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MONITORING OF THE FLU SYNFROME IN FORTALEZA USING QGIS

MONITORAMENTO DOS CASOS DE SÍNDROME GRIPAL EM FORTALEZA COM O USO DO QGIS

MONITORATORIO DOS CASOS DE SÍNDROME GRIPAL EM FORTALEZA COM O USO DO QGIS

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ABSTRACT
Objective: To evaluate the spatial and temporal distribution of flu-like illness cases in the city of Fortaleza. **Methods:** This is a descriptive, exploratory and analytical epidemiological study, with a quantitative approach, carried out using a spatial analysis of flu syndrome data from health centres in Fortaleza - CE, between 2021 and 2023. **Results:** 5938 ILI records were analysed. During the period studied, the annual target was not reached. The viral identification panel showed an increase in cases of unspecified GS, even with the incidence of SARS-Cov-2 circulation and an increase in COVID-19 cases. Females were prevalent in the economically active population. Georeferencing facilitated the monitoring of the spread of SARS, as well as health care for the areas of greatest viral circulation. **Conclusion:** Monitoring flu-like illness facilitated the identification of viral spread and the determination of priority health areas.
Keywords: *Sentinel surveillance; Geographic mapping; Respiratory tract disease.*

RESUMO
Objetivo: Avaliar a distribuição espacial e temporal dos casos de síndrome gripal na cidade de Fortaleza. **Métodos:** O estudo epidemiológico de caráter descritivo, exploratório e analítico, com abordagem quantitativa, realizado por meio de análise espacial dos dados de síndrome gripal das US's em Fortaleza – CE, entre os anos de 2021 e 2023. **Resultados:** 5938 registros de SG foram analisados. No período estudado não houve alcance da meta estabelecida anual. O painel de identificação viral, demonstrou a crescente de casos de SG não especificada, mesmo com a incidência da circulação de SARS-Cov-2 e o aumento dos casos de covid-19. O sexo feminino foi prevalente dentro da população com idade economicamente ativa. O georreferenciamento facilitou o acompanhamento da disseminação das SG, bem como a assistência em saúde para as áreas de maior circulação viral. **Conclusão:** O monitoramento da síndrome gripal facilitou a identificação de disseminação viral e determinação de áreas prioritárias em saúde.
Descritores: *Vigilância de evento sentinela; Mapeamento geográfico; Doenças respiratórias.*

RESUMEN
Objetivo: Evaluar la distribución espacial y temporal de los casos de síndrome gripal en la ciudad de Fortaleza. **Métodos:** Estudio epidemiológico descriptivo, exploratorio y analítico, con enfoque cuantitativo, realizado mediante el análisis espacial de datos sobre síndrome gripal en centros de salud de Fortaleza, CE, entre 2021 y 2023. **Resultados:** Se analizaron 5938 registros de ILI. Durante el período estudiado, no se alcanzó la meta anual. El panel de identificación viral mostró un aumento en los casos de síndrome gripal no especificado, incluso con la incidencia de la circulación de SARS-CoV-2 y un aumento en los casos de COVID-19. El sexo femenino fue predominante en la población económicamente activa. La georreferenciación facilitó el monitoreo de la propagación del SARS, así como la atención médica en las áreas de mayor circulación viral. **Conclusión:** El monitoreo de los síndromes gripales facilitó la identificación de la propagación viral y la determinación de áreas de salud prioritarias.
Descriptores: *Vigilancia de guardiã; Mapeo geográfico; Enfermidades respiratórias.*

INTRODUCTION

Sentinel Surveillance (SS) is a strategic model of monitoring and systematic data collection related to the surveillance of etiologic agents with a relevant role to public

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health, especially those associated with a higher morbidity and mortality cause. The information obtained by model can be applied on a populational scale, belonging to the earlier identification of groups with higher risk to develop severe forms to certain diseases[1-3].

As for this surveillance model, a strategy of Sentinel Surveillance of Flu Syndrome (SSFS) was developed, responsible for monitoring circulation and detection of viruses, as well as the alteration in epidemiological scenarios of respiratory viruses, and relevant information provisions to plan the actions and decision taking[4].

