Multidisciplinary Approach to Health Care through Spatial Analysis with QGIS Software

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Abstract

The integration of a multidisciplinary approach to health care with spatial analysis using QGIS is an innovative and relevant proposal in the educational field. It allows students to approach complex health problems from multiple perspectives, fostering critical and collaborative thinking. By using geospatial tools, students can visualize and analyze data more effectively, which facilitates the understanding of epidemiological patterns. This approach also promotes interaction between students from different disciplines, enriching learning. In addition, it develops practical skills in the use of geospatial technology.

QGIS is a digital tool that allows the management, analysis and visualization of spatial data related to geography. It promotes data analysis and evidence-based decision making. The use of this ICT arises from the motivation to use an educational innovation experience that favors the effective use of this technological tool applied in the area of health.

The innovation lies in the combination of theoretical knowledge with practical applications, since it allows us to analyze the geographical distribution of diseases, evaluate the coverage and accessibility of health services in a specific geographical area, visualize environmental risk factors and their impact on public health, as well as assist in decision-making on prevention and health care strategies.

QGIS - in addition to being a powerful tool for improving public health planning and management - is accessible and free, which facilitates its adoption in educational institutions with limited resources.

Keywords: *Health care, educational innovation, QGIS.*

Theoretical Framework

Comprehensive and interdisciplinary health care are key elements for the training of students in health faculties. Technology has impacted several areas of our lives and health is one of them. Digital health or e-health refers to the use of communication and information technologies for health care and health services (Fernández Silano, 2014). These include digital applications, social networks, devices, artificial intelligence, data management, among others, and are ultimately aimed at improving efficiency, cost-benefit and speed in health care (Iyamu et al., 2021). The Centers for Disease Control and Prevention (CDC, 2022) defines e-health literacy as the degree to which people have the ability to find, understand, and use digital information and services to inform health-related decisions and actions for themselves and others.

Public health is a subject of utmost importance that every nursing student should learn through different approaches and tools that allow them to understand, prevent and manage health problems at the population level. Public health education for nurses includes knowledge in epidemiology, health promotion, health policy and health resource management. A key area in the study of public health for nursing is prevention and health promotion, immunization campaigns, nutrition and chronic disease control programs, community and family care, emergency and disaster response, including infectious diseases, epidemic outbreaks and natural disasters.

Therefore, according to Ivanitskaya et al. (2002), multidisciplinary learning makes it possible to articulate diverse perspectives and methodologies around the same object of study, broadening the understanding of the phenomenon.

Type of Research

The work presented is classified as applied research, exploratory in nature and with a mixed approach. It is applied because it responds to a specific need: to identify areas with community health

issues. The design is exploratory because the work starts from a little explored scenario, and a mixed approach is adopted by integrating quantitative geospatial analysis with qualitative observation of the interaction between disciplines. This way of approaching the problem is relevant to generate useful learning adapted to the real context (Hernández, Fernández & Baptista, 2014; Sampieri, 2018).

Methodology

This innovation was carried out through a collaborative learning strategy between students of the Bachelor's Degree in Nursing and students of the Bachelor's Degree in Agroforestry Engineering, in which they showed the use of this technological tool to identify areas with specific needs for human health care, such as communities that make up the municipality of Tetela de Ocampo, Puebla, which is located in the Sierra Norte of the State, and this mountainous area is part of the Sierra Madre Oriental, which is lagging behind in public health.

During one week, the students worked together to learn how to use this tool and prepare thematic maps. Data were collected from the communities of La Cañada, San Nicolás (Third section) and Cuapancingo by means of a survey, identifying the place and classifying it according to the indicators mentioned in the previous paragraph. To spatially represent the information obtained during the fieldwork, QGIS software version 3.14 was used. This open source tool made it possible to organize and visualize the data in a geographic environment, integrating thematic attributes linked to each community. Its application proved to be relevant as it facilitated a clearer reading of the territory and made it possible to identify, by means of cartographic representation, the levels of preventive health care recorded during the diagnostic phase. This exercise integrates knowledge from the health field and the mastery of a hard skill studied in agroforestry engineering to generate visible, tangible and measurable information.

