

Spatiotemporal Analysis of Injury Events Against Doctors in Guangdong Province by Geographic Information System

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Background: Violence against doctors is a global concern. Violent injuries against doctors occur periodically in China. At least one violent injury event was witnessed by 54% of medical staff against doctors in 2020. Analyzing this phenomenon and establishing preventive measures is a common concern of the medical and criminal communities.

Methods: This study comprised 712 injury events against doctors in Guangdong Province, China, from January 2019 to October 2022. The spatial distribution and spatiotemporal changes of these events were analyzed using ArcGIS and Excel software.

Results: Considering the geographical distribution, the injury events against doctors showed a three-level concentric circle pattern where, Guangzhou and Shenzhen, adjacent cities, and distant cities were ranked as high, medium, and low-risk areas, respectively. In temporal distribution, the periods of high incidence were 9–11, 14–15, and 20 o'clock, and the incidence tended to be similar daily, with the peaks in June and July.

Conclusion: We found that the risk level of injury events against doctors was positively correlated with the medical resources level in the areas. The injury event incidence was higher during the daytime working hours. Temperature may have a strong positive effect on injury events against doctors.

Keywords: injury events against doctors, Guangdong Province, spatiotemporal distribution characteristics, spatiotemporal distribution analysis, geographic information system

Introduction

Violent injuries against medical professionals are a global challenge,¹ with large-scale violent injury events reported by doctors in China.² At least one violent injury event was witnessed by 54% of medical staff against doctors in 2020.³ Scholars have found a positive correlation between violent behavior towards healthcare workers and their willingness to resign, job burnout, and depression.^{4–6} Violent injuries against doctors constitute crimes as per Chinese law.⁷ Any crime occurring in a specific geographical space and time, and the criminal act is closely linked to the geographical environment, suggesting the aggregation of crimes in space and time.⁸ Therefore, assessing the violent injury events against doctors from the criminal geography perspective may recognize the geographic distribution of violent injury events against doctors. This perspective may help prevent the occurrence of violent injury events and the detection of such criminal cases.

Criminal geography focuses on the spatial distribution of criminal activity, as well as the social, environmental, and psychological factors that contribute to this distribution. There are several research areas. The analysis of crime hotspots studies the distribution and aggregation of criminal events within specific geographical regions. Environmental criminology emphasizes the impact of environmental factors on criminal behavior. Crime forecasting focuses on analyzing historical crime data and predicting future locations of criminal activity. In addition, Geographic Information System (GIS) technology is also utilized for analyzing criminal incidents.

GIS is a technology for spatial data analysis based on map geocoding.⁹ The GIS technology allows us to direct observe the degree of aggregation of criminal activities by the decision-makers and areas that the high-intensity zones of criminal hotspots belong to,¹⁰ that is, the criminal area visualization. For example, GIS technology was used by Bianchini et al to obtain crime maps for the crackdown and prevention of crimes in Bologna, Italy.¹¹ The analysis of violent injury events against doctors using GIS technology allows researchers to observe the spatial distribution of injury events against doctors more specifically and assists in the better prevention of injury events.

Methods

The data used in this study comes from media reports and field investigations.

The study selected Guangdong Province, China as the survey area. On the one hand, Guangdong Province boasts a well-developed economy, abundant medical resources, a larger number of medical staff, and a substantial population for conducting surveys. On the other hand, Guangdong Province's abundance of high-quality medical resources attracts patients from all over the country who are seeking medical treatment. However, this also leads to a significant number of violent medical injuries caused by doctor-patient disputes, which serves as a representative example to some extent. The survey was conducted in hospitals throughout the entire Guangdong Province region.

The survey period is from January 2019 to October 2020. The selection of cases is mainly based on the following criteria: 1. There was a conflict between the doctor and the patient, resulting in violent behavior. 2. The police rushed to the scene to intervene and resolve the situation. 3. The victim is a registered physician or nurse. Relevant media reports were also collected during this period.

All participants are aware of this study and have agreed to participate. This study was approved by the Medical Ethics Committee of the Chinese PLA General Hospital (No. 2023KY098-KS001).

The survey collected a total of 712 data samples, which are in tabular format. Because this study utilizes geographic spatiotemporal analysis to investigate the visualization and prevention of criminal areas, only the location and time of the events were considered, while the specific details of the events were briefly recorded.

