn) that same year, and the third was in the second trimester of 1919 (spring) [18].

As in the early 20th century with the Spanish influenza, we do not have a vaccine or specific treatment for COVID-19. The recommendation is for general public health and personal hygiene measures, called nonpharmacological interventions, including social distancing and even isolation of populations, aimed at reducing viral transmission [19].

Davies et al. [20] also make an important contribution with detailed analyses on the effects of different interventions, besides analyzing the effects of these measures on the overload of demand for hospital beds, particularly ICU beds [21].

According to Horton [22], we must constantly employ combined preventive measures, including personal hygiene, mask wearing, a ban on mass events, and social distancing in general. This under-

standing is indispensable and needs to be assimilated and practiced by all those who make decisions at different levels of power. Another observation by the author is the fact that COVID-19 is not socially neutral., affecting the more vulnerable more heavily.

The COVID-19 pandemic has found the Brazilian population in a vulnerable situation, with high unemployment and severe cutbacks in social policies. The approval of *Constitutional Amendment n. 95*, making radical cuts in public expenditures, and the currently implemented economic policies have led to increasingly intense strangulation of funding for health and research in Brazil [8].

This scenario is aggravated to the extent that restrictions on the circulation of persons directly influences access to income by informal and self-employed workers. The confinement directly and immediately threatens families' financial livelihood and survival. This condition is exacerbated by the suspension of school activities, compromising the food and nutritional security of low-income children and adolescents due to the lack of access to food [23].

The current study's results also highlight the more vulnerable populations, manifested by the spread of SARS-CoV-2 from the central neighborhoods to the periphery of Recife, then to the rest of Greater Metropolitan Recife and finally to the state's interior, with fewer available healthcare resources. The results reveal that the epidemic's path mirrors the map of inequality.

However, health is a state policy, as highlighted by the Public Memorandum by the Brazilian National Health Council [24] on April 16, 2020. The memorandum states that the government has prioritized the economic discourse over the population's life, which especially affects the more vulnerable, who suffer the effects more heavily. In this context, the memorandum further emphasizes the fundamental role of the Brazilian Unified National Health System (SUS):

"*...As the body legally responsible for overseeing and monitoring actions by the Ministry of Health and Public Health, we will continue to demand that the Ministry consistently follow the guidelines of the World Health Organization (WHO) and human rights agencies, reaffirming the need for isolation measures, valuing science and clinical and social research based on the social determination of the health-disease process*" [24].

The COVID-19 pandemic has led different countries to develop their strategies to deal with the disease, based on their epidemiological situations and their capacities and available resources. In the case of China, the control practices have included active case searches, strategies for viral suppression and containment, aimed at reducing harms to health and economy in order to allow a return to normalcy. Relying on the population's support for control policies, including the report of confirmed or suspected cases within two hours and contact tracing and isolation in quarantine, it was possible to implement an effective containment strategy that led to a reduction in deaths.

The incorporation of nonpharmacological interventions served to strengthen the measures in epidemiological surveillance by expanding the capacity to reduce case incidence. Such social distancing interventions included the suspension of public transportation, closing of entertainment venues, and a ban on mass events. During periods of loosening of social distancing, active case search and contact surveillance should be maintained to guarantee the control of community transmission. As stated by Ferguson et al. [19], loosening social distancing measures based on trends in short-term surveillance data should be reviewed if a new increase in cases is seen [8,19].

Although we have evidence that starting in April 13 the daily mean growth rates in the accumulated number of cases were decreasing, based on analysis of the series with local regressions, the mean threshold of more than 6,000 weekly cases of COVID-19 in Pernambuco does not allow loosening surveillance. At the end of the hundred days, the state's case series showed stable growth, but still with high numbers of detected cases. The reports indicate that more than 90% of these cases are mild or moderate and do not require hospitalization, which could be explained by the increase in testing of suspected and symptomatic cases (Secretaria de Planejamento e Gestão. COVID-19 em dados. https://dados.seplag.pe.gov.br/apps/corona.html#testes). However, this high weekly average indicates persistent circulation of SARS-CoV-2 in the state.

The discussion on the importance of persevering with surveillance requires a vision with an open focus to really understand our current phase in the pandemic. And this need, alongside the observation that COVID-19 affects the most vulnerable population groups, brings to mind a passage from *One Hundred Years of Solitude* [25] (p. 274), one of the most important works in Latin American and world literature:

"It rained for four years, eleven months, and two days. There were periods of drizzle in which everybody put on his full dress and a convalescent look to celebrate the clearing, but the people soon grew accustomed to interpret the pauses as a sign of redoubled rain".

Has the storm really passed, or are we merely in a pause from the rain?

Contributors

W. V. Souza, C. M. Turchi Martelli, A. P. S. C. Silva and M. F. P. M. Albuquerque contributed in the conception, writing, analysis, and discussion of the results. L. T. S. Maia, M. C. Braga, L. C. A. Bezerra, G. S. Dimech, U. R. Montarroyos, T. V. B. Araújo, D. B. Miranda-Filho and R. A. A. Ximenes contributed in the revision of the text, analysis, and discussion of the results.

