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Spatial analysis of social vulnerability in health in the Mexican South Pacific region

Abstract

This article reflects on the current context of social and health vulnerability, which has become a central issue in government agendas at all levels. They represent social, economic, environmental and health processes that generate a mixed exposure of the territory and the people who inhabit it, making some more vulnerable than others; on the other hand, these conditions are also reflected in the response capacity of each individual, household and society.

The objective of this research is to determine the social vulnerability in health in the Mexican South Pacific region, using the official data from the Population and Housing Census of 2020, disaggregated at the municipal level. The variables or socio-spatial conditioning factors of health have been selected, which have been standardized using an omega index to obtain a synthesis indicator of all the variables used, applying a multivariate analysis technique called Spatial Classification Scores (SCS). It allows carrying out an integration of the variables used in a systematic way, which allows a better evaluation and understanding to identify areas with greater or lesser vulnerability.

The Mexican South Pacific region is a territory of great diversity and complexity, both in the social as well as in the economic and geographical context, which is why at the national level is the region with the greatest social backwardness and with the worst health rates. The results show that the highest vulnerability values are located in Cochoapa *el Grande*, Metlatónoc (Guerrero) and San Simón Zahuatlán (Oaxaca), characterized by high deficiencies in health services, education, decent housing and employment.

Key words: health, Mexican South Pacific region, socio-spatial conditions, vulnerability

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Introduction

In recent years, social and health vulnerability have become a central issue on government agendas, being a dominant feature that characterizes society and responds to socio-spatial conditioning factors such as social, economic, and environmental ones. They allow the understanding of social inequalities, the degree of exposure to a disease or some other conditions that affect their wellness, as well as the response capacity of each individual, household and society.

The Mexican South Pacific region is a territory of great diversity and complexity, both in the social as well as in the economic and geographical context, so at the national level it is the region with the greatest social backwardness and with the worst health rates. In this sense, the objective of this research is to determine the social vulnerability in health in the region, by the year 2020, from the socio-spatial conditioning factors of health to identify areas with greater or lesser vulnerability.

To achieve the objective, the research applied the perspective of quantitative spatial analysis, since it allows an integration of the various elements in a systemic and spatial way, for a better evaluation and understanding of the problems. The data source corresponds to the 2020 Population and Housing Census of the National Institute of Statistics and Geography (INEGI). The statistical technique applied was a multivariate analysis based on the calculation of the omega spatial classification scores (PCEΩ). To carry out the cartographic representation, a software for Geographic Information Systems (GIS) was used, where a classification of social vulnerability in health was established, at the municipal level, with different ranges.

The results of the research show the different levels of vulnerability, to which the population of the Mexican South Pacific region is exposed, to identify the variables or conditioning factors that have a greater or lesser impact on the vulnerability values. In this sense, research becomes a support tool to understand the differential behavior of vulnerability in the territory and thereby contribute to decision-making and public policies, according to the characteristics of each place, in order to point out specific strategies that help reduce vulnerability and, therefore, create territories that are more equitable.

Socio-spatial conditioning factors of health

Throughout history, the concept of health has been restated, identifying it as an adaptation process, where the conditions and modifications that human beings make in the environment they inhabit influence their state of health, to a greater degree than drugs or vaccines (Frenk, 1977). Among the oldest background we can trace Hippocrates (460 BC - 370 BC), who preached before the Greek society that human beings would have a greater chance of not contracting a disease if they lived reasonably, having good hygiene conditions, a home, adequate food, and clothing. Likewise, Virchow's studies in 1848 attributed the origin of a typhoid epidemic to the meteorological and poverty conditions in which the population lived (Dubos, 1975).

Based on these approaches, governments began to implement social reforms that helped counteract health problems and promote health among individuals. In 1978, at the international conference "Alma Ata", held in Kazakhstan, health was

declared as a fundamental human right and as a complete state of physical, mental and social wellness (PAHO, 2012).

In this way, to achieve an optimal condition and to safeguard health, the intervention of governments is necessary to develop and implement public policies and social programs that help reduce social inequalities and improve the health conditions of the population. According to the World Health Organization (WHO, 2010), social, cultural, economic, environmental and lifestyle factors can intervene for or against health.