The specific description of the event from the data was omitted, the time (with fields like Hour, Date, Week, Month, and Year) and information regarding location of the event were retained.

Geocoding in GIS technology was used to determine the location event for the spatial analysis of events. The city level of Guangdong Province (a total of 21 cities) was taken as the basic unit, the location of the events was entered into the ArcGIS software, and to obtain the spatial map of the injury events, address information was spatially matched. A density analysis of the spatial map was then performed to obtain a risk distribution map (Figure 1).

This study included 712 injury incidents against doctors in Guangdong Province, China that occurred from January 2019 to October 2022, which were analyzed for spatial distribution and temporal changes using ArcGIS software (based on GIS technology) and Excel software. The study found that the risk level of injury events against doctors was positively correlated with the medical resources level in the areas. The injury event incidence was higher during the daytime working hours. Temperature having may have a strong positive effect on injury events against doctors.

Results

Spatial Distribution of Injury Events Against Doctors in Guangdong Province

The levels of risk are based on the number of events in each region. First, the event means falling in each city (A_n) was calculated as follows:

$$A_n = \frac{N}{n}$$

Therefore, in the first step, based on the total number of events (N) of 712, the mean of events (A_n) in 21 (n) cities in Guangdong Province was approximately 34.

In the second step, based on the four (n) risk levels (non-occurrence and low, medium, and high risks). As the mean of events in each city was 34 (N), the mean of events per risk level (A_n) was approximately nine.

