Spatial Distribution of Dental Clinics in Pasig City, Philippines: A GIS-Based Approach

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ABSTRACT

Background. Dental clinics are the extension of dental professionals in delivering oral health care; however, comprehensive data on their distribution remains limited. Spatial analysis using Geographic Information Systems (GIS) offers a robust approach to evaluating disparities in dental service accessibility.

Objective. This study used ArcGIS to analyze the spatial distribution of private and public dental clinics across Pasig City, mapping their locations relative to population density and serving as a baseline for a feasibility assessment of a national study.

Methods. This is an ecologic study that employed an exploratory multigroup comparison design. Using GIS, the spatial distribution of dental health care facilities (dental clinics) in Pasig City, Metro Manila, Philippines was mapped in ArcGIS version 10.8.2. Data about the dental clinics in Pasig City were obtained from the Pasig City Government. Locations of each clinic were geocoded using ArcGIS. Population data were obtained from the Pasig City Government and the Philippine Statistics Authority (PSA). Analysis was conducted to assess population coverage within 5-kilometer radii of dental clinics, and clinic-to-population (CtP) ratios were calculated to evaluate service distribution.

Results. A total of 40 public dental clinics and 191 private dental clinics were distributed across the 30 barangays with a total population of 680,135. The dental clinic-to-population (CtP) ratio was 1:2,945, and the barangay with the lowest CtP ratio is Brgy. Sta Lucia. The barangays of San Antonio and Sta. Rosa had the highest CtP ratios: 1:199 and 1:98, respectively. The public dental clinic-to-population (PuCtP) ratio was highest in Brgy. Sta. Rosa, with the average PuCtP ratio in Pasig being 1:17,003. Over ten years, the number of private dental clinics generally trended upwards for six of those years. However, within that decade, there were also three years during which the number of clinics decreased. Several challenges were identified in the data collection and analysis for a national study on dental facilities. The study revealed the primary issues: the absence of a centralized database of information on the list of private dental health facilities and a centralized list of all public health facilities, including hospital-based facilities. Additionally, the Local Government Unit (LGU) list of population statistics differs from the numbers provided by the PSA. Despite these issues, using online data collection and analysis makes this study replicable on a national scale.

Conclusion. There is variability in the spatial distribution of private and public dental clinics in Pasig City, whereas private dental clinics were more concentrated in the highly commercialized barangays of the city. The findings and methodology of this study demonstrate the feasibility of mapping dental service distribution at a city level, providing a baseline for scaling to a regional or national level study.

Keywords: Geographic Information System, spatial analysis, dental clinics, health services accessibility

eISSN 2094-9278 (Online)
Published: August 15, 2026
https://doi.org/10.47895/amp.v60i15.14034

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INTRODUCTION

Approximately 3.5 billion individuals are affected by oral diseases, which is considered among the most prevalent noncommunicable conditions worldwide.[1] The burden of oral diseases is particularly severe in low- and middle-income countries, where the prevalence of untreated oral health conditions is present in nearly half of the population, highlighting disparities in healthcare accessibility and delivery.

In the Philippines, according to the 2018 National Survey on Oral Health, the prevalence of caries in Metro Manila is 78.96%, and that of gum disease is 43.29%.[2] Further, the healthcare system is fragmented and decentralized, where the national government transferred responsibility for government health services to LGUs, with private dental clinics operating independently, unaccounted for in national monitoring.[3-5] The passage of the Universal Health Care (UHC) Act of 2018 includes a strategic effort to address inequities, promoting universal and equitable access to healthcare services, including oral health.[6]

Assessing the spatial distribution of dental clinics can contribute to strategic planning, policy formulation, and resource allocation in public health accounting for oral health. Spatial analysis, the process of examining geographic patterns and relationships within data, offers valuable insights compared to methods that fail to account for spatial variation in the utilization of health services, which may limit their utility in identifying and addressing service gaps.[7,8]

Geographic Information Systems (GIS) provide a tool for analyzing the spatial availability of healthcare services, especially in urban contexts. GIS allows stakeholders to visualize and interpret patterns in service distribution and population needs.[9] However, despite the essential role of private dental clinics in the delivery of oral healthcare services, information regarding their geographic distribution remains limited and is often absent from official healthcare registries.

To the researchers' knowledge, no published studies have used GIS-based spatial analysis to assess the distribution of dental clinics in the Philippines. This study aims to address this evidence gap by determining the spatial distribution of public and private dental clinics in Pasig City and evaluating the spatial patterns in relation to population density and available socioeconomic indicators. The study supports national and global public health priorities, including the Department of Health's goal of equitable healthcare access and the United Nations Sustainable Development Goal 3 (SDG 3), particularly the promotion of access to essential healthcare services.[10] The findings are intended to serve as a baseline for scaling the methodology to a national level, guiding future research and policy toward a more equitable oral health service distribution.

