Territorialization using georreferencing and stratification of the social vulnerability of families in Primary Care

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Abstract *This article describes a process of territorialization undertaken in Family Health Strategy micro-areas by a team of residents from the Interprofessional Public Health Residency Program at Cariri Regional University using georeferencing tools and the stratification of families according to degree of social vulnerability. A map of social vulnerability was created using SW Maps and Google Earth Pro based on sociodemographic and clinical data obtained from forms A and B of the e-SUS and inputted into an Excel worksheet. The families were stratified into five degrees of vulnerability based on the overall score obtained for a set of socioeconomic and clinical sentinel indicators: without risk, low risk, medium risk, high risk and very high risk. During the territorialization process, we identified streets and side streets and georeferenced points of risk, social facilities, registered and unregistered families, and vacant homes. Over half of the 615 georeferenced families (316 or 51.38%) were not registered in the e-SUS or had not completed their registration at the time of data collection. Most of the 299 registered families (60.53%) were classified as being at low risk and a considerable portion were medium risk.*

Key words *Geographic mapping, Primary Health Care, Social problems*

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Introduction

Considered the front door of Brazil's national health service, the Unified Health System (SUS, acronym in Portuguese)[1], cornerstone of the Health Care Network and first level of care within this network[2], primary care, also called primary health care, consists of a set of actions developed by an interprofessional team assigned to a territory aimed at making a positive impact on population health[1].

The division of family health teams into local health areas ensures the comprehensiveness of health actions based on situation assessments, establishing stronger affiliation and promoting better health care. Territorialization is one of the main intervention instruments used in the Family Health Strategy (FHS) to implement health surveillance actions[3,4], enabling health managers and professionals to gain an understanding of the specific social characteristics and health needs of an area[5] by recording family and geographic data used to plan disease prevention and health promotion actions[6].

To improve the analysis and assessment of public health data, professionals can combine territorialization with the use of geographic information systems (GIS)[7], which enables the processing of georeferenced data with high data integration and processing power[8]. According to the Pan American Health Organization (PAHO), GIS technologies are one of the most effective tools for supporting public health decision-making[9].

The computerization of primary care is a key strategy for automating processes and improving information management in various countries[10]. With the aim of restructuring the national Primary Care Information System (PCIS), in 2013, the Ministry of Health produced a number of software systems (e-SUS APS or e-SUS primary health care), including the Simplified Data Collection (SDC) system[11]. The e-SUS APS forms, including the individual and household registration forms, are paper forms that make up the SDC and feed this computerized system[12].

The analysis of e-SUS forms can help determine the social and health risk of registered families, showing the propensity to illness of each family unit based on the definition of sentinel indicators and risk scores, as proposed by Coelho-Savassi's Family Risk Scale[13]. This scale provides a simple, clear and easy-to-use tool for prioritizing home visits according to degree of family risk and micro-areas of greatest need[14].

The risk stratification model developed by the Interprofessional Public Health Residency Program (IPHRP) at Cariri Regional University (URCA, acronym in Portuguese) articulates education, health service and community processes. Created by residents working in primary care centers (PCCs) in Crato, Ceará, this health surveillance model uses data on social and environmental determinants of health collected during the territorialization process and from the stratification of family risk[15].

Based on this information, epidemiological maps are created showing family distribution according to risk. Using technology tools, situation rooms are then created in PCCs and ecosystem indicator and planning frameworks are constructed to guide health actions[15]. This article describes a process of territorialization undertaken in FHS micro-areas by a team of IPHRP residents using georeferencing tools and the stratification of families according to degree of social vulnerability.

Methods

We conducted a quantitative descriptive study applying georeferencing technology and performing the stratification of the social vulnerability of families based on socioeconomic and clinical sentinel indicators. The study was conducted during a process of territorialization undertaken between March 2019 and March 2020 by the third class of URCA's IPHRP in FHS micro-areas in the Parque Grangeiro II neighborhood in Crato, Ceará.

