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## Correspondence

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

## KEYWORDS

Geographic information system;  
dental institutions;  
spatial accessibility;  
spatial and geographical distribution;  
population distribution

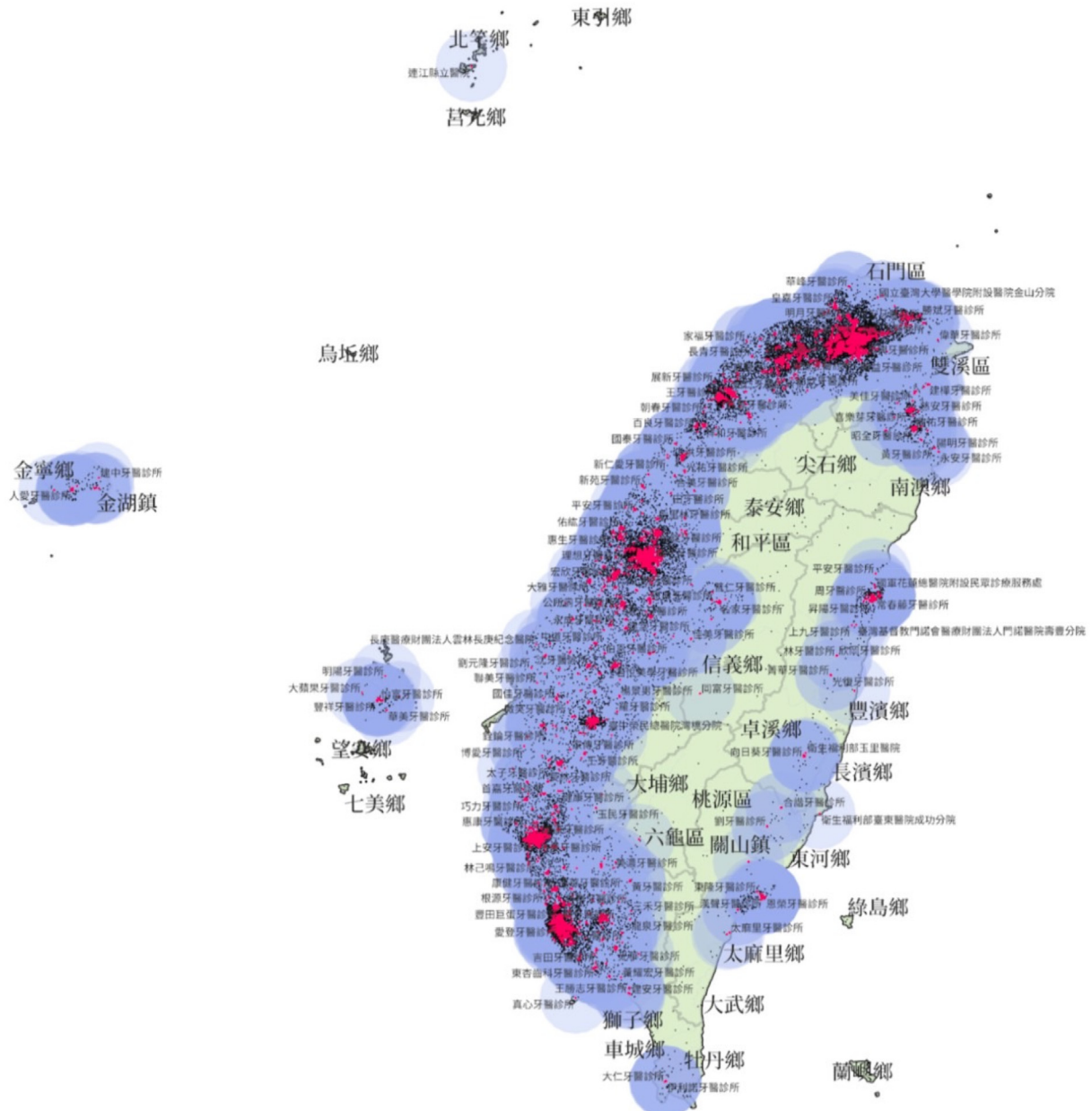
The geographical information system (GIS) technology is an interdisciplinary field, and its applications are widely used in the government departments, academic institutions, and private enterprises. Due to the vigorous development of the GIS technology, the government departments, academic institutions, and private enterprises have all undergone revolutionary changes in the application of geographical data. The large amounts of geographical data that originally exist in the government departments and academic institutions, such as the various maps, aerial photographs, reports, inventories, and statistical data, can be integrated into a geographical database through the GIS technology and computer networks. Moreover, through the development of the GIS application systems, the quality and efficiency of the government's spatial decision-making, planning, and management have been greatly improved. The academic institutions and private enterprises can also use the large amounts of geographical data from government for geographical information-related research and business management analysis.<sup>1</sup> This article aimed to use the spatial and geographical distribution analysis of a geographic information system software (QGIS) to draw the distribution map of accessibility coverage of dental institutions in Taiwan, and compare it with the population distribution.