MATERIALS AND METHODS

Study Area

The study area was Pasig City, one of the cities in the National Capital Region (NCR) in the Philippines. Located on the eastern border of Metropolitan Manila, it is bounded on the east by the municipalities of Cainta and Taytay in the province of Rizal. On the west, it is bounded by Quezon City and Mandaluyong City. In the north, it is bounded by Marikina, Pateros, and Taguig lies to its south. Having a total land area of 48.46 sq. km., it is divided into 30 villages, each called a "*barangay.*" These barangays were grouped into two legislative districts (Figure 1). The population of Pasig City was 680,135 at the time of the 2021 City-wide Census.[11] The barangays were presented with different population sizes ranging from at least 1000 residents to around 147,000. Sixty-seven percent (~452,800) of the residents were from the eight barangays of District 2. This highly urbanized city was selected for this study due to its active engagement in UHC initiatives, data accessibility, and representativeness within an urban setting.[12-14]

Study Design

Ecologic studies can be exploratory if there is no exposure of interest to be included in the analysis, or explanatory if an ecological association between the summary measures of the exposure and outcomes of the different groups will be explored. Groups of an ecological study can be further categorized by place (multi-group comparison design), by time (time-trend design), and by a combination of the two (mixed design). Therefore, this ecologic study employed an exploratory multigroup comparison design to examine the distribution of dental health care facilities (dental clinics) across barangays in Pasig City, Metro Manila, Philippines.[15,16]

Data Collection

The location and yearly distribution of private dental practices were obtained from the Business Permit and Licensing Department of the City Government of Pasig (email communication, July 2025). Information on public dental clinics housed in barangay health centers was provided by the Pasig City Health Department (email communication, June 2025). For other public health facilities, such as hospital-based practices, data were not available.

ArcGIS is a group of GIS mapping technology software products produced by the Environmental Systems Research Institute, Inc. (ESRI). Population statistics were provided by the Office of the City Mayor (email communication, June 2025), reflecting numbers from respondents of a City-wide Census (Community-based Monitoring System) in 2021, providing population per barangay.

Data Processing and Analysis

Descriptive analysis was employed in order to calculate clinic-to-population ratios in Microsoft Excel 2016 Version