The beginning of SARS-CoV-2 pandemic and the community transmission declaration of covid-19 in 2020, the Health Surveillance Secretary of Health Minister released adaptation to the SSFS system, due to the combined circulation of the new coronavirus, influenza, and other respiratory viruses[5].

The SSFS system in Fortaleza city is reasoned in two important aspects. First, its strategic importance in monitoring, preparation, and response to public health events caused pathogens with clinical importance (influenza, SARS-CoV2, syncytial respiratory virus) with impact directly in populations and health service locations. Second, the importance resides in sharing experiences with other health secretaries, searching for change of knowledge and good practice in the surveillance area and flu syndrome control.

It's fundamental to ensure the quality, reliability and applicability of the data collected, considering the information created of relevance by SSFS to risk management in public health. In this way, the use of geoprocessing tools such as QGIS, can amplify the analytic capacity of the surveillance group, belonging to view and interpretation spatial and time of flu syndrome cases. QGIS application makes the monitoring of case distribution possible, standard identification of geographic spread such as analyses of the evolution of disease over time, subsidizing the strategic decision taking, and the direction of sources to areas with higher vulnerability. Thus, the present study has a goal of analyzing the spatial and time distribution of flu syndrome cases in Fortaleza city, using the QGIS software as the tool in construction of thematic maps, and support to health surveillance.

METHODOLOGY

Epidemiologic study of descriptive, exploratory and analytic model, with quantitative approach, released with spatial and time analyses of data of flu syndrome of Sentinel Unity in Fortaleza – CE, in the year of 2021 to 2023.

Fortaleza city is on the North coast of Ceará State, with a territorial area of 312,353 km². It borders the Atlantic Ocean to the North, Eusebio and Aquiraz cities to the east, Maracanaú, Pacatuba, and Itaitinga cities to the south, and with Caucaia and Maracanaú cities to the west. IBGE data estimate to 2022 a population of 2.428.708 inhabitants, representing 27,61% of the Ceará population (8.794.957 people). According to the IBGE census, Fortaleza exceed Salvador amount inhabitants, turns on the third city most populated from Brazil[6]. The town is divided into 121 districts distributed in 6 health regions named Health Regional Coordination – CORES[7].

The search was executed respecting the Ethical principles according to Resolution of Health National Council nº 466, December 12th of 2012, upon being presented to the Ethical Committee of Search of State University of Ceará – UECE, with approval by report nº 6594786 and Presentation Certificate of Ethic appreciation nº 71322123.7.0000.5534, December 27th of 2024.

DATA COLLECTION

The secondary data of Information System of Epidemiologic Surveillance of Flu (SIVEP-Flu)was used, with information of Flu syndrome cases collected in Sentinel Unities in Fortaleza between the years of 2021 to 2023. The data was extracted from notification registers in SIVEP-Flu, supplied by the Municipal Health Secretary of Fortaleza with Data Base File (DBF) format, not nominals, and by the National Register Health Establishment (CNES), after, it was organized and analyzed in Microsoft Excel® sheet version 18.0.

The georeferencing construction used was QGIS software version 3.22.8, free access, open source-code, multiplatform system of geographic information belonging to view, editing and analyzing of georeferenced data.

GEOREFERENCING ANALYSIS

Quantum GIS (QGIS) free software and Geographic Information System (SIG) were used to create maps. Kernel's estimator was used to create warmth maps representing the spatial density of registers. This estimator endeavors to view areas with higher concentration of occurrence about one event, providing an interpretation most intuitive of geographic standard observed through color gradient. In this case, the notification data of flu syndrome was plotted on map by QGIS demonstrating higher and smaller areas with case incidence by color gradient.

Color gradients classify high, middle, down areas of concentration of Flu Syndrome cases (SF), to the green gradient – down cases concentration; yellow gradient – middle cases concentration; and red gradient – high cases concentration. One case was representative of one red point, while that purple color identifies the division between districts from Fortaleza.