According to the government statistics, there are totally 16,285 dentists in 7237 dental institutions (including 211 dental departments in hospitals and 7026 dental clinics) and 23,420,442 people in Taiwan in 2023, showing that there are 6.95 dentists per 10,000 people.<sup>2</sup> However, only from the overall data analysis, we could not know the actual spatial or geographical distribution of dentists or dental institutions, as well as the coverage of spatial accessibility of dental institutions. In order to obtain the above information, this study used the QGIS to draw the distribution maps. First, the longitude and latitude data of dental institutions were integrated through the Google Maps and imported into the QGIS to draw the distribution map of dental institutions. Second, the population data of districts/townships level were imported into the QGIS to draw the population distribution map. Third, with reference to previous research, a 15-km radius of a dental institution (reachable by car within 30 min) was set as the coverage area in the QGIS to draw the distribution map of the spatial accessibility coverage of dental institutions.<sup>3</sup> Finally, the above distribution maps were integrated to obtain the final diagram as shown in Fig. 1.

This diagram set a 15-km radius of a dental institution (reachable by car within 30 min) as the coverage area of the spatial accessibility of a dental institution. It could be

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**Figure 1** The diagram of the dental institution and population distributions, and the spatial accessibility coverage of dental institutions in Taiwan in 2023. The red dots represented the distribution of dental institutions, while the black dots represented the population distribution. The denser the dots, the more dental institutions or population were concentrated in these areas. It showed that the dental institution and population distributions were highly consistent and parallel. The purple areas represented areas covered by spatial accessibility of dental institutions, while the green areas represented areas not covered by spatial accessibility of dental institutions. These green areas had a sparse population distribution. The Chinese words were the names of dental institutions or places randomly displayed after the geographic information system software (QGIS) drawing was completed.

clearly seen that almost all of the Taiwan areas were covered by the spatial accessibility of dental institutions except for the central mountain range, some east coast areas, and the remote islands among outlying island counties, which had a sparse population distribution. In addition, the dental institutions and population were highly uniformly concentrated in the metropolitan areas of the western Taiwan, showing the extreme uneven geographical distribution of dental institutions and population in Taiwan.

Regarding the limitation of this study, it was consistently set a 15-km radius of a dental institution (reachable by car within 30 min) as the accessibility coverage of a dental institution, which was less accurate for the remote areas (such as mountainous areas and outlying islands). Overall, it could still be confirmed that most areas in Taiwan were covered within high accessibility to dental institutions. However, in Taiwan, there was still a sparse population distribution in the areas not covered by spatial accessibility

of dental institutions. The improvement of medical equality for these uncovered people must be taken seriously. Based on the existing health centers in Taiwan, dental treatment rooms are built in the health centers in the remote areas, and existing dentists are deployed to establish a dental itinerant medical service system to provide oral health services in the remote areas.<sup>4</sup> The locals in the remote areas are trained to become dentists at public expense for local practice in the future.<sup>5</sup> These are feasible ways to solve the problem of insufficient dental resources in the remote areas.

## Declaration of competing interest

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

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