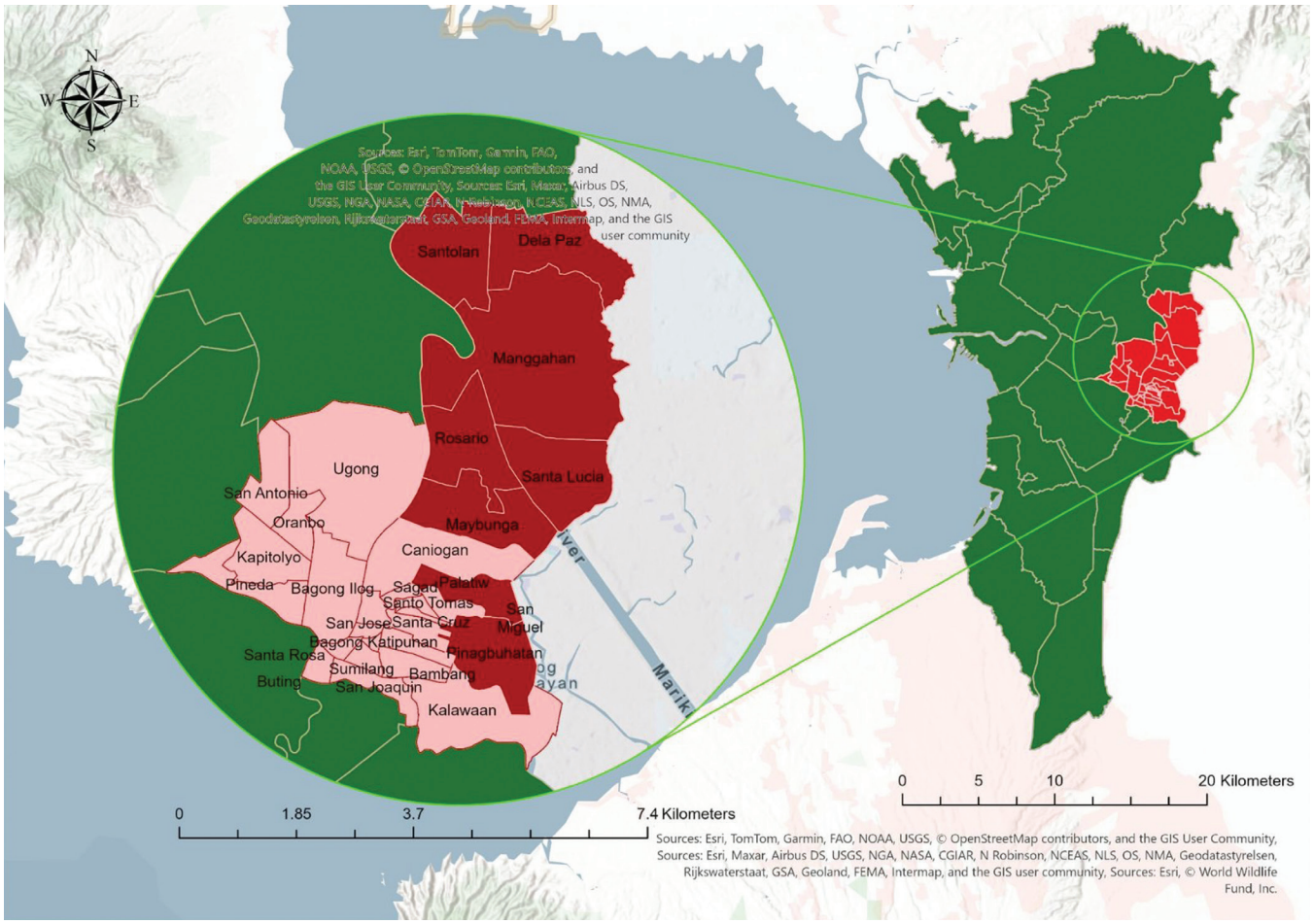

Figure 1. Reference map of Pasig City in the National Capital Region, Philippines. Pasig City is one of the 16 highly urbanized cities in NCR. It has 30 barangays, grouped into two distinct legislative districts.

16. Using ArcGIS 10.8.2 (Environmental Systems Research Institute, Inc., Redlands, CA, USA), Choropleth maps were developed to present the numbers of registered private dental clinics in Pasig City. Local Moran's I statistics were also performed in the identification of hotspots and cold spots of limited performance at a 95% confidence level. It is a local indicator of spatial association (LISA) that could identify the exact location of spatial aggregations. The statistic is given by the equation below:

$$I_i = \frac{x_i - \overline{X}}{S^2} \sum_{j=1,\ j\neq i}^{n} w_{i,j}(x_j - \overline{X})$$

A positive I value is indicative of aggregation of barangays with high dental clinic incidence or aggregation forming a cluster of high incidence barangays (dental clinic hotspots), or conglomeration of barangays with low dental clinic incidence forming a cluster of low incidence barangays (dental clinic cold spots). On the other hand, a negative I value indicates aggregation of barangays with different levels of dental clinic incidence, thus forming spatial outliers. A *p*-value of less than or equal to 0.05 is indicative of statistical significance of clustering.[17]

Document challenges related to data availability, cost, and technical aspects of GIS software for insights on scaling up the study to the national level were recorded in detail for feasibility assessment. This involved evaluating technical, operational, ethical, and legal aspects of mapping dental clinic distribution.

Ethical Considerations

All data were collected online through the Freedom of Information (FOI) process. The study used de-identified secondary data in full compliance with the Data Privacy Act of 2012. It was given exemption from Ethical Review by the University of the Philippines Manila Research Ethics Board (UPMREB 2025-0366-EX).

RESULTS

Comparative Distribution and Accessibility of Private Dental Clinics with Public Dental Healthcare Facilities in Pasig City

The city dental clinic-to-population (CtP) ratio was 1:2,945. The barangay with the lowest CtP ratio is Brgy. Sta Lucia. The Barangays of San Antonio and Sta. Rosa had the highest CtP ratios: 1:199 and 1:98, respectively. The public dental clinic-to-population (PuCtP) ratio was highest in Brgy Sta Rosa, with an average PuCtP ratio of 1:17,003 in Pasig. Six barangays had no private clinics (Table 1).

Distribution of Private and Public Dental Clinics in Relation to Pasig City's Population Density

A total of 40 public dental clinics and 191 private dental clinics (as of June 2025) were distributed across the 30 barangays. In total, 231 clinics (40 public and 191 private)

Table 1. Dental Clinic/Population Ratios of Different Barangays in Pasig City, Arranged by District