In the development of this experience, some principles of the territorial stratification methodology proposed by Pérez Betancourt and collaborators (2016) were taken up again, adapting them to local conditions and the type of information available. To this end, three indicators were chosen that reflect key aspects of the state of community health: the percentage of people with a complete vaccination schedule, the proportion of the population dewormed during the last year and the presence of chronic degenerative diseases.

These data, collected by students in the three rural communities mentioned above, made it possible to identify important contrasts between the territories in terms of preventive coverage and health conditions. From this analysis, it was possible to classify each community according to the level of care it might require, considering the social and health context.

Although the number of communities was limited, the exercise made it possible to put into practice the logic of territorial stratification from an educational approach. By organizing the information by community and visualizing the results in a comparative manner, a clearer reading of the differences and specific needs was facilitated. This methodological adaptation demonstrates that, with basic resources and from the local scale, it is possible to apply conceptual tools and spatial analysis techniques useful for public health planning.

To begin the data collection, the main street of each community was taken as the starting point; this is a convenience sampling due to the accessibility and availability of the participants, which is particularly useful when there are time and resource limitations or for exploratory research (Atlas.ti, 2023).

Results

The information collected in the field made it possible to systematize the level of preventive health coverage, specifically in relation to two key actions: vaccination and deworming. Below is the distribution by community considering the total number of families surveyed:

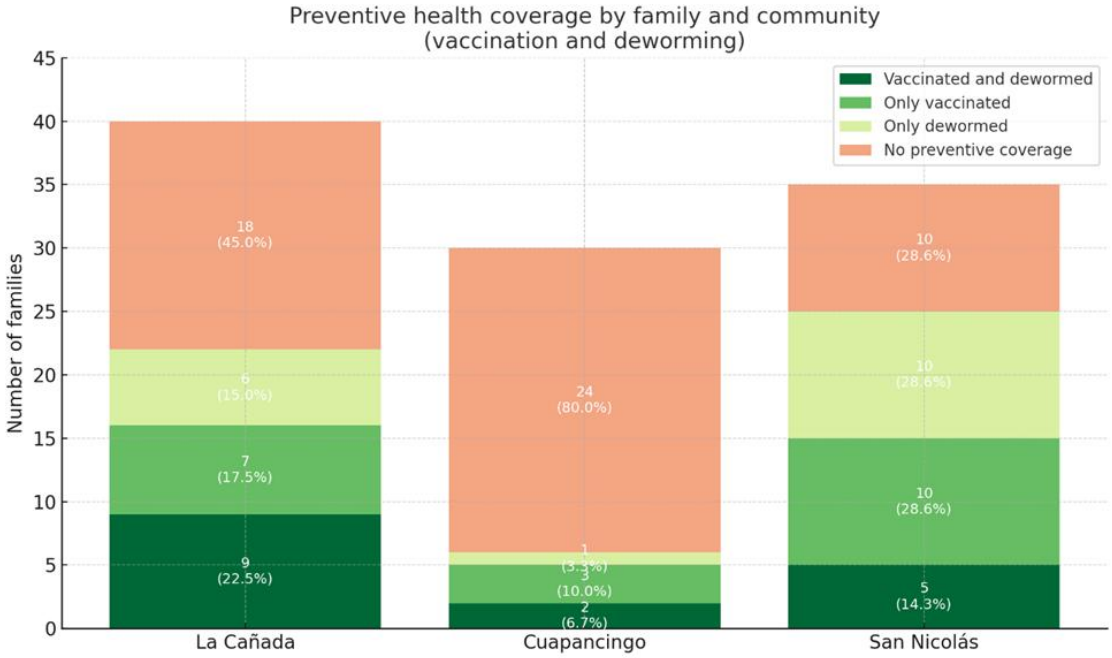
Table 1. *Distribution of preventive coverage by family and community (n=105)*

Community	Total families	Vaccinated and dewormed	Vaccinated only	Dewormed only	No preventive coverage	% Not covered
La Cañada	40	9	7	6	18	45%
Cuapancingo	30	2	3	1	24	80%
San Nicolás	35	5	10	10	10	28.6%

Note: Based on information gathered through surveys applied in rural communities of Tetela de Ocampo.