Additional informations

ORCID: Wayner Vieira de Souza (0000-0002-0939-9332); Celina Maria Turchi Martelli (0000-0002-2491-0688); Amanda Priscila de Santana Cabral Silva (0000-0003-2337-9925); Lívia Teixeira de Souza Maia (0000-0002-0161-7729); Maria Cynthia Braga (0000-0002-7862-6455); Luciana Caroline Albuquerque Bezerra (0000-0001-6074-6072); George Santiago Dimech (0000-0003-0295-3393); Ulisses Ramos Montarroyos (0000-0001-8967-5693); Thalia Velho Barreto de Araújo (0000-0001-9956-4145); Demócrito de Barros Miranda-Filho (0000-0003-2537-1476); Ricardo Arraes de Alencar Ximenes (0000-0002-9951-8840); Maria de Fátima Pessoa Militão de Albuquerque (0000-0002-4999-4160).

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Resumo

A pandemia de COVID-19 iniciou sua linha do tempo em 31 de dezembro de 2019 na China e o SARS-CoV-2 identificado como agente etiológico. O objetivo deste manuscrito é descrever a dinâmica espacial e temporal da epidemia de COVID-19 nos primeiros cem dias, no Estado de Pernambuco, Brasil. Apresentamos a evolução de casos e óbitos segundo semana epidemiológica. Realizamos a análise da série do acumulado diário de casos da COVID-19 confirmados, com projeções para os 15 dias subsequentes, utilizando o aplicativo JoinPoint. Esse programa possibilita identificar pontos de inflexão testando sua significância estatística. Analisamos também a tendência de interiorização da COVID-19 no estado, considerando a distribuição percentual de casos ocorridos no Recife, municípios da Região Metropolitana de Recife e do interior, por conjuntos de três semanas, com construção de mapas temáticos. Os 100 dias da epidemia de COVID-19 resultaram em 52.213 casos e 4.235 óbitos entre 12 de março, correspondendo se 11, até 20 de junho de 2020 (semana epidemiológica 25). O pico da curva epidêmica ocorreu na semana epidemiológica 21 (23 de maio), seguido por desaceleração do número de casos. Detectou-se, inicialmente, a periferização dos casos na capital e região metropolitana, seguida por rápida disseminação para o interior do estado. Houve redução das taxas de crescimento médio diário a partir de abril, mas com patamar de mais de 6.000 casos semanais de COVID-19, em média. Ao final do período, a série de casos do estado indica persistência da circulação e transmissão comunitária do SARS-CoV-2. Finalmente, questiona-se parafraseando Garcia Marques em Cem Anos de Solidão, *se estaríamos diante de "uma estiagem ou prenúncio de recrudescimento".*

COVID-19; Fatores Epidemiológicos; Estudos de Séries Temporais

Resumen

La pandemia de COVID-19 inicia su línea del tiempo el 31 de dicembre de 2019 en China y el SARS-CoV-2 identificado como agente etiológico. El objetivo de este trabajo original es describir la dinámica espacial y temporal de la epidemia de COVID-19 en los primeros cien días de epidemia, en el Estado de Pernambuco, Brasil. Presentamos la evolución de casos y óbitos según las semanas epidemiológicas. Realizamos el análisis de la serie del acumulado diario de casos de COVID-19 confirmados, con proyecciones para los 15 días subsiguientes, utilizándose la aplicación JoinPoint. Este programa posibilita identificar puntos de inflexión, probando su significancia estadística. Analizamos también la tendencia de interiorización de la COVID-19 en el estado, considerándose la distribución porcentual de casos ocurridos en Recife, municipios de la Región Metropolitana de Recife y del interior, por conjuntos de tres semanas, con unas construcciones de mapas temáticos. Los cien días de la epidemia de COVID-19 resultaron en 52.213 casos y 4.235 óbitos entre el 12 de marzo, correspondiendo a la semana epidemiológica 11, hasta el 20 de juno de 2020 (semana epidemiológica 25). El pico de la curva epidémica ocurrió en la semana epidemiológica 21 (23 de mayo), seguido de una desaceleración en el número de casos. Se detectó, inicialmente, la periferización de los casos en la capital y región metropolitana, seguido por la rápida diseminación hacia el interior del estado. Hubo una reducción de las tasas de crecimiento medio diario a partir de abril, pero con un nivel de más de 6.000 casos semanales de COVID-19 de media. Al final del período la serie de casos del estado indica la persistencia de la circulación y transmisión comunitaria del SARS-CoV-2. Finalmente, se cuestiona, parafraseando a García Márquez en Cien Años de Soledad, *si estamos ante "un periodo de remisión o la antesala de un recrudecimiento".*

COVID-19; Factores Epidemiológicos; Estudios de Series Temporales