Barangay	Population	Land area (km²)	Dental clinics (n)	DCPu (n)	DCPr (n)	CtP ratio	PuCtP ratio	PrCtP ratio
District 1								
Bagong Ilog	14,380	1.213	4	1	3	1:3,595	1:14,380	1:4,793
Bagong Katipunan*	1,268	0.02231	1	1	-	1:1,268	1:1,268	–
Bambang	19,259	0.521	2	1	1	1:9,630	1:19,259	1:19,259
Buting	9,368	0.3485	4	1	3	1:2,342	1:9,368	1:3,123
Caniogan	25,883	1.044	10	1	9	1:2,588	1:25,883	1:2,876
Kalawaan	27,757	1.008	3	2	1	1:9,252	1:13,879	1:27,757
Kapasigan*	4,402	0.1566	11	1	10	1:400	1:4,402	1:440
Kapitolyo	7,531	1.017	13	1	12	1:579	1:7,531	1:628
Malinao*	3,959	0.2414	6	1	5	1:660	1:3,959	1:792
Oranbo	2,928	0.5212	5	1	4	1:586	1:2,928	1:732
Palatiw	23,333	0.3038	5	3	2	1:4,667	1:7,778	1:11,667
Pineda	17,942	0.5815	2	1	1	1:8,971	1:17,942	1:17,942
Sagad	6,687	0.1096	4	1	3	1:1,672	1:6,687	1:2,229
San Antonio	7,362	0.7376	37	1	36	1:199	1:7,362	1:204
San Joaquin	12,523	0.5921	5	1	4	1:2,505	1:12,523	1:3,131
San Jose*	1,703	0.093	1	1	-	1:1,703	1:1,703	–
San Nicolas	2,513	0.2296	1	1	-	1:2,513	1:2,513	–
Santa Cruz	5,435	0.04697	9	1	8	1:604	1:5,435	1:679
Santo Tomas	10,698	0.1381	1	1	-	1:10,698	1:10,698	–
Santa Rosa*	1,173	0.1503	12	1	11	1:98	1:1,173	1:107
Sumilang*	5,627	0.1072	1	1	-	1:5,627	1:5,627	–
Ugong	15,604	3.749	10	1	9	1:1,560	1:15,604	1:1,734
District 2								
Dela Paz	16,958	1.314	6	1	5	1:2,826	1:16,958	1:3,392
Manggahan	86,788	3.558	18	3	15	1:4,822	1:28,929	1:5,786
Maybunga	36,271	2.186	12	2	10	1:3,023	1:18,136	1:3,627
Pinagbuhatan	147,950	3.546	19	3	16	1:7,787	1:49,317	1:9,247
Rosario	47,092	2.594	15	1	14	1:3,139	1:47,092	1:3,363
San Miguel	28,683	1.224	8	1	7	1:3,585	1:28,683	1:4,098
Santa Lucia	37,628	1.872	2	2	-	1:18,814	1:18,814	–
Santolan	51,430	2.079	4	2	2	1:12,858	1:25,715	1:25,715
Total	680,135	31.30	231	40	191			

*DC – Dental Clinic; DCPr – Private dental clinics as of 2025; DCPu – Public dental clinics as of 2025; CtP – dental clinic to population; Population – as of 2021 from the Community-based Monitoring System; PrCtP – private dental clinic to population; PuCtP – public dental clinic to population; *Heritage Preservation Zones*

were included in this study (Table 2). Brgy. San Antonio had the highest number of dental clinics (37), 97% of which are private dental clinics. Brgy. Pinagbuhatan, with the largest population of 147,950, has only 19 dental clinics (Figure 2). Public dental clinics are more evenly distributed throughout the city, with District 1 holding a 65% share, despite its smaller population (Figure 3).

For almost a decade, Brgy. San Antonio has been a stable hotspot of dental clinics in Pasig City. Oranbo was identified as a stable hotspot from 2016 to 2022 only (Figure 4).