In order to facilitate the understanding of the data and highlight the differences between communities, a graphic presentation was prepared to clearly show the distribution of preventive health coverage by type of intervention. This visualization shows the proportions of families with combined, partial or no care, which provides key elements for the territorial interpretation of the findings.

Fig. 1. *Preventive coverage by family and community*



The data show important differences in the way families access preventive health services in the communities evaluated. Although full coverage -vaccination plus deworming- is limited in all three cases, the levels of care vary significantly among them.

In La Cañada, close to half of the families do not have either of the two interventions, which reveals a relevant area for improvement. Thus, this community registers a considerable number of households with some form of partial attention, which could facilitate complementary actions in the short term.

Cuapancingo, on the other hand, faces a more complex scenario: eight out of ten families did not have access to basic preventive schemes at the time of data collection. This may be tentatively due to the fact that the community has a marked tendency towards a religious cult that puts divine intervention to improve health before the application of a health scheme, in addition to this, the new way of obtaining information through social networks may distort disease prevention campaigns.

In the case of San Nicolás, the results are less alarming, although still insufficient. The more balanced distribution among the different categories of coverage opens the possibility of reinforcing existing strategies and closing gaps with interventions aimed at families that have not yet been served.

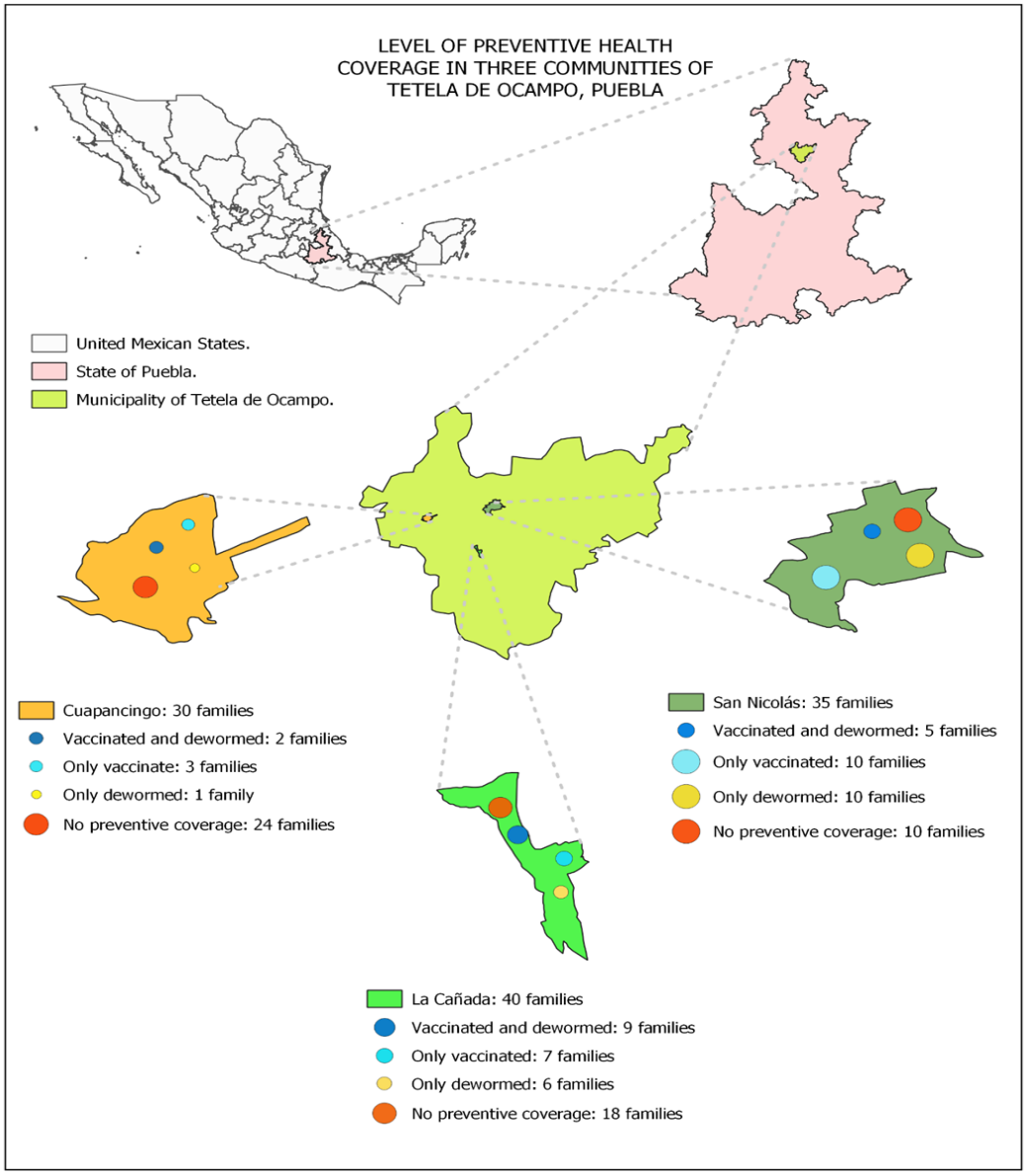
This panorama shows the need to reconfigure the territorial design of health prevention campaigns, considering not only the number of beneficiaries, but also the quality and continuity of the interventions. Adding this reading from the family level makes it possible to design actions closer to local realities.

