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## Correspondence

# Analysis of spatial accessibility of dental emergency hospitals in Taiwan: The application of a geographical information system software

## KEYWORDS

Geographic information system;  
Dental emergency hospitals;  
Spatial accessibility;  
Spatial and geographical distribution;  
Population distribution

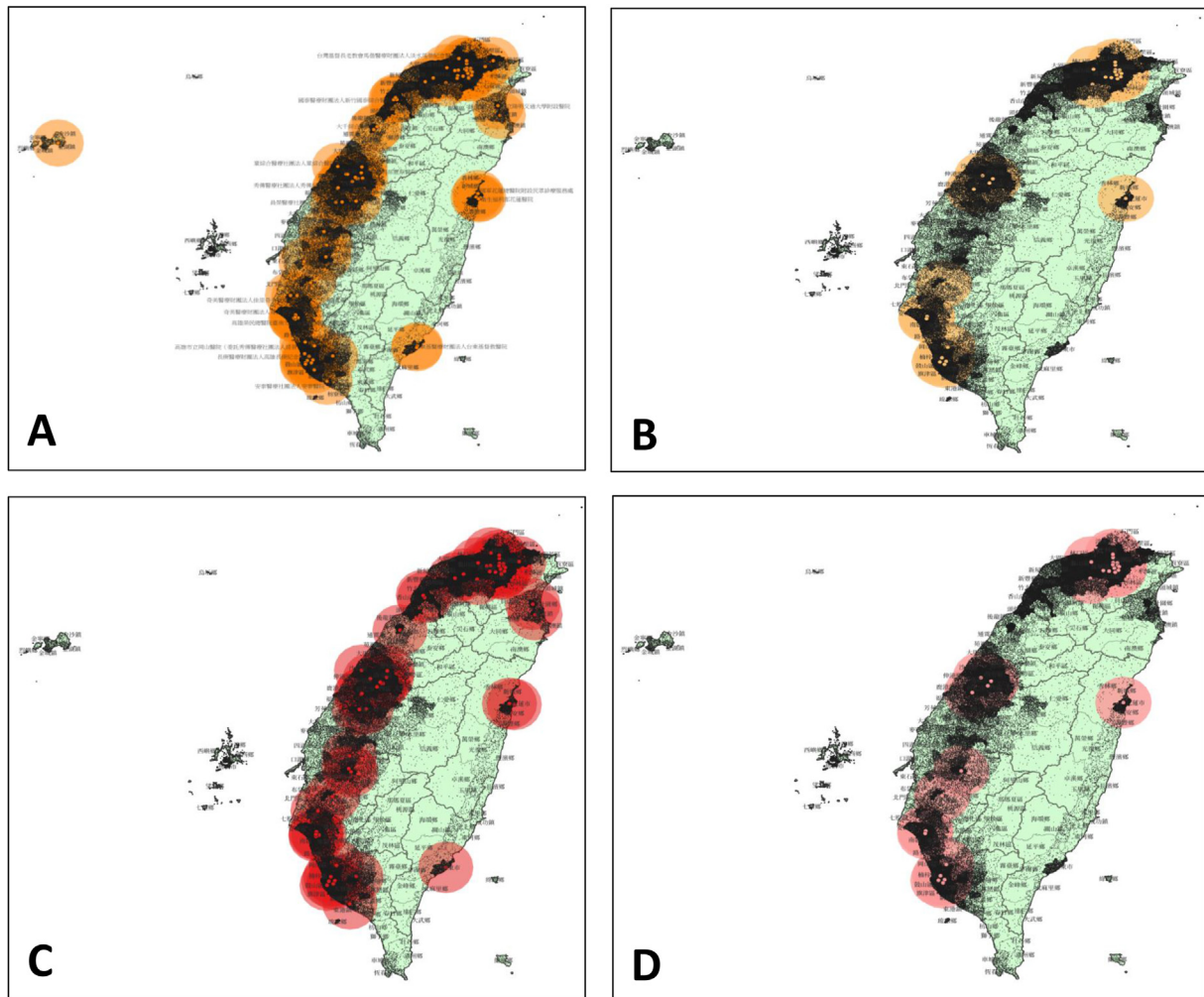
Taiwan implemented the National Health Insurance (NHI) since 1995. The insured population coverage rate has reached 100 %. It covers the outpatient, emergency, and inpatient medical services for all Taiwan residents. The medical services also include the dental outpatient, emergency, and inpatient services. In fact, the real dental emergency services in the Taiwan NHI refer to the dental emergency services provided by the hospital emergency departments.<sup>1</sup> According to the information released by the Ministry of Health and Welfare, there were 79 hospitals providing dental emergency services in Taiwan in 2023. Among the outlying islands, only the Kinmen Hospital provided the general dental emergency services for some limited hours. Nonetheless, Taiwanese can choose any level of the contracted medical institutions without a formal referral. Taiwan is probably the most convenient country for the medical care. However, seeking treatment in a dental emergency visit often results in a temporary treatment with only the symptomatic relief prescribed by antibiotics or analgesics, which does not completely treat the underlying oral diseases.<sup>2,3</sup> Therefore, the dental emergency visits for dental problems may be a sign of