Therefore, the way in which societies are organized and distributed generates inequalities in the way of accessing conditions that favor an optimal development of health and quality of life. Inequities are observed among countries, cities and among the same population in the same place (WHO, 2009).

In 2005, in order to reduce social inequalities, the WHO created the Commission on the Social Determinants of Health whose purpose was to investigate those social and environmental circumstances that affect health, to establish measures or interventions to achieve equity in health in all societies. In order to achieve this equity, the commission defined Social and Environmental Determinants of Health (SEDH) as the circumstances in which people are born, grow, live, work and age, which are the result of the distribution of money, power and resources within the three scales: global, national and local (Castro, 2011).

According to the conceptual framework proposed by the SEDH commission (Solar and Irwin, 2007), inequities in health can be analyzed considering social, economic, cultural and environmental features, as well as services, medical infrastructure and housing, but it must also take into account the habits of the individual, genetic factors and access to a quality medical service.

In terms of Weilt (2012), identifying the health conditions of a population is to describe the spatial and temporal characteristics that influence mortality and fertility, where some aspects should be considered such as the size of the locality, age, gender, racial origin or ethnicity, structure of the household and headship, level of education and economic activity. The characteristics of houses, such as the material used in their construction and the availability of services also influence when making decisions regarding health care, as well as the access and use of medical services, thus affecting the exposure to the risk of contracting a disease.

Likewise, the unequal distribution and concentration of the population generates a disproportionate distribution of economic resources in the territory, which affects the economic growth of each place. This situation makes a social, an economic and a differentiated-capability panorama between each society and individuals (Godínez and Burns, 2012), resulting in poor and marginalized territories, which are exposed to a continuous deterioration in their health status.

On the other hand, it is important to point out that the determining issue in the geographical area is considered as an extreme perspective, because it suggests that health is determined by the social context through a permanent and univocal relationship. For this reason, this term was applied from a possibility approach, which makes a change from determinants to socio-spatial conditions of health, pointing out that those social elements and the environment constitute an agent or positive factor, but not an active one, because the individual has the ability to modify those spatial characteristics (Buzai and Santana, 2018).

In summary, the socio-spatial determinants of health allow an approach to analyze the health status of the territory, since these factors are responsible for inequalities and inequities in health. When they are identifiable, they allow the definition of strategies and public policies that help reducing these disparities, in order to promote healthy lifestyles in individuals, so that they can offer ideal health conditions and wellness.

Social vulnerability in health

At the end of the 19th century, the proposal of the social vulnerability approach began to be developed (White, 1974; Cannon, 1991; Hewitt, 1983; Maskrey, 1993; Wilches-Chaux, 1993; Moser, 1998). Cannon himself (1991) synthesizes the proposal of this new approach in the sense that social and economic processes determine certain particular characteristics of population groups. In the event of a risk or threat of a given intensity, some processes prevent disasters and others do not, since the elements that make the population more or less vulnerable are those that generate differences in wealth and control over resources.

Social vulnerability appears as a predominant characteristic in most societies, since it is the result of economic inequalities as well as changes in the population and political structure, resulting in the loss of wellness caused by the risk of some aspect before mentioned, that can be as adverse on families and societies as a natural disaster (Moser, 1998). In this sense, Blaikie, *et al.* (2004) refers to this type of vulnerability as the characteristics and capacities that an individual or group possesses to anticipate, face, resist and recover from a negative situation, that is, how resilient a society or an individual is.

Pizarro (2001) identifies two explanatory components of social vulnerability. The first one refers to the insecurity and abandonment experienced by communities, families and individuals in their living conditions, because of the impact caused by some type of socioeconomic event. The second one is the management of resources and the strategies used by communities, families and individuals to face the effects of this event.

The concept of social vulnerability in health is polysemic, multidimensional and dynamic in space-time, because it provides an approximation to the reality of the health situation of population, which must be understood as a system where various socio-social conditions interact. They cannot be analyzed separately, since the relationships that are generated between each of them explain a part of that reality and together show the degree of comprehensive health vulnerability to which an individual is susceptible (Cutter and Finch, 2008; Juárez, *et al.*, 2014).

