

# Geographic information system-based comparison of the accessibility of primary public dental care for children in Saudi Arabia

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## Research Article

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# Abstract

**Objective:** To examine the geographic distribution and accessibility of primary public dental services (PPDS) for the child population in Al Madinah in comparison with that in Jeddah in Saudi Arabia (SA).

**Methods:** A cross-sectional study design was used to conduct this descriptive study in two of the main cities in the western region of SA: Al Madinah and Jeddah. PPDS locations were mapped using geographic information system (GIS) and associated with child population data of 0- to 17-year-olds, within buffers of 1,2.5, and 5 km around each PPDS location.

**Results:** An uneven distribution of dental services was found, with services concentrated in certain districts (with high density populations) in both cities and other districts with far fewer or no dental services. The proportion of children who lived within 1 km of a dental service was 53% in Al Madinah and 22 % in Jeddah. Most children lived within 5 km of public health centres in both cities.

**Conclusion:** In both cities, acceptable access to dental services for children was found on the basis of the data and variables analysed in this study. However, further analysis is recommended.

## Background

Access to health care is one of the determinant of oral health in children and is a critical public dental health issue. Different methods have been developed to evaluate accessibility to dental care from various aspects. Penchansky and Thomas's theory of access to health care incorporated several dimensions: accessibility; availability; acceptability; affordability; and accommodation(1). The main focus in this study is on the aspect of geographic accessibility.

Geographic information system (GIS) has been adopted in dental health planning in recent years to measure the spatial dimensions of access to dental care services and to identify inequalities in the provision of health care (2). A recent study investigated access to private and public dental care in New South Wales (NSW) in Australia using GIS and found an uneven geographic distribution of services across the state (3). Furthermore, when the geographic distribution was examined according to socioeconomic conditions, it was found that in the rural part of NSW, 12% of the most deprived population, compared with 0% of the least deprived population, lived farther than 50 km from a public dental care service.

In Saudi Arabia (SA), children experience an alarming level of dental caries, despite all the developments and investments made in the dental health sector by the government. The results from our previous study indicated that among schoolchildren in Al Madinah, the prevalence of caries was incredibly high (85%) (4). Dental care service utilisation was driven mainly by symptomatic dental care, and regular dental clinic visits were a rare behaviour (9.2 % (4)).

Nevertheless, the application of GIS in SA in dental public health research is uncommon. Alsharif (2020) examined the geographic distribution of private and public dental services in Al Madinah and found that 37% of the districts in the city were recognised as areas of need and were mainly located in the peripheral areas of the city (5). Al Madinah is a city in the western region in SA and the second holist city in Islam while Jeddah is the gateway city to the two main holy cities in SA, Makkah and Al Madinah. The aim of this study was to examine the distribution and accessibility of primary public dental services (PPDS) in Al Madinah in comparison with that in Jeddah, and to determine if the distribution of dental services reflects the geographic and demographic characters of the child population.

## **Materials And Methods**

A cross-sectional study design was used to conduct this descriptive study in two of the main cities in the western region of SA: Al Madinah and Jeddah. All the data used was obtained from open-access online sources; therefore, no ethical approval was required. Microsoft Office Excel software was used to store the data collected.

### **2.1 Data sources**

#### **2.1.1 Child population data**

The population data of the urban area of each city were obtained from (2010) census data which is the latest data available on the General Authority of Statistics website (6). As child population data were not available at the city level, an estimation for children aged between 0 and 17 years old was made on the basis of the SA "United Nations Children's Fund" country profile document (UNICEF, 2016). The child population data were then divided by census collection districts (CD), which are outlined by geographic boundaries.

#### **2.1.2 Primary public dental service locations**

Primary public dental services (PPDS) are publicly funded dental clinics by the Ministry of Health in SA located and provide at primary public health centers.

The location of all PPDS was obtained from the Ministry of Health website (8). The PPDS in SA operate with integrated child and adult services. Thus, the dental services mapped in this study provide services for all age groups.

### **2.2 Mapping**

The PPDS locations were geocoded using geocoding website which is a free-access form Google Maps. Geographic coordinates which constitute of longitudes and latitudes were allocated to the addresses of the PPDS locations. The data collected were transferred into QGIS software (version 2.14.1) for the analysis.

To evaluate geographic accessibility to PPDS, buffers were made to measure the child population in catchment areas. The buffers were constructed with radii of 1, 2.5, and 5 km were produced around the public health centres and used as substitutes for driving distances. The use of the buffers enabled quantification of the child populations inside and outside each catchment area. Child population sizes were extracted within or outside the different buffers created around the dental service locations. The numbers in the tables were rounded off to the nearest hundred, and the percentages are shown as whole numbers, as they are modelled estimates.