Site visits were made to micro-areas by the class and the community health worker (CHW) responsible for each respective area. Family health teams consist of a doctor, nurse and nursing technician, four CHWs, an administrative assistant, and general services assistant. Georeferencing tools were used to gain a more in depth knowledge of the areas and classify registered families according to degree of socioeconomic and clinical vulnerability.

The study was developed in two stages. The first stage was conducted between April and September 2019 during the territorialization of the four micro-areas: Micro-area I (Vila Gregório and Vila Pedrosa), Micro-area II (Vila Nova), Micro-area III (Sítio Coqueiro), and Micro-area IV (Sítio Caiana).

We used the free Android GIS mapping app SW Maps, which enables users to load shapefiles, symbolize attributes, navigate, collect data manually or using a GIS device, and export and share information[16]. Using latitude and longitude co-

ordinates, locations were georeferenced by adding points. These points were then exported to Google Earth Pro, creating a georeferenced map of the territory. Google Earth Pro is a cutting edge technology that provides a 3D image of any location around the world[17].

In the second stage, we analyzed the sociodemographic and clinical characteristics of registered families using data from the e-SUS individual and family registration forms. The data were inputted into a Microsoft Excel worksheet and the families were stratified into five degrees of vulnerability based on the overall score obtained for the socioeconomic and clinical sentinel indicators shown in Chart 1: without risk, low risk, medium risk, high risk, and very high risk (Chart 2).

The study was approved by URCA's research ethics committee.

Results

The Parque Grangeiro II family health team works in four micro-areas, each with one CHW: Micro-area I (Vila Gregório and Vila Pedrosa), Micro-area II (Vila Nova), Micro-area III (Sítio Coqueiro) and Micro-area IV (Sítio Caiana). Micro-area IV is a semi-rural area, while Sítio Coqueiro is totally rural. The areas located furthest from the PCC are micro-areas III and IV.

During the territorialization process, the team identified the area's streets and side streets and georeferenced points of risk, social facilities, registered and unregistered families, and vacant homes. The results are shown in Chart 3.

Over half of the 615 georeferenced families (316 or 51.38%) were not registered in the e-SUS or had not completed their registration at the time of data collection, even in areas closer to the PCC. The registered families were classified into five degrees of vulnerability based on the socioeconomic and clinical sentinel indicators. Figure 1 is an image taken from Google Earth Pro showing the degree of vulnerability of the families in the four micro-areas.

The majority of the 299 families registered using e-SUS forms A and B (60.53 %) were low risk and a considerable proportion were medium risk (Chart 4). The variables of the socioeconomic sentinel indicators that contributed most to family risk (Chart 1) were rudimentary septic tank (44.14% of families), followed by dirt road access (42.47%) and chlorinated water (34.44%). Monthly household income per capita varied considerably across micro-areas. In micro-areas I and II, 49.10% and 45.67% of the families, respectively, had a per capita monthly income of up to R$ 238.00, compared to only 10.93% in micro-area III and 23.80% micro-area IV.

The most frequently occurring variables of the clinical sentinel indicators among the 935 registered service users were drinking (14.97%), high blood pressure (13.90%) and diabetes (4.38%).

Discussion

A considerable number of points of risk were identified during the territorialization process, including open-air sewers, wastelands, and abandoned houses. These points pose a public health and safety problem due to the accumulation of household and building waste and standing water, creating potential breeding grounds for mosquitos such as *Aedes aegypti*, which transmits a number of arboviruses (dengue, Zika, chikungunya and yellow fever). These areas also provide places for criminals to hide after *committing a crime*[18].

The research team also georeferenced a number of polluted points of the River Granjeiro, the municipality's main river, which begins in the Chapada do Araripe and empties into the River Batateiras[19], including: building waste and other items along the river, flooding (especially during rainy periods), and disposal of household wastewater directly into the river due to lack of adequate sanitation facilities. The pollution of aquatic ecosystems, deforestation, and urban sprawl, including the illegal occupation of areas close to water courses, dramatically transform natural environments, resulting in major social and environmental impacts[20].