Georeferencing was analyzed excluding the white fields or marked such as NA (not available) or presenting inconsistency in the notification data. After the filter process, 5380 registers were considered valid to analyze. Sentinel units were identified through the address that an individual lives in, and by geographic coordinates.

Six Health Regionals of Fortaleza were considered in the georeferencing analysis, a better detail for each Regional, highlighting the districts and consequently the points with areas of higher necessity of monitoring and intervention in public health. The maps were segmented, numbered and identified for each Regional (I to VI) belonging to a comparative analysis of regional areas within the CORES zone.

RESULTS

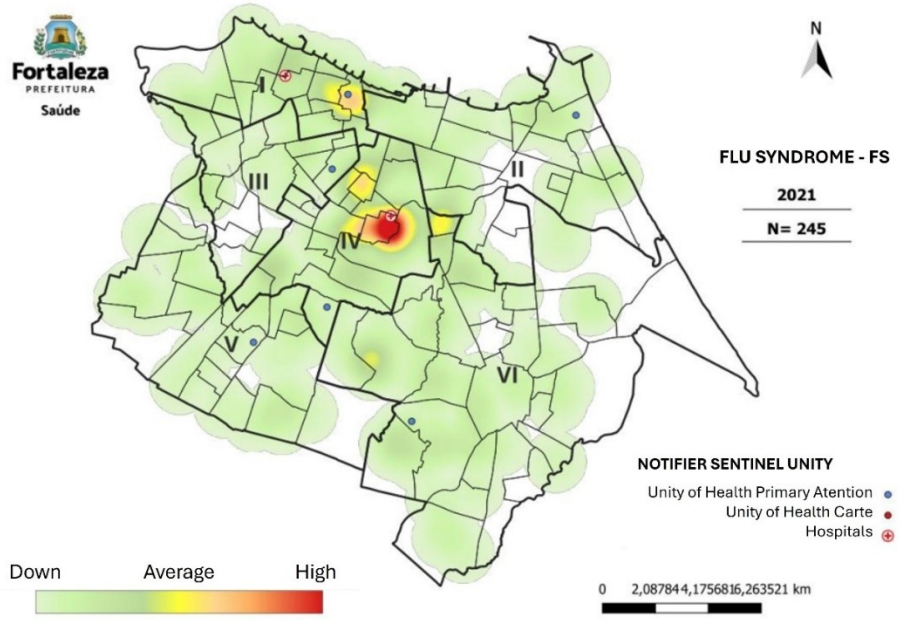
Data analysis of SIVEP-Flu from the years of 2021 to 2023 demonstrates variation in percentage of notifications by Sentinel Unity in relation to yearly target

established in 2021 (240 samples), in 2022 (480 samples), and in 2023 (960 samples) include UPAS (Primary Attention Health Units), Children hospital, and UPAS (Service Prompt Units). 5939 registers were evaluated for the studied period, only one register was not referent to Fortaleza city. The agreed targets for the years of 2021 and 2022 were not reached, therefore, the classification was unsatisfactory. In 2023, the classification was regular.

GEOREFERENCING

The maps constructed by QGIS were representative of the spatial distribution of FS cases in Fortaleza, identifying areas with down cases concentration by units. The Warmth map helped to view the regions most affected by FS for a long period of search, facilitating the identification of viral spread standard, as well as the determination of public health actions priority areas.

Figure 1 - Notified cases of Flu Syndrome by Sentinel Unities, according to residence and georeferencing, in Fortaleza/CE - 2021