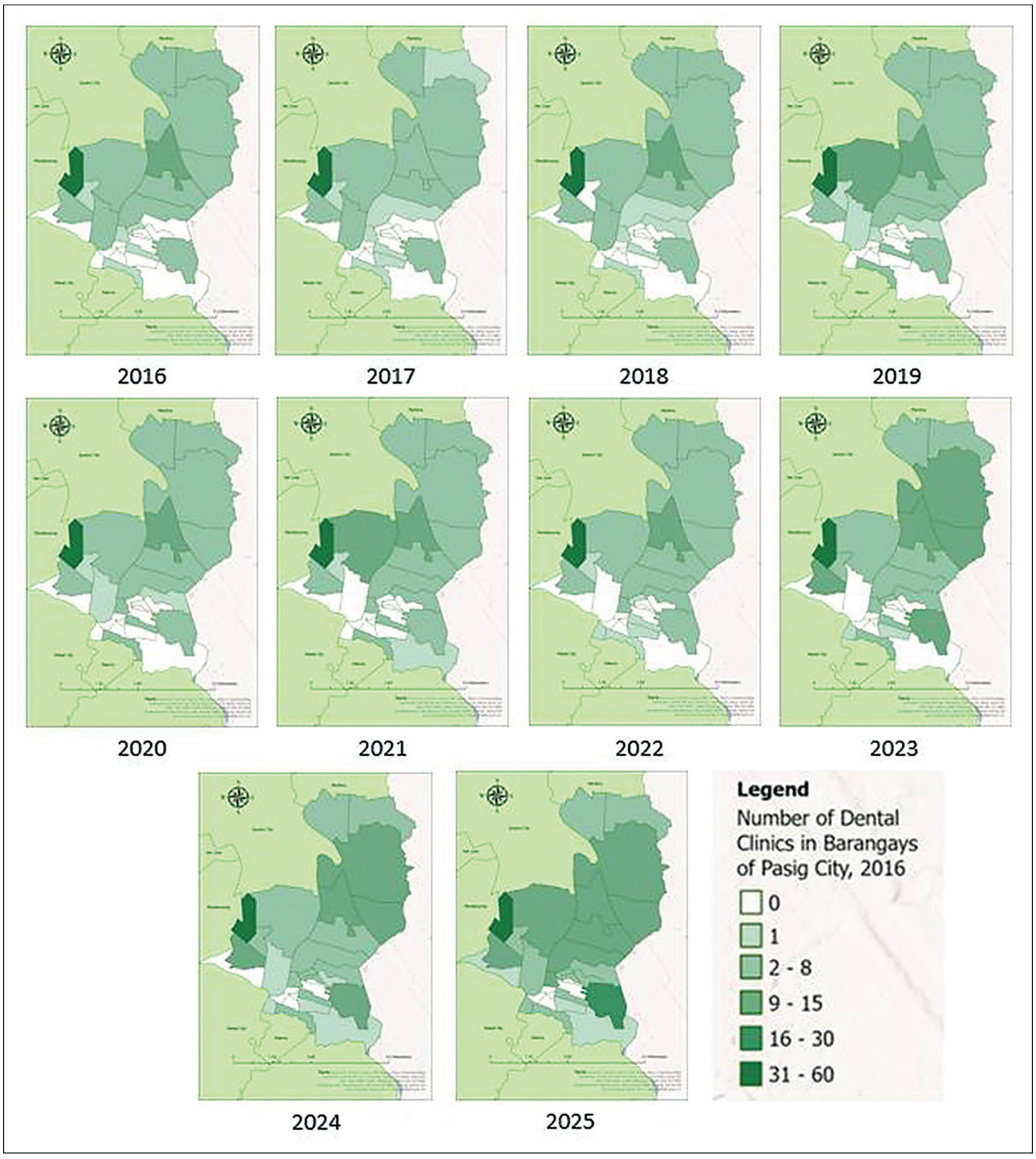

Figure 2. Number of registered private dental clinics in Pasig City, Metro Manila, Philippines, 2016–2025.

Table 2. Number of Dental Clinics and Dental Clinic/Population Ratios Stratified according to District (D1 and D2)

	Population	Land Area (km²)	DCs	DCPu (n)	DCPr (n)	CtP ratio	PuCtP ratio	PrCtP ratio
District 1 – 22 Barangays	227,335	9.48878	147	25	122	1:1,546	1:9,093	1:1,863
District 2 – 8 Barangays	452,800	21.816	84	15	69	1:5,390	1:30,187	1:6,562
Total	680,135	31.30	231	40	191	1:2,945	1:17,003	1:3,561

DCs – Dental Clinic; DCPr – Private dental clinics as of 2025; DCPu – Public dental clinics as of 2025; CtP – dental clinic to population; Population – as of 2021 from Community-based Monitoring System; PrCtP – private dental clinic to population; PuCtP – public dental clinic to population

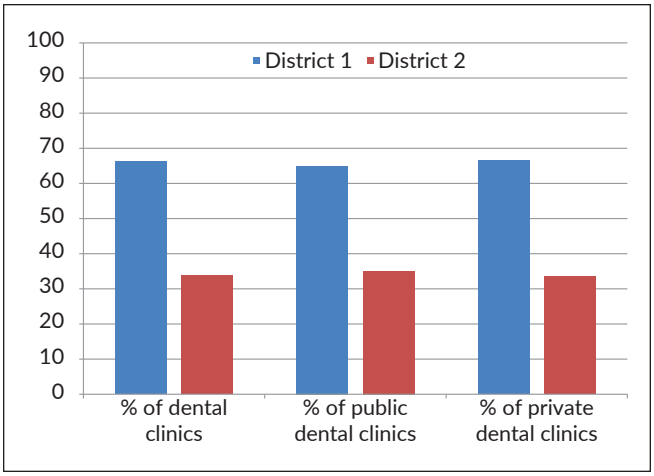

Figure 3. Percentage of public and private dental clinics for each district in Pasig City.