Another important finding was the lack of social facilities, which requires special attention from local public managers responsible for the design and implementation of the city master plan to expand existing facilities or create new services, including schools, crèches, pharmacies, dentist clinics, gyms, parks, laboratories, and public telephones.

Neves[21] points out that the fact that criteria related to the planning of urban community facilities are defined in city master plans means that these services are unsustainable, not very accessible, poorly designed and distributed, and based on the reality of other municipalities rather than local needs[21].

Chart 1. Scores for each socioeconomic and clinical indicator and criteria for scoring per capita income.

Socioeconomic sentinel indicators	Variable	Score
Living conditions	Homeless	2
Type of access to the household	Dirt road/waterway	1
Electricity	No	1
Room/household member ratio	<1	1
Room/household member ratio	<0.3	2
Predominant construction material	Unrendered brick/wattle and daub/ reused material/thatched	1
Drinking water supply	Chlorinated/untreated water	1
Wastewater disposal	Rudimentary septic tank/directly into a river, lake or the sea/open air	1
Waste disposal	Burning/burying/open air	1
Presence of a carer for illiterate elderly person	Yes	1
Children left alone or under the care of another person	Yes	1
Clinical sentinel indicators	**No of cases**	**Score**
Child (children) aged 0 to 2 years/pregnant woman (women)/people who drink/with high blood pressure/ diabetes/cardiovascular risk/kidney disease/respiratory disease/Hansen's disease/tuberculosis/aged over 80 years	1	1
Disabled person(s)/drug users/people with cancer/ people with mental health problems/bedridden people	1	2
Monthly family income	**No household members**	**Score**
1/4 minimum salary	2	1
1/2 minimum salary	3	1
1 minimum salary	5	1
2 minimum salaries	9	1
3 minimum salaries	13	1
4 minimum salaries	17	1

Source: URCA IPHRP.

Chart 2. Degree of family risk based on overall scores.

Degree of risk	Score
Without risk	0
Low risk	1-3
Medium risk	4-6
High risk	7-8
Very high risk	9-10

Source: URCA IPHRP.

Community facilities include educational, cultural, health, leisure and other similar facilities[22]. It is important to highlight that the only school in the territory is a disused facility in Sítio Coqueiro, meaning that students have to travel to areas outside the territory, which is a factor that discourages enrollment and permanence of pupils at school[23]. The accessibility of public facilities is related to the characteristics of the territory, because people's behavior is influenced by their surrounding environment, which can facilitate, inhibit or define actions[24].

Places for physical activity in the territory are limited to a few football pitches, private sports grounds and the residents' association in Vila Nova, where the physical education intern is developing a project for women offering physical exercise and muscle relaxation workshops and conversation circles to promote self-care. The lack of social facilities to promote physical exercise, such as football grounds, gyms and *recreational clubs,* has a direct effect on community

Chart 3. Georeferenced points of interest in Parque Grangeiro II. Crato-CE, Brazil, 2019.

Georeferenced points	Vila Gregório/ Vila Pedrosa	Vila Nova	Sítio Coqueiro	Sítio Caiana	Total
Streets and side streets	17	14	*	*	*
Points of risk	66	21	21	55	163
Social facilities	05	03	06	04	18
Families registered in the e-SUS	112	81	42	64	299
Families not registered in the e-SUS	149	66	58	43	316
Number of individuals with completed e-SUS registration	362	253	139	181	935
Vacant homes	06	08	14	21	49