Once the information was systematized by community through tables and graphs, it was possible to identify differentiated patterns of preventive coverage among the localities studied. However, in order to deepen the territorial reading of the data and visualize its geographic distribution more clearly, this information was represented by means of thematic cartography generated in QGIS.

The use of maps made it possible to integrate health variables with the spatial characteristics of each community, facilitating the detection of critical areas and the planning of more focused interventions. Unlike tables and graphs, which show numerical trends, spatial representation provides a contextual perspective that enriches the interpretation of findings and strengthens the link between data analysis and decision making in community public health.

Thus, the following representation of the information gathered in the field is shown as a thematic map, which seeks to have a more precise and easier-to-understand visual impact, considering that behind an image lies structured research work that is visible, tangible, and measurable.

Fig. 2. *Thematic map "Preventive health coverage in three communities of Tetela de Ocampo, Puebla".*



Discussion

The multidisciplinary development of this research showed how Information and Communication Technologies (ICTs), especially Geographic Information Systems (GIS) such as the open-source program QGIS, can be effectively integrated into public health projects to strengthen territorial analysis and intervention planning. The data presented in the table, graph, and thematic mapping not only systematized the information but also gave it spatial meaning that facilitated its interpretation by students. The collaboration between the higher education programs in nursing and agroforestry engineering was not limited to the collection of information, but, went beyond to the joint construction of visual solutions that reflected the needs of the communities studied. This joint work made it possible to recognize that the use of tools such as QGIS, beyond their technical capacity, contributes to the training of professionals with a territorial perspective that is sensitive to the social factors that condition health.

The potential of GIS as strategic allies in primary care has been highlighted in recent research, as they allow for the precise delimitation of risk areas and the optimization of resource allocation (Soto et al.,

2024). In line with the findings of this project, it was possible to identify areas with low preventive coverage using QGIS, information that would have been difficult to obtain through traditional reports. In addition, the role of ICT in health education continues to gain recognition. According to recent studies, integrating digital technologies such as GIS platforms into educational processes not only improves understanding of health determinants, but also promotes active, collaborative, and contextualized learning (Salud Pública de México, 2023). The presentation of this experience confirms the following: QGIS management was not an isolated resource, but a fundamental component in transforming scattered data into relevant educational actions.

Conclusion

QGIS as an academic innovation in the training of nursing professionals is a strategy that allows the approximation of several disciplines, the linkage and collaborative work with a global vision that positively impacts the learning of students from different areas and the development of competencies in public and community health, scientific and evidence-based research, management and leadership, teamwork, decision making and disease prevention, which significantly enriches learning, strengthening their ability to make evidence-based decisions and improve the planning of public health interventions.

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