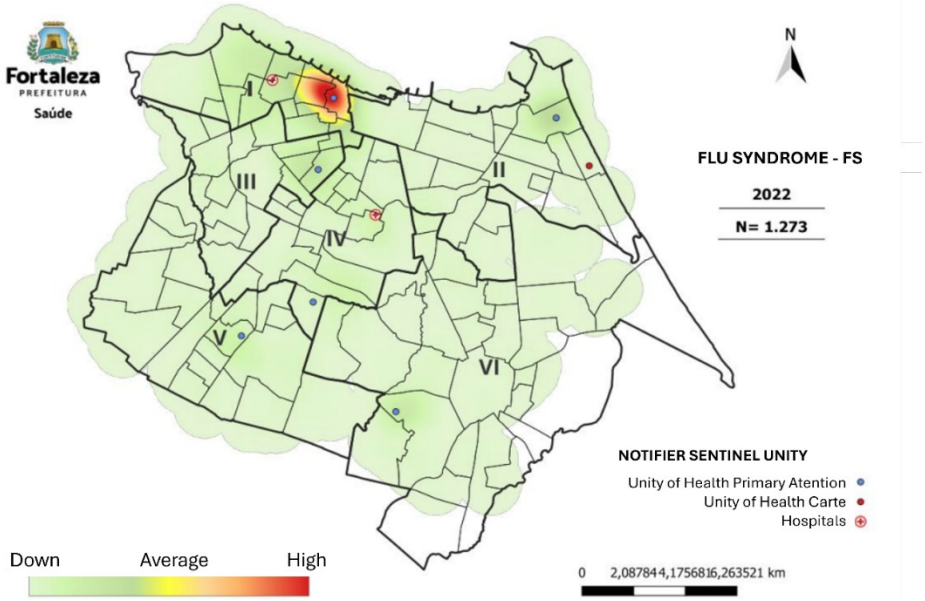
Source: SMS/CEVEPI/CIEVS/SIVEP-Flu

The IV and II regions demonstrated high density of notifications in Notifying Sentinel Units; however, it was perceived that the distribution of Notifying units is homogeneous, with high concentrations in central and north regions associated with the populational density, and proximity to the Health Unit. It was observed that a notification concentration to the I and IV Regional, justified by presence of two children's hospitals located in this CORES.

The sample collection was done in 124 districts in Fortaleza, and it was observed that I and II CORES had higher case concentrations justified to be a region habited densely (PPA, 2022), soon, FS cases had concentrations of covid-19 too, mainly around HIAS-SU and Anastácio Magalhães UPAS in 2021, but the Carlos Ribeiro UPAS had

capacity to identify SARS-CoV-2 in the collected samples.

Figure 2 - Notified cases of Flu Syndrome by Sentinel Unities, according to residence and georeferencing, in Fortaleza/CE – 2022

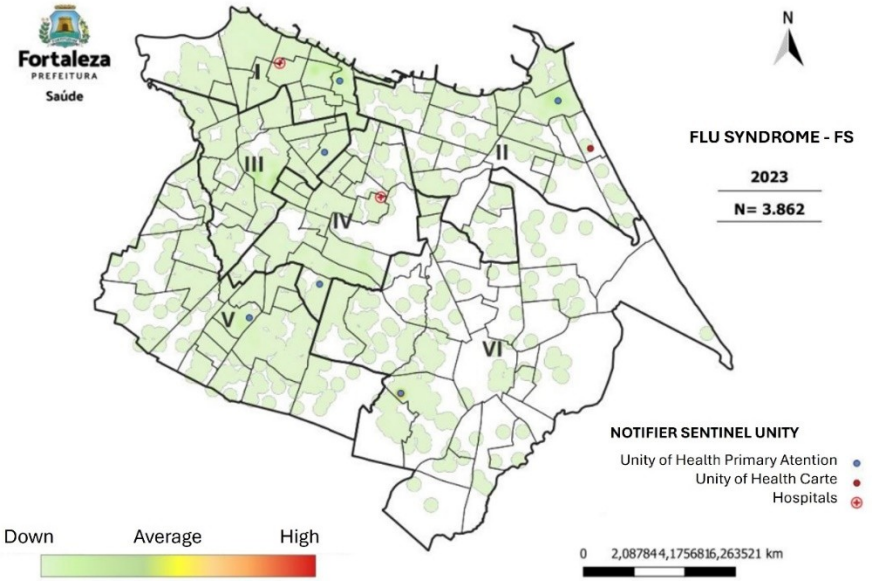


Source: SMS/CEVEPI/CIEVS/SIVEP-Flu

In 2022 the SU it was possible to identify 1273 cases of FS with geographic distribution in 6 regions in town. The VI, V, IV, II, and I Regional presented down case concentrations, with a difference between the case numbers and health regions in specific areas of regions, next to the border with mainly III regional. The III regional had high concentrations of FS cases caused by the presence of commerce points, transport stations, and high populational density, but it was possible to identify the Health Primary Attention Unit, Prompt Service Unit, and hospitals in the neighborhood, suggesting a strategic conduction of health services in areas with higher affected populations (Figure 3).