Distribution Trends of Private Dental Clinics over a Ten-year Period

Over 10 years, from 2016 to 2025, the number of dental clinics fluctuated between growth and decline. A sharp reduction was observed in 2017 (–19.47%) compared to the baseline year, followed by a strong recovery in 2018 (+10.99%). Another decrease was recorded in 2022 (–6.72%), but subsequent years showed substantial increases, with growth peaking in 2024 (+27.61%), the highest level in the period included. Although there was a decline in 2025 (+11.7%), the overall trend indicates a net increase in the number of dental clinics compared with the baseline year. These findings suggest that, despite intermittent downturns, the long-term trajectory reflects a significant expansion in the number of dental clinics over the decade (Figure 5).

Potential Challenges Identified in Data Collection and Analysis for a National Study

During the study, several challenges in data collection and analysis were identified. One is the absence of a centralized database that consolidates information on private dental clinics, making it difficult to obtain a comprehensive view of service availability on a national level. Although public dental clinics are documented, there is no unified list that captures all types, including hospital-based and school-based dental facilities, which can limit the accuracy of facilities mapping. An additional challenge is the variations between population statistics from local government units and official figures released by the PSA. These discrepancies highlight the need for standardized, coordinated data management systems to support evidence-based planning and policymaking in health care.

Feasibility of Replicating Data Collection and Analysis on a National Scale

Based on the experiences from this study, the feasibility of replicating data collection and analysis on a national scale provided valuable insights for scaling up the methodology. One main consideration is the cost-benefit balance, particularly the investment of time and resources required to hire and train data collectors, as well as to consolidate and validate data from multiple sources. Another challenge concerns the use of Freedom of Information (FOI) channels, which often necessitate detailed, highly specific requests to obtain the needed information, thereby prolonging the data-gathering process. These emphasize the importance of developing streamlined strategies and allocating resources to ensure the feasibility of conducting the study at a national level.

DISCUSSION

The main aim of this study is to explore the spatial distribution of public and private dental clinics across the 30 barangays in Pasig City and to inform future strategies for a national study. As of writing, the Department of Health's (DOH) Health Services and Facilities Regulatory Bureau, responsible for overseeing health facilities in the country, has yet to regulate private dental clinics (Director IV, HFSRB, Philippines; personal communication; 2024 Sep 25). Instead, their registration and regulation are handled by local government units and are subject to local memoranda. The decentralized oversight poses challenges for data collection and underscores the need to identify an appropriate strategy for broader replication of the study.

Although the overall city-wide CtP ratio for Pasig City is within the World Health Organization (WHO) recommendation of 1:10,000, the distribution of dental clinics across the 30 barangays of Pasig City revealed significant differences in access to oral healthcare services.[18] Brgy. San Antonio, a highly commercialized area with only a mid-range residential population, had the highest number of clinics (37), with over 97% privately operated, suggesting a mix of dental clinic types, favoring a target population that