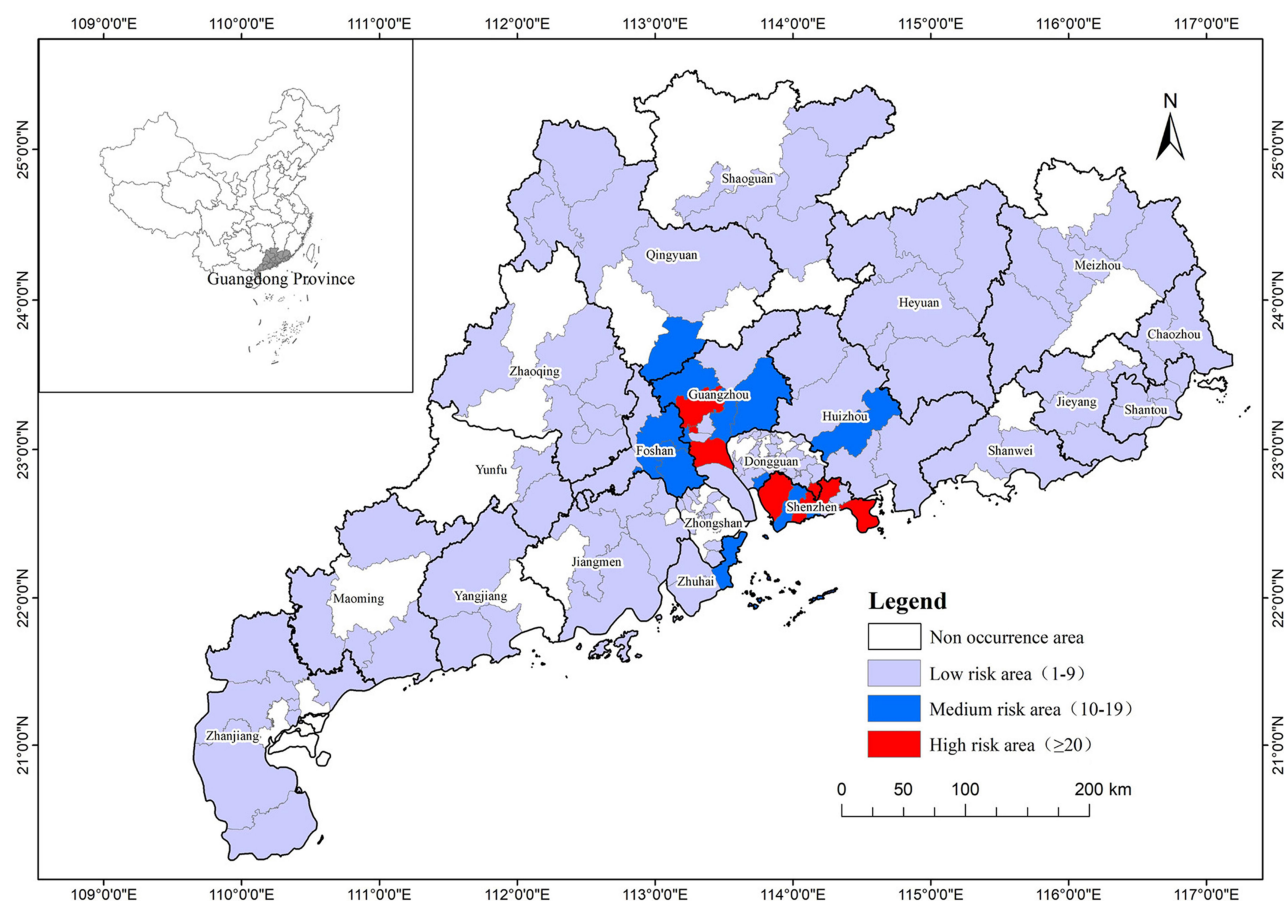


Figure 1 The risk distribution map of injury events against doctors in the Guangdong Province.

Therefore, the number of events in the low, medium, and high-risk areas was determined to be 1–9, 10–19, and ≥ 20 . The risk distribution map of injury events against doctors in the Guangdong Province is illustrated in Figure 1.

The risk distribution of injury events against doctors illustrated in the figure presented a high-medium-low pattern of three concentric circles. The high-risk areas comprise provincial capital and special zones (such as Guangzhou and Shenzhen), medium-risk areas containing adjacent cities (such as Huizhou and Foshan), and low-risk or even risk-free areas include distant cities (such as Meizhou and Zhanjiang). High-risk areas have the most tertiary hospitals in Guangdong Province, with a high population density and a large number of patients. The role of complementary medical care is performed at medium-risk areas adjacent to high-risk areas. However, low-risk and non-occurrence areas are distant from high-risk areas. Because their economic development and medical resources are much lower than those of the provincial capital cities.

Time Distribution of Injury Events Against Doctors in Guangdong Province

Intra-Day Variation

The number of injury events against doctors that occurred in each hour of the day in Guangdong Province was statistically analyzed according to the “Hour” field, and the intra-day variation chart was obtained (Figure 2).

Intra-Week Variation

The number of injury events against doctors that occurred on each day of the week in Guangdong Province was statistically analyzed according to the “Week” field, and the intra-week variation chart was obtained (Figure 3).

The incidence of injury events tended to be consistent daily, with relatively few events on Fridays and Saturdays. In China, Saturdays and Sundays are off days for outpatient doctors, with only residents and emergency doctors on duty;