In this context, the complexity, multidimensional nature, and dynamism of social vulnerability in health make it possible to identify territories with vulnerable conditions, with the possibility of contracting certain diseases or affecting their wellness and quality of life. Therefore, analyzing the different exposure degrees to vulnerability will allow governments to implement public policies that help reduce social inequalities.

Study area

The Mexican South Pacific region is located to the southwest of the Mexican Republic. It is bordered to the north by the State of Mexico, Morelos, Puebla, Veracruz and Tabasco; to the south with the Pacific Ocean; to the west with Michoacán and to the east with Guatemala. Territorially, the region is made up of 775 municipalities, distributed in the states of Guerrero, Oaxaca and Chiapas (Fig. 1). It has an area of 231,262 km² and a population of 13,216,661 inhabitants, which corresponds to 10.48% of the population at the national level. Its density is 57.1 inhabitants / km², where 66.4% of the people are settled in rural locations, while 33.6% are in urban locations (INEGI, 2020).

According to the latest 2020 Population and Housing Census 2020 (INEGI, 2020), 24.18% of the total population of the region is indigenous (47.88% men and 52.11% women), 13 out of 100 people aged 15 years and over do not know how to read or write. The average grade of schooling is 8.22, which is equivalent to the second year of high school.

Regarding health characteristics in the region, 30 out of 100 inhabitants do not have an affiliation to a public or private medical institution. There are 4,033 public medical units, of which 0.14% are highly specialized hospitals, 5.08% are general hospitals, and 94.76% are primary-care hospitals. The proportion of doctors and nurses at the national level is 21 and 19 respectively per 10,000 inhabitants, while in the region it is 8.7 and 16.4 respectively (SS, 2020).



Fig. 1 Map of the South Pacific Mexican region

Source: own design based on the 2020 Population and Housing Census, INEGI, 2020.

The distribution of the working-age population within the economic sectors is as follows: primary sector 32%, secondary sector 17% and tertiary sector 51%. Regarding wages, 36% receive a minimum wage, 27% receive up to two minimum wages, 19% receive no income and 1% obtain more than five minimum wages. The minimum wage in the region is \$ 141 Mexican pesos (INEGI, 2019).

Geographically in the region, the *Sierra Madre del Sur* is located, which is a mountain range that crosses the state of Guerrero and covers 70% of the territory of Oaxaca, while in Chiapas, the Central American mountain range is located, which is a continuation of the *Sierra Madre del Sur*. This land relief that predominates in the region contributes to social inequality and increases vulnerability among the population (Herrero, 2018).

Methodological aspects

A series of procedures were applied to analyze the social vulnerability in health of the population in the Mexican South Pacific region. The first was to structure the SCS database, which was made up of 12 variables classified in the social, economic and housing infrastructure dimensions (Tab. 1). The definition of these dimensions and variables are based on the theoretical foundations of the socio-spatial conditioning factors of health and social vulnerability in health (Cordero and Murayama, 2012; Pizarro, 2001). This information was obtained from the 2020 National Population and Housing Census (INEGI, 2020).

Tab. 1 Variables of the SCS

Dimension	Variable	Type of variable (benefit or cost)
Social	Population affiliated to a health institution	Benefit
	Schooling grade	
	Indigenous population	Cost
	Illiterate population	
	Overcrowding	
Economic	Economically active population (EAP)	Benefit
	Income	
	Per capita gross domestic product (GDP per capita)	
Housing infrastructure	Homes without electricity	Cost
	Home without drinking water	
	Homes without sewer system	
	Homes without any goods	

The variables were classified into two types: cost (VC) and benefit (VB). The first type is characterized by the fact that its highest scores indicate greater vulnerability, while in the second type, its highest values present less vulnerability.

The Spatial Classification Score (PCE) technique was applied (Buzai, 2014). This technique is a multivariate analysis that considers the standardization of the variables, both cost and benefit, obtaining as a result a synthesis of the values of the BV and CV in each territorial unit, that is, spatial aggregations are formed from the behavior of the SCS variables.