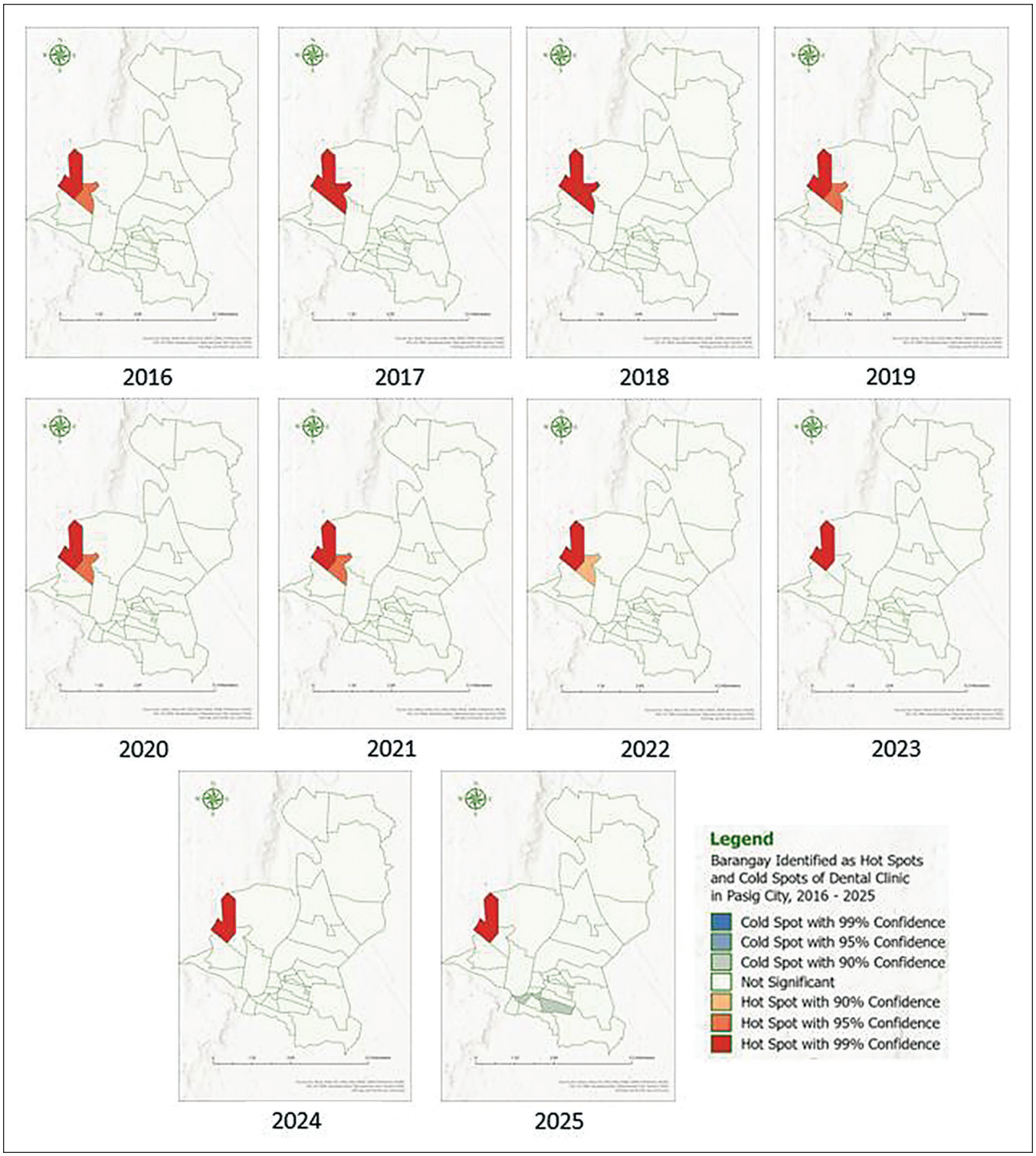

Figure 4. Local cluster analysis of the 30 barangays in Pasig with hotspot analysis from 2016 to 2025.

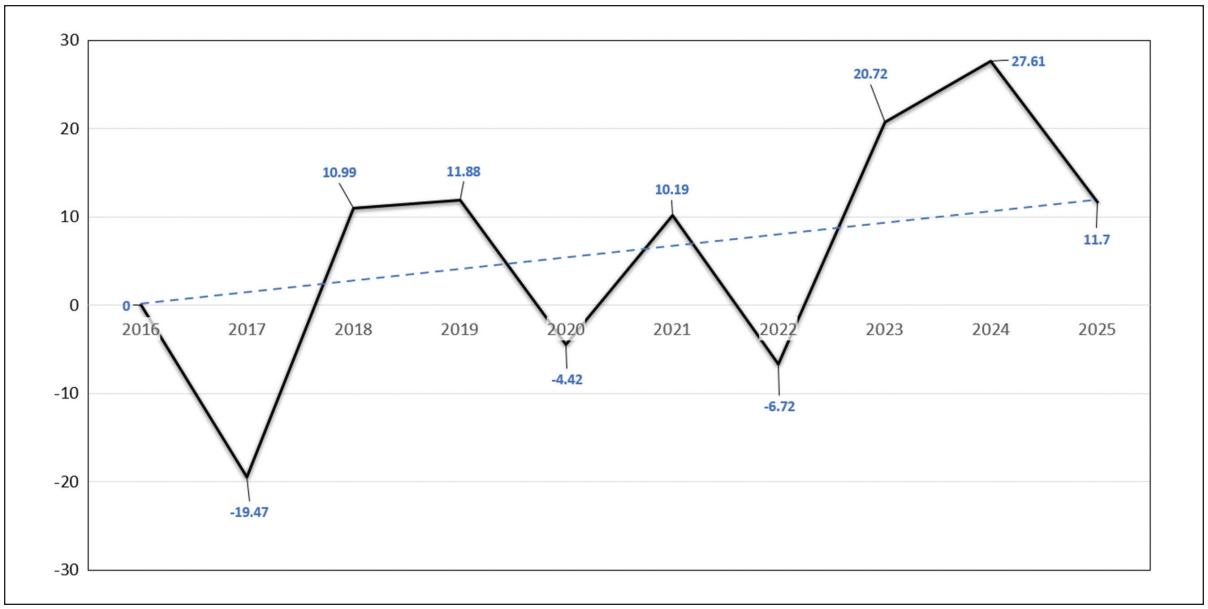

Figure 5. Percentage growth of private dental clinics within a 10-year period.

may be economically better off. Hence, it was identified as a stable hotspot in local cluster analysis. In comparison, the highly populated Brgy. Pinagbuhatan, remained underserved, suggesting that clinic availability may not be proportionate with population density.