*These areas are rural, meaning that some places do not have street/side street names.
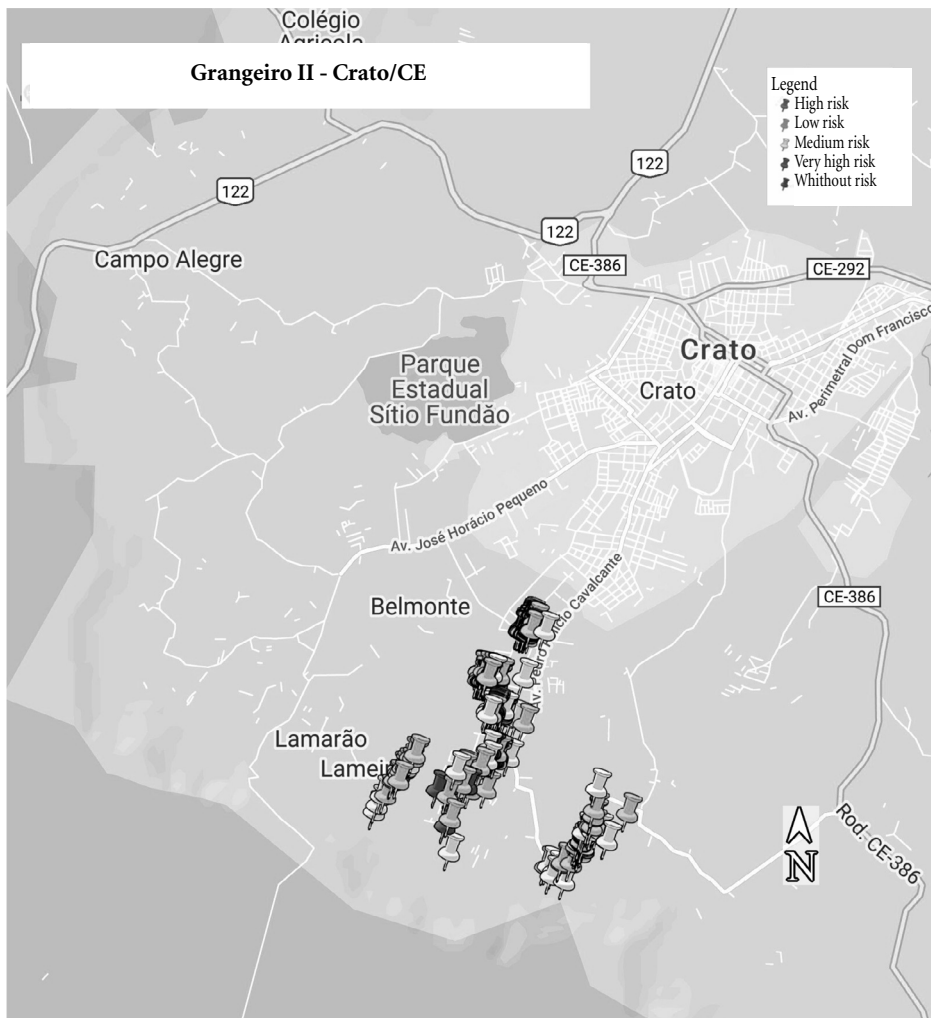
Source: Authors' elaboration

Figure 1. Social vulnerability of families registered in the e-SUS in FHS micro-areas in Parque Grangeiro II. Crato-CE, Brazil, 2019.

Source: Authors' elaboration.

Chart 4. Social vulnerability of families in the FHS micro-areas in Parque Grangeiro II by area. Crato, CE-Brazil, 2019.

Degree of risk	Vila Gregório/ Vila Pedrosa	Vila Nova	Sítio Coqueiro	Sítio Caiana	Total	%
Without risk	0	0	0	9	9	3.01
Low risk	67	55	27	32	181	60.53
Medium risk	38	25	11	22	96	32.10
High risk	06	1	3	1	11	3.67
Very high risk	1	0	1	0	2	0.66
Total families	112	81	42	64	299	

Source: Authors' elaboration.

health, leading to the development of chronic diseases.