In 2023, 3862 cases of FS were captured and notified by SU geographically distributed in six administrative regions in the city. The light green color on map was indicative of lower case concentration of FS, with samples collected of homogeneous form in VI, IV, III, and II. In 2022, III Regional presented high case concentrations of FS with reduction of case numbers in 2023. It was observed that the location of Health Primary Attention Units (UPAS), Prompt Service Units (UPAS), and hospitals were located strategically to attend areas most affected for FS, although the distribution of cases has been diffused in relation to year 2022 (Figure 3).

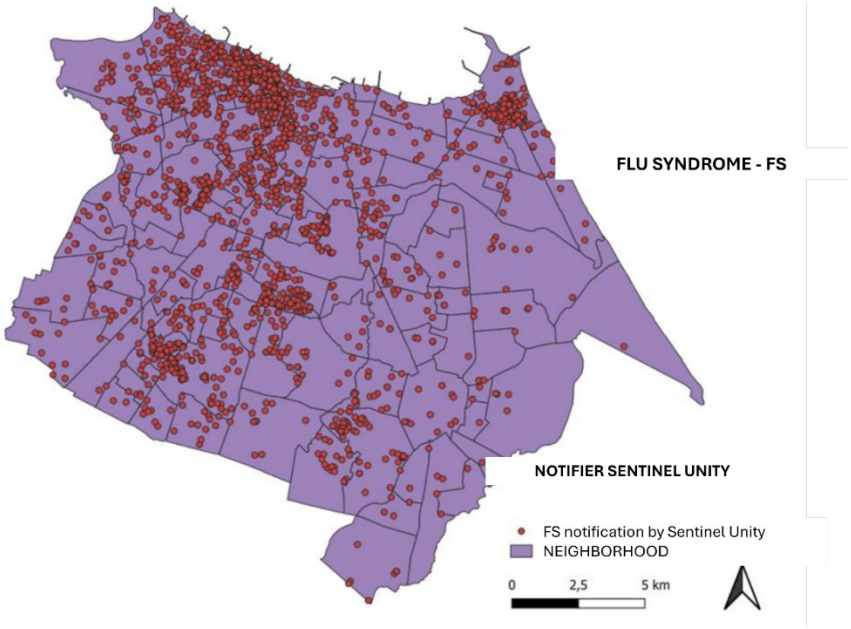
Figure 3 - Notified cases of Flu Syndrome by Sentinel Unities, according to residence and georeferencing, in Fortaleza/CE – 2023



Source: SMS/CEVEPI/CIEVS/SIVEP-Flu

Fortaleza presented a high concentration of FS cases from 2021 to 2023 in the north and central areas, next to the coast with areas densely inhabited. South and Southeast regions presented a dispersed distribution of FS cases, with down notifications observed in anterior maps, and directly related with localization of Sentinel unities, suggesting a possible association of factors contributing to areas with high populational density searching for health services (Figure 4).

Figure 4 - Spatial distribution of notified cases to Flu Syndrome in Fortaleza, in period 2021 – 2023



Source: SMS/CEVEPI/CIEVS/SIVEP-Flu

DISCUSSION

Sentinel Surveillance (SS) works with weekly targets, and their information was evaluated according to the standard collect numbers in technical notes and guiding documents of the Health Minister[8], but for understanding and monitoring of FS cases in Fortaleza, we choose to demonstrate yearly targets. SS implantation increased during the studied period not differing the quantitative and collection of samples observed in other States of Brazil.