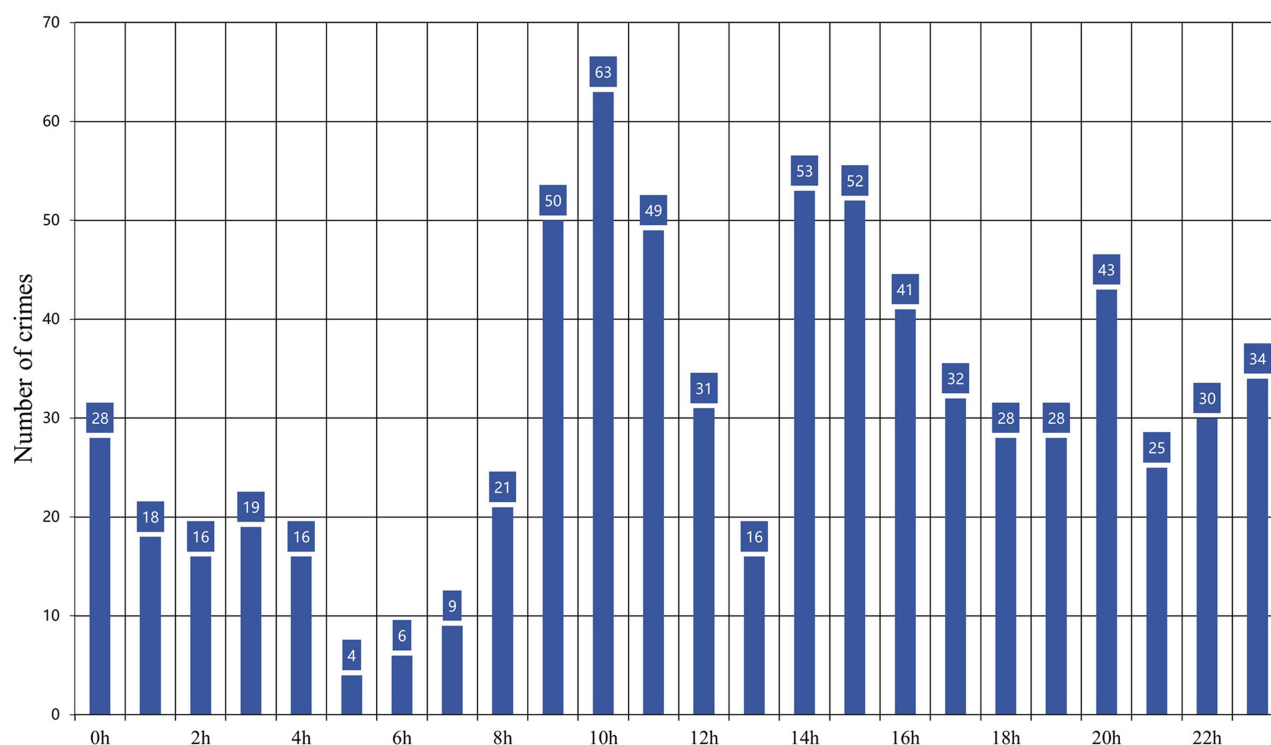


Figure 2 Intra-day variation chart of injury events against doctors in the Guangdong Province.

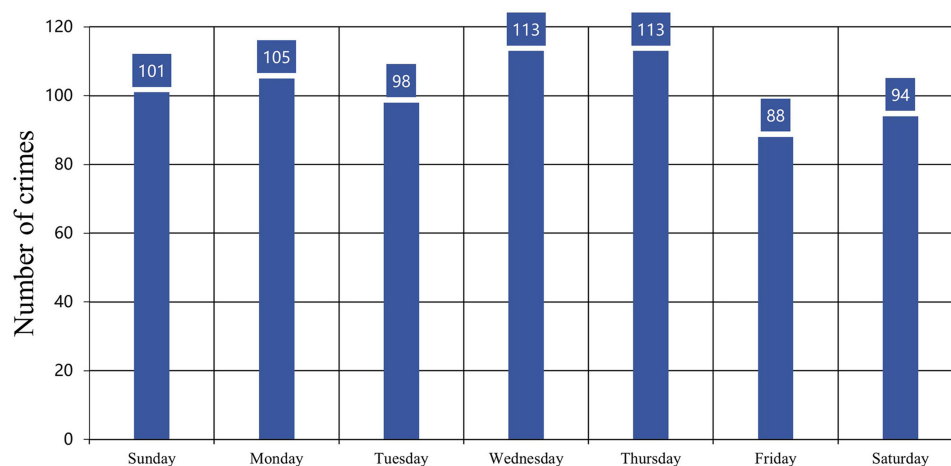


Figure 3 Intra-week variation chart of injury events against doctors in Guangdong Province.

however, a considerable number of injury events were noted on these days. This showed that Chinese doctors are facing a high risk of violent injuries.

Intra-Year Variation

The injury events against doctors in Guangdong Province were statistically analyzed according to the “Month” field, and the intra-year variation chart was obtained (Figure 4); a periodic pattern was presented. The overall four-year data of 2019–2022 showed that the number of events was lowest from January to March, peaked in June, and started to decline to a certain extent and maintained from July.



Figure 4 The intra-year variation chart of injury events against doctors in Guangdong Province.