The 2017 National Primary Care Policy (NPCP) provides that all primary care professionals are responsible for registering families and individuals and updating the registration and other individual/family health data in the primary care information system, highlighting that CHWs are responsible for registering all people in their respective area and keeping their data up to date through home visits[1]. Despite the importance of family records for conducting situation assessments, less than half of the georeferenced families had completed their registration in the e-SUS at the time of the study, thus hampering data collection.

One of the various reasons that may explain the low level of registration is the fact that the territory has a large number of *upper-income households. These families tend to have* private health insurance and therefore do not seek public health services. A study conducted by Baralhas and Pereira[25] showed that challenges faced by CHWs include services users with insufficient time to receive home visits and the refusal of visits by others due to a lack of understanding of the role played by these workers in disease prevention and health promotion.

Out of date family records are common in other PCCs, such as those in Salinas in the north of the State of Minas Gerais, where this issue was defined as a priority problem in FHS micro-areas in the Floresta I neighborhood[26]. The PNAB also altered the number of service users under the responsibility of a single CHW, setting a maximum limit of 750 people, regardless of the number of families in the micro-area. As a number of families in Parque Grangeiro II had yet to be registered at the time of data collection, it was not possible to compare the data to determine

whether the population assigned to each worker was greater than 750 people.

The most prevalent risk categories were low risk and medium risk. These findings are similar to those of a study undertaken by Nataka et al.[27] in family health services in Porto Alegre in 2013 using data from form A of the Primary Care Information System. The results showed that a significant proportion (31.5%) of the 927 families assessed by the study were classified as being at some degree of risk, with the majority of families being in the low-risk group. The variable that contributed most to risk was poor sanitation, followed by high blood pressure and drug addiction.

With regard to socioeconomic conditions, monthly household income per capita showed a large variation across the micro-areas. It is worth mentioning that the Parque Grangeiro II neighborhood has upper-income households, while most of the families who live in the area surrounding the PCC are low-income households.

A study conducted by Tavares[28] suggests that upper-income households are attracted to Parque Grangeiro II due its distance from high density areas and the fact that it is located in a large environmental protection area on the foothills of the Chapada do Araripe, resulting in a milder climate than neighboring cities.

Final considerations

The territorialization process allowed the research team to conduct a situation assessment of the FHS territory in Parque Grangeiro II, identifying its diversities, vulnerabilities, strengths and weaknesses. The study is especially relevant considering that it used cutting-edge tools, made possible by the IPHRP's involvement in the FHS,

representing an innovative strategy for the local health team. The application of geotechnologies proved to be effective, in so far as it facilitated the generation, storage, georeferencing and analysis of population health data.

The main limitation of the use of risk scores to stratify families living in Parque Grangeiro II according to degree of vulnerability – another innovative practice for the PCC – was the fact that a large part of the georeferenced families were not registered in the e-SUS at the time of data collection, despite the importance of family records for conducting situation assessments. More than half of the registered families were classified as low risk and a considerable portion were at medium risk, which is consistent with the findings of previous studies. The most frequent-ly occurring variables of the clinical sentinel indicators among the 935 registered service users were drinking, high blood pressure and diabetes. These findings can make a significant contribution to strategic planning, providing the necessary input to prioritize families at greater risk and promote more equitable health care.

This study also helped to raise awareness among residents from the IPHRP of the importance of understanding the territory and keeping a vigilant eye on the local context to ensure that health care is tailored to the specific needs of the local population, viewing the territory as an ever-changing living space. The use of information systems brought agility to the process and gave greater visibility to the results and should be encouraged in FHS work processes.

Collaborations

MO Calistro contributed to study conception and design, data collection, analysis and interpretation, drafting the article and approving the final version to be published, and ensured that the article complies with the journal's guidelines. SM Souza and IRAS Lacerda contributed to data collection and analysis. Y Texeira contributed to formatting the article, including the references, general text, figures and tables, selecting the keywords, and submitting the article to the email address provided by the journal. FE Brito Júnior and SP Duavy contributed to the methodology, project administration, supervision, and drafting and revising the article. J Agostinho Neto contributed to the methodology and reviewed the article.

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