differences in the dental care quality.<sup>1</sup> The hospitals have the ability to provide effective and comprehensive dental emergency services and appropriately arrange the dental emergency patients to return to the general dental clinics for the subsequent treatment. The application of geographical information system (GIS) helps to improve the quality and efficiency of the spatial decision-making, planning, and management of the medical resources.<sup>4</sup> This article aimed to use the geographical information system software (QGIS) to conduct the spatial and geographical distribution analysis, draw the distribution maps of the accessibility coverage of the dental emergency hospitals in Taiwan, and compare it with the population distribution.

In Taiwan, the hospital dental emergency services are divided into the general dental emergency (such as dealing with general conditions of toothache or loose dentures) and the oral and facial critical emergency (such as dealing with the facial bone fracture, tooth and alveolar bone trauma, head and neck infection, jaw dislocation, postoperative bleeding after the dental surgery, and other serious situations). Among the 79 dental emergency hospitals in Taiwan

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**Figure 1** The distribution maps of the dental emergency hospitals and population, and the spatial accessibility coverage of the dental emergency hospitals in Taiwan in 2023. There were four categories, including (A) the dental emergency hospitals providing the general dental emergency services in overall (B) the dental emergency hospitals providing the general dental emergency services without time limits (C) the dental emergency hospitals providing the oral and facial critical emergency services in overall, and (D) the dental emergency hospitals providing the oral and facial critical emergency services without time limits. The dental emergency hospitals included those providing the emergency services during limited hours and those providing the emergency services without time limits. The color dots represented the distribution of the dental emergency hospitals, while the black dots represented the population distribution. The denser the dots, the more dental emergency hospitals or population were concentrated in these areas. It showed that the distributions of the dental emergency hospitals and population were highly consistent and parallel. The color circles with a 20-km radius of the hospital as the center point represented areas covered by the spatial accessibility of the dental emergency hospitals, while the other areas represented areas not covered by the spatial accessibility of the dental emergency hospitals. These areas had a sparse population distribution.

in 2023, 78 hospitals provided the general dental emergency services, while 58 hospitals provided the oral and facial critical emergency services. Some of them had time limits on providing the dental emergency services (usually only providing dental emergency services during the outpatient clinic hours). As for the hospitals providing the related dental emergency care 24 h a day, 365 days a year (without time limits), there were 29 and 36 hospitals providing the general and critical emergency services, respectively. This study distinguished the above four categories, and further used the QGIS to draw the distribution maps of the spatial accessibility coverage of the dental

emergency hospitals based on their geographical location, a 20-km radius of a hospital, and the population distribution in Taiwan in 2023, as shown in Fig. 1.

According to other research, 15 miles (approximately 24 km) is a reasonable range for the accessibility assessment of the medical resources.<sup>5</sup> This study used a more stringent standard (20 km) to map the spatial accessibility coverage of the dental emergency hospitals. It could be clearly seen that almost the western region and the major eastern towns of Taiwan were covered by the spatial accessibility of the dental emergency hospitals, except for the central mountain range extending to the southern coast

areas, some eastern coast areas, and the outlying islands, which had a sparse population distribution. Furthermore, the dental emergency hospitals and population were highly uniformly concentrated in the metropolitan areas of the western Taiwan, demonstrating the extremely uneven geographical distribution of these dental institutions and population in Taiwan (Fig. 1).

Comparing the distribution maps of the different categories, the range and density of the spatial accessibility coverage of the dental emergency hospitals without time limits were less than those of the overall hospitals. Among the dental emergency hospitals without time limits, the range and density of the spatial accessibility coverage of the critical emergency hospitals were better than those of the general emergency hospitals. This highlights the importance of the 24-h oral and facial critical emergency care to respond to any oral and facial related injuries in a timely manner, thereby reducing the complications caused by the delayed medical treatment. Overall, it could still be confirmed that most populated areas in Taiwan were covered within the spatial accessibility of the dental emergency hospitals. However, in Taiwan, there was still a sparse population distribution in some areas not covered by the spatial accessibility of the dental emergency hospitals. The improvement of the medical equality for these uncovered people must be taken seriously.<sup>4</sup> By 2023, there were 211 hospitals equipped with the dental facilities in Taiwan. Based on this, the government-subsidized resources should be used to enrich the dental emergency facilities in the hospitals, especially those in the remote areas, deploy the existing dentist manpower, and establish a hospital dental emergency service system, providing more comprehensive oral health services to the remote areas in terms of the oral and facial critical emergency.

## Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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