Each barangay in Pasig City houses at least one public dental clinic. Still, these facilities accounted for only a minority of the total and showed disproportionate clustering in District 1, even though District 1 accounted for only 33% of the city's population. This difference in distribution suggests potential barriers to access to dental care for the residents of District 2, where 67% of the population resides. All dental facilities were located 0.5 to 2 kilometers from the barangays, but availability does not always equate to accessibility. This is especially true when private clinics dominate service availability, and the difference in affordability from public dental clinics may hinder utilization and service acceptability, as noted in Penchansky's framework of access, where the concept of access includes five distinct dimensions: availability, accessibility, accommodation, affordability, and acceptability.[19]

The findings of this study are similar to previous international research. Bohari et. al. showed similar trends in Malaysia where dental health facilities are concentrated around cities with higher economic activity and population density.[20] Similar to the key finding of the study by Kruger, where practices are highly concentrated in the most populous and high socioeconomic areas of West Australia, since practice operation is fundamentally on a user-pays basis.[21] Except that this present study showed higher concentrations of private dental clinics around areas with higher economic activity, and not in areas with higher population density. Liu et al. also emphasized the impact of sociodemographic factors on clinic distribution in selected cities in China.[22] Aligning with these studies, this research shows the influence of commercialization or urbanization in private clinic location patterns, often in contrast with population health needs.

The 20% increase in private dental clinics from 2022 to 2024 may reflect a dynamic oral healthcare landscape, possibly driven by shifts in urban development or the LGU's leadership. It should also be noted that the absence of private clinics in six barangays with lower socioeconomic activity demonstrates gaps that may reinforce health inequity. Some barangays in Pasig without private dental clinics are within the Heritage Preservation Zone, which can impede the establishment of private dental clinics due to conservation restrictions and preservation priorities.[23]

All barangays in Pasig are considered urban, but the lack of socioeconomic data at the barangay level and inconsistencies between the LGU and PSA population statistics represent key limitations.[24] Still, this study demonstrated the feasibility of scaling this research approach nationally, assuming adequate support for FOI channels, data-sharing protocols, and availability of GIS tools.

The findings of this study may support policy interventions under the UHC Act – such as partnering with private dental clinics to offer incentives for opening in underserved areas, as well as exploring price control subsidies for essential oral health services.[25] A recommendation is for the DOH to facilitate a centralized registration of private clinics, allowing for a database that can support strategic planning for better health equity.

In summary, Pasig City demonstrated high geographic availability of dental clinics, with variability in their distribution. The findings suggest that clinic presence does not

resolve public health challenges and that evidence-based policy adjustments are essential. The procedure piloted in this study provided a scalable blueprint for nationwide mapping of dental health facilities, contributing to discussions on equity, health systems planning, and spatial epidemiology.

However, the scope of the study was limited by several factors. These include the absence of data from the local dental chapter, household income or poverty index per barangay, and data on education level, road networks, and transportation modes. While our findings highlight the importance of incorporating geographical context, a more complete understanding of dental service distribution requires consideration of other variables, such as social determinants of health, which may be more difficult to collect. Future studies may attempt to incorporate these variables and expand the study to a national context.

CONCLUSION

The analysis revealed significant variability in the distribution of private and public dental clinics in Pasig City, with private dental clinics more concentrated in the city's highly commercialized barangays. The findings and methodology of this study, however, demonstrate the feasibility of mapping dental service distribution at the city level, providing a baseline for scaling to a regional or national-level study.

Of particular importance, future research should prioritize the mapping of rural and underserved areas, where access to dental care is often most critical and least understood. Additionally, it is recommended that subsequent mapping efforts employ primary data collection using a Global Positioning System (GPS) to obtain precise XY coordinates, enabling the generation of spot maps that accurately reflect the geographic distribution of dental clinics, which is out of the scope of the current study.

Acknowledgments

The authors would like to thank the City Government of Pasig, especially to the Business Permit and Licensing Office, City Health Department, Office of the Mayor, and Ugnayan ng Pasig during data acquisition; and to Ms. Jasmine Joelle Santos, Engr. Mike Capua and the UPCD Ad Hoc Committee for the Special Issue of AMP for their assistance that led to the accomplishment of this study.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Authorship Declaration

All authors declared no conflicts of interest.

Funding Source

None.

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