The standardization of the benefit and cost variables was through the omega score calculation (Ω) (Buzai, 2014) [1]:

$$\Omega = \left(\frac{X-m}{M-m} \right) 100 \quad [1]$$

Where X is the data of each spatial unit, m and M are respectively the smallest and largest data of the data series; the result takes the data in a range from 0 to 100.

Once the variables were standardized, the spatial classification was calculated as follows [2]:

$$PCE = \frac{\sum \text{Dim}(\Omega)}{n} \quad [2]$$

Where the PCE is the sum of the n dimensions of variables, previously standardized, between the total number of dimensions. The procedure results in a synthesis map that represents social vulnerability in health based on the SCS, showing the favorable and unfavorable areas for each spatial unit.

Results

Spatial distribution of social vulnerability in health in the Mexican South Pacific region

Spatial distribution is a main concept in territorial research and an important element, from the health perspective, since it allows a differentiation of the territory, according to each variable, providing a first approach to the identification and spatial configuration of the vulnerable sectors in health. Therefore, this type of cartography is of great importance and helps in the geographic targeting of public policies that aim to reduce health disparities (Curto, 2003).

The application of the Spatial Classification Scores methodology (PCE) allowed defining the homogeneous areas based on benefit and cost variables, highlighting those areas that meet the best and worst social, economic, educational, health and housing services conditions, showing high socio-spatial differences in the territory (Fig. 2).

The result of the analysis shows that only 1.8% of the municipalities present very low vulnerability. These municipalities are located in the central area of Oaxaca, in the municipalities of San Sebastián Tutla, San Pablo Etla and San Andrés Huayápam, which are part of the metropolitan area of Oaxaca de Juárez. Some characteristics that these territories have in common is a high degree of schooling, that is, the population aged 15 and over has completed satisfactorily or is in the last year of high school.

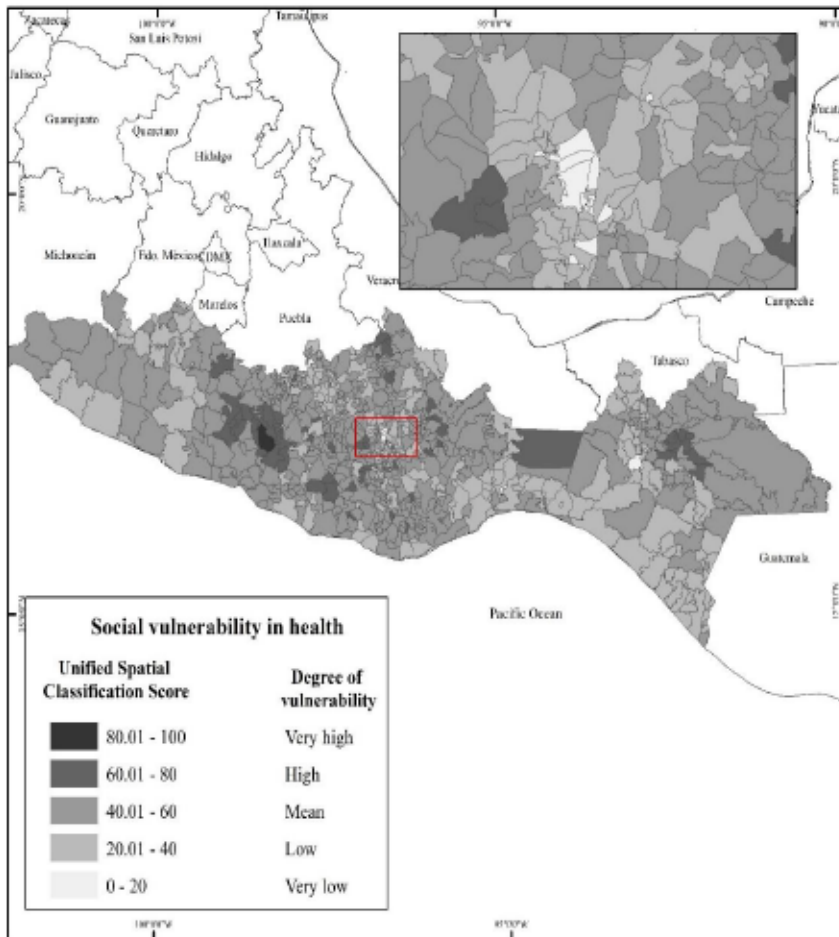


Fig. 2 Map of social vulnerability in health in the South Pacific Mexican region

Source: own design based on the 2020 Population and Housing Census, INEGI, 2020.