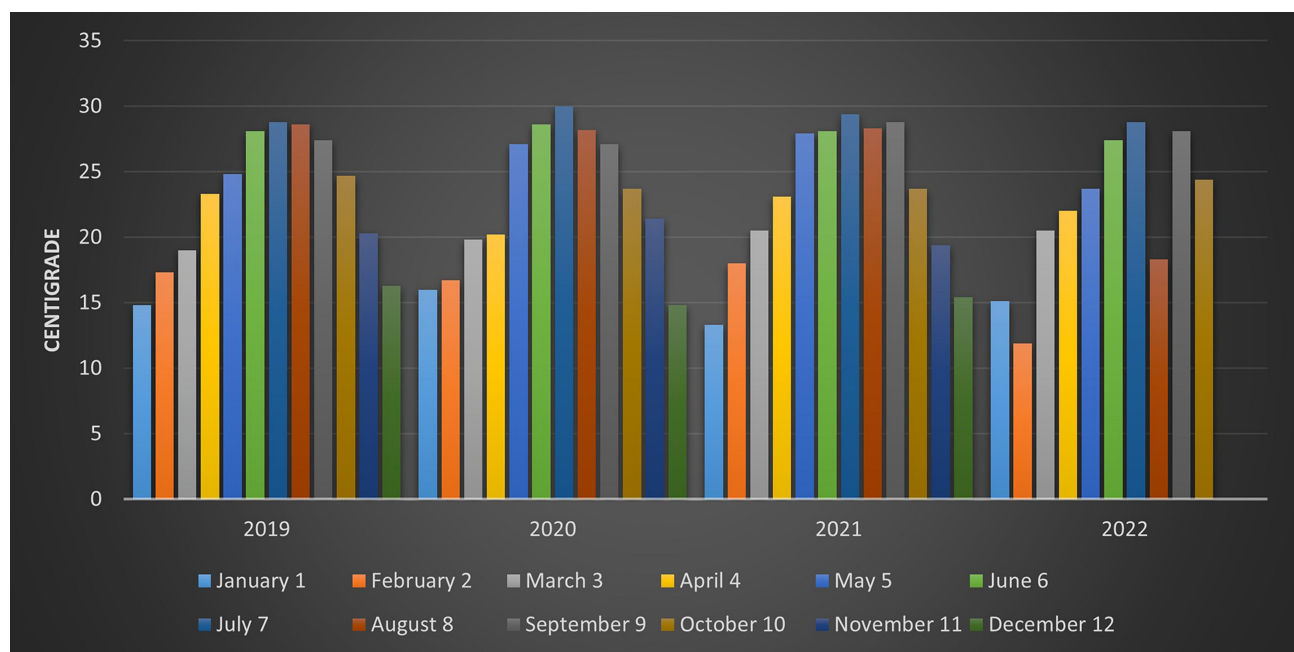


Figure 5 The monthly average temperature in Guangdong Province.

To discuss whether temperature has an impact on violent injuries against doctors. This study collected monthly average temperature data from January 2019 to October 2022, as reported by the Guangdong Meteorological Service. The monthly average temperature chart was obtained (Figure 5). Figures 4 and 5 indicate that the period of high temperatures (June and July) is also a stage of high incidence of injury events against doctors. There is same trend between temperature and the occurrence of violent events.

With the arrival of the rainy season in July, the number of injury events began to decline. The inconvenience of travel in the rainy season may be one of the reasons for the decline in injury events, which should be further confirmed in future studies.

However, the number of injury events decreased substantially in October 2022, during this period the Chinese government implemented a series of measures to maintain social security and stability,¹² and the incidence of injury events decreased significantly.

Discussion

The Risk Level of Injury Events Against Doctors Showed a Positive Correlation with the Area's Medical Resources

Since medical resources are in the leading position in Guangdong Province, Guangzhou, Shenzhen, and Foshan are medium and high-risk areas.¹³ In general, areas with sufficient medical resources attract more patients for medical treatment, and the injury event probability against doctors would be higher than that in other areas. Therefore, more security measures should be allocated to medium and high-risk areas in the limited hospital security resources. For example, dispatching police to the hospitals, establishing a security inspection system at the hospital entrance, and strengthening security patrolling of the hospital have a positive effect on preventing and reducing injury events.