When comparing with other cities in the Northeast from Brazil, Paraíba presented the quantitative of 5 SS logged in SIVEP-Flu distributed in João Pessoa, Campina Grande, and Monteiro cities with standard collection of 20 samples. Viral screening identified the increase of syncytial respiratory viruses, influenza, rhinovirus, and adenovirus circulating when compared to the year 2022[9]. Distrito Federal in the same year presents common trends such as Fortaleza in the increase associated with covid-19, as well as graded reduction to next years[10].

The SS enhances the role identification of the panorama of circulating viruses. This monitoring of respiratory viruses using strategy of sampling distributed for territories differently belongs to a systematic collection of data about the occurrence of viral infections in population divers, and geographic regions, contributing to the extensive understanding of viral epidemiology, understanding each scenario, such as the pandemic, distribution of material, health professionals, and input interfere in the detection and monitoring of data.

The SS facilitates the collaboration between health sector differences such as epidemiologic, laboratory, and clinical, promoting a coordinated response to strengthen against viral threat. An integral approach is essential to strengthen the health systems and promote a fast and efficient response to sanitary crises potential. Therefore, the SS doesn't only identify the circulating virus panorama but also become a fundamental tool to protection of public health in local and global levels[11].

SARS-CoV-2 pandemic brings many challenges to health services with work overload to block and management of infected individuals, as well as evidenced the fragility in screening and identification of circulating respiratory viruses[17,18]. Demonstrated by a number of FS not specified, that same the reality was the prevalence of covid-19 in population, justified by viral dynamic to change in new variants most infectious[19], and the circulating of other respiratory viruses such as influenza[20], suggesting the need of improvement in diagnostic precision, since the flu symptoms presence are common to respiratory infections of diverse types.

Genomic monitoring, although with gaps, is fundamental to the viral dynamic understanding and identification of new variants. The absence of consistent registers about the variants in Fortaleza can upset the capacity of health system fast for adaptation, as the occurrence in other regions in Brazil, such as São Paulo and Bahia that amplify the sentinel unities cover to monitoring the viral circulating way were mostly diferrent[21], not enough registers were located referring to the subgroups and viral strains.

Data analysis about causes of flu syndrome also suggests the importance of epidemiologic surveillance to think about the viral dynamics. The predominance of not specified FS cases can indicate a necessity improvement in the diagnostic precision as suggested by authors Kelin and cols[14]. Variants Evolution of SARS-CoV-2, increase of influenza, rhinovirus, and syncytial virus cases, and circulation of new respiratory viruses in the last years, reinforce the epidemiologic scenario complexity.

SS strategy contributes to a fast response to outbreak and viral variant identification allowing a constant adaptation of public health necessity. Though, an efficient approach needs a continuous capacitation of health professionals with integration of different data sources, such as laboratory, clinical, and epidemiological. Besides that, the improvement of information systems about reinfection and amplification of samples collected in SS with down performance can improve the representative and the data quality.

Proportion models between SS units and inhabitants number suggest the units number is enough to achieve ideal coverage, although the increase of sentinel units for a long year have represented a progress. The study carried in 2024 about the organization the SS in Brazil points to a population representative with a consistent geographic coverage[20]. In Fortaleza, according to current sources of Data SUS in Information technology to SUS services, the capital in 2024 had 2574,412 people registered, therefore in agreement with sentinel units proportion for each 500,000 inhabitants and result the SS in the representativity attribute[22].

The necessity to amplify the sentinel unit number and a more equal distribution of collection points are a prominence in scientific literature[20], pointing to amplification of sentinel units coverage is fundamental to ensure better representativity of the population, and consequently to improve the monitoring and detection of respiratory diseases. In Fortaleza city, just the amount of sentinel units the representative contemplates will be necessary for a reconstruction to collect target, monitoring and data quality.

CONCLUSION

QGIS tool allowed better monitoring of the flu syndrome cases in Fortaleza, making the views of affected regions possible and facilitating the identification of viral standard dissemination, and the priority action area in public health.

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