Likewise, the population residing in these municipalities receives more than 5 minimum wages. In the last year, they had the highest GDP per capita in the region. These values show an approximation to the material wellness of the population and the governmental capacity to make investments in social, educational and health projects, which are reflected in the good living conditions they have.

On the other hand, 29.25% of the territorial units present a low degree of vulnerability. They can be observed in the coastal zone of the region, such as Santa María Huatulco and others located on the Isthmus of Tehuantepec. They are tourist sites and belong to the “La Venta” wind corridor, one of the main energy projects not only in Oaxaca, but also in Mexico.

Similarly, municipalities such as Chilpancingo in Guerrero, Oaxaca de Juárez and Chiapas de Corzo, are characterized by being the capital of each state, therefore

it is here where the greatest opportunities for employment and education are concentrated. However, the GDP per capita variable and entitlement make the difference between very low and low vulnerability.

61.63 % of the territorial units have a medium vulnerability, the distribution shows that they are located in the part of the *Sierra Madre del Sur* and *Sierra de Chiapas*; some characteristics that these municipalities have is that the level of education in the population is between secondary and the second year of high school, as well as low incomes. 46 % of their homes lack basic services and people live in overcrowding conditions, examples of this are Coyuca de Catalán (Guerrero), Ocosingo (Chiapas) and Santiago Yosondúa (Oaxaca).

7.32 % of the municipalities present a high and very high vulnerability, they are located on the limits of the States of Guerrero and Oaxaca. Examples of this are Cochoapa el Grande, Metlatónoc in Guerrero, San Simón Zahuatlán (Oaxaca) and Coicoyán de las Flores (Chiapas). It should be noted that, at the national level, they are the most marginalized and poorest municipalities, which is why these social, economic and housing conditions prevent satisfying their basic needs and their right to have a decent quality of life.

In conclusion, it is important to point out that despite having different degrees of vulnerability in the region, most of the health problems are linked, in one way or another, to the socioeconomic conditions of the population that suffers them, so it is not exempt to any society to be the target of any specific disease. For example, people having poor socioeconomic conditions can suffer from traditional diseases such as gastrointestinal or respiratory diseases, while the units with better conditions can have diseases related to lifestyles.

Final considerations

Social vulnerability in health is a complex and multidimensional issue that has gained greater relevance and importance for government over time, since reducing social inequalities has become a priority topic and can be seen reflected in the Development of Sustainable Goals (DSG).

Likewise, the socio-spatial conditioning factors of health, at their theoretical and explanatory level, provide an overview of the social, economic and environmental characteristics in which the population develops. Although the public policies that are exercised focus on the treatment of diseases, many factors that SCS provide must be considered, since the health problems suffered by the population are linked to socioeconomic and environmental conditions.

The analysis of social vulnerability in health allowed the analysis of territorial fragility in the region, based on the socio-spatial conditioning factors of health, which reflect the particular characteristics of each territory and which have a positive or negative impact on vulnerability.

The spatial classification score methodology established a distribution pattern regarding the behavior of the variables and identified the various degrees of social vulnerability in health to which the population is susceptible. It was observed that the highest values predominate in the municipalities that are located on the *Sierra Madre del Sur* and Chiapas, for example, the municipality of Cochoapa el Grande

(Guerrero), which has the highest degree of vulnerability in the region, while the lowest corresponds to San Sebastián Tutla, located in the central valleys of Oaxaca.

The spatial distribution pattern shown in this research provides an overview of the vulnerability that exists in the region, at the municipal level. However, it is important to differentiate between the urban and rural environments of each municipality, since in each one of them particular conditions are developed that lead to generating social inequalities and a differential vulnerability among the inhabitants.

In this sense, the methodology applied and the results obtained serve as a tool that facilitates the understanding of social vulnerability in health, in the Mexican South Pacific region. It will help decision makers to identify strategies or public policies focused on reducing vulnerability and creating territories with a better wellness and quality of life for the population that lives there.

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