The Incidence of Injury Events Was Higher During Daytime Working Hours Than the Night

Figure 2 demonstrates that 9–11 a.m., 2–3 p.m., and 8 p.m. were the periods of high incidence, and 5–6 a.m. of low incidence throughout the day. Injury events were higher during daytime doctor visits than those at night, and the high incidence at 8 p.m. was mainly concentrated in the emergency departments, which was consistent with some studies.¹⁴

According to the “hot spot policing” theory, police officers and security personnel stationed in hospitals should increase the frequency of patrols and prolong the duration of stay at the sites of the high incidence of injury events. This concept was supported by the studies by Koper et al¹⁵ and Wu et al¹⁶ For example, patrolling can be intensified in the hospital at 10 a.m., 2 p.m., and 8 p.m., and the patrol frequency can be increased in the emergency department at night to prevent and reduce injury events.

The Temperature May Have a Strong Positive Effect on Injury Events

The temperature is associated with violent behavior,¹⁷ and high temperature in summer increases violent behavior.¹⁸ Extremely high temperatures for a long duration, crowding, and noises within a healthcare facility predispose individuals to negative emotional reactions and violent behaviors, as suggested by environmental psychology.¹⁹ Thus, situational preventive measures to transform the medical environment are reasonable. For example, installing an air purification system to provide a medical environment with a suitable temperature, improving the waiting areas, creating an orderly waiting space, increasing devices that can absorb noise, and reducing noise levels in the treatment space may assist in reducing the overall tension of patients and their families; thereby, reducing doctor-patient conflict and the probability of injury events against doctors.

The pattern observed in Figure 4 was due to the Chinese Spring Festival generally occurring between January and March. Owing to the Chinese festival, most non-acute and non-critical patients often prefer visiting their home towns for family gatherings instead of visiting the hospital for treatment. Therefore, the decline in the number of visits also contributed to the reduction of injury events from January to March.

However, after the festival, the injury events demonstrated a slowly increased trend with the increase in the number of medical visits, which peaked in June. This may also be owing to the climate. In Guangdong Province, June is characterized by hot weather, and aggressive behavior is more likely to happen with high temperatures, as suggested by the temperature attack theory.²⁰

There are some valuable studies worth learning from on the impact of temperature on crime. For example, Hou et al found that high ambient temperatures have a promoting effect on urban crime in Chicago.²¹ Peng et al research on 129 cities in China also supports this viewpoint.²² Currently, the impact of temperature on violent injuries against doctors has not been studied. This study only conducted one preliminary discussion.

Therefore, we anticipate bringing a new solution to the growing challenge of violent injury events against medical professionals.

This study analyzed the spatiotemporal distribution of injury events against doctors. Multifaceted research based on existing studies is required for the prevention of violent injury events against doctors.

Limitation and Future Research

However, the research still had several limitations. First, our research on the relationship between temperature variables and event characteristics is not sufficient which needed to gather more information. In future research, we will use statistical methods to measure the influence of temperature. Second, violence against doctors may be influenced by multiple factors. The departments where injury events occur, the type of injury, communication between doctors and patients, and the preventive ability of medical staff themselves will be assessed in the next stage of research. Third, this study presents a descriptive analysis of criminal geography and violence against doctors. In future research, detailed collection of event data is needed, a disaggregate analysis may be more appropriate than an aggregate analysis. Nevertheless, this study still provides valuable perspectives and discussions on reducing violence against doctors.

Conclusion

We found that the risk level of injury events against doctors was positively correlated with the medical resources level in the areas. The injury event incidence was higher during the daytime working hours. Temperature may have a strong positive effect on injury events against doctors.

Specific measures can be implemented. Such as, more security measures be allocated to medium and high-risk areas in the limited hospital security resources, police officers and security personnel stationed in hospitals should increase the frequency of patrols and prolong the duration of stay at the sites of the high incidence of injury events, installing an air purification system to provide a medical environment with a suitable temperature, improving the waiting areas, creating an orderly waiting space, increasing devices that can absorb noise, and reducing noise levels in the treatment space may assist in reducing the overall tension of patients and their families.

Databases

The data used in this study comes from media reports and field investigations.

Clarification

The data in this study has been obtained with individual informed consent.

Data Sharing Statement

The map used in this article is sourced from the Ministry of Natural Resources of the People's Republic of China. Drawing review No. GS (2022)1873. The original data used in this study has not been disclosed. The data used and analyzed during the study were available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Institutional Review Board (IRB) of the Chinese PLA General Hospital. Written informed consent was obtained from all participants.

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Disclosure

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