## Results

Al Madinah had a total number of 103 CDs with a total population of 1,105,465 in 2010, which represents 4% of the total Saudi population. By contrast, Jeddah had 128 CDs and a higher population density, with a total population of 3,430,697, which represents 12.6% of the total Saudi population. The 0- to 17-year-old child population in 2010 was estimated to be 330,206 in Al Madinah and 1,024,762 in Jeddah. The total number of PPDS geocoded was 38 in Al Madinah and 54 in Jeddah.

An uneven distribution of public dental services was observed, with services more concentrated in the city centre in Al Madinah and in the southern part of Jeddah (shown in Figs. 1 and 2). In Al Madinah, the number of CDs with high-density populations ranged from 453 to 1690, with the number of dental services ranging from 2 to 3 per district, compared with 0 to 1 in districts with low-density populations. In Jeddah, the number of CDs with high-density populations ranged from 1,393 to 6,638, with 1–2 services per districts, although most of the districts with low-density populations had no dental services.

One (53%) of two children lived within 1 km of a dental service in Madinah, compared with 22% (1:5) in Jeddah (shown in Table 1). In Madinah, most children lived within 5 km of public dental health services (96% vs. 90% in Jeddah), leaving a small percentage of children residing outside the 5-km zone.

Table 1

Distributions of Children aged between 0 and 17-years who resided inside and outside the buffer zones from primary public dental services in Al Madinah and Jeddah.

Distance from public dental services, km	Al Madinah (N*) %		Jeddah (N*) %	
	Within the zone	Outside the zone	Within the zone	Outside the zone
1	(174,700) 53	(155,500) 47	(228,600) 22	(796,100) 80
2.5	(265,000) 80	(65,300) 20	(676,300) 66	(348,400) 34
5	(317,300) 96	(13,000) 4	(886,900) 90	(137,900) 10

\*numbers are rounded up to the nearest hundred

## Discussion

The principal outcome of this study was the geographic distribution of public dental services according to the child population demographics in Al Madinah, in comparison with that in Jeddah.

An uneven distribution of dental services was found, with services concentrated in certain districts with high-density populations in both Al Madinah and Jeddah. However, some highly populated districts had far fewer or no dental care services. This result aligns with the finding of a previous study that 38% of districts had limited access to dental services (9). This unequal distribution of dental services in relation to population density can also be observed in other countries worldwide (10, 11) .

The distribution of public dental care services according to the data analysed in this study is considered acceptable, with most children living within 5 km from a public dental service in both Al Madinah and Jeddah, but with relatively better access in Al Madinah than in Jeddah. However, these results should be interpreted with caution because many variables were not considered in the analysis. All the distances referred to in the findings were Euclidean distances, and the actual travel distance to a service might be farther than 5 km.

One factor to consider is that the dental services were not dedicated solely to children; they catered to both adults and children. Dental services focused on children, such as school dental services, which operate in other countries such as Australia, New Zealand and the United States, are lacking in SA (12, 13). Moreover, the dentist-to-population ratio in PPDS in Al Madinah (1:10,848) is higher than the ratio recommended by the World Health Organization (1:7,500) (9, 14). In addition, each primary healthcare centre serves a large proportion of the population. According to the annual statistics report in 2017, the average number of people served by each centre in SA was 13,813 persons (15).

In addition, barriers to access to dental care have been reported in SA including the lack of dentists in the community, and long waiting lists and times at clinics, which add to the perception that public dental care is of low quality compared with private dental care (16, 17).

The results are challenged by the inadequate transport facilities in SA. Private cars are the primary means of transport in SA and public transport systems are lacking in the cities which contributes to the burden of and barriers to low-income families.

Private dental services, which have been increasing in number in recent years, were not incorporated in the analysis. However, children from families of low socioeconomic status could not afford the high cost of private dental care compared with the free public dental care services delivered by the government.

The number of dentists per public dental service was not examined in the study; however, the shortage of dental workforce is expected to influence the results of this study. Public health policies to address the maldistribution of the workforce and dental health centers in cities and rural areas are recommended.

## Conclusion

Our results identify areas where there is limited access to PPDS. And although we found most children residing within the 5-km zone appeared to be covered by dental care services, many factors should be considered when interpreting these results. The findings of this study could provide a foundation for future research and guide policy makers in identifying locations for additional and new dental services in SA.

## Declarations

### Ethics approval and consent to participate

All the data used was obtained from open-access online sources; therefore, no ethical approval was required. The study was conducted in accordance with the principles of World Medical Association of Helsinki.

### Consent for publication

Not applicable.

### Availability of data and materials

The population data were obtained from the website of General Authority of Statistics, Kingdom of Saudi Arabia through this link <https://www.stats.gov.sa/en/5655> and geographic data for PDD are available from The Ministry of Health website through this link [https://www.moh.gov.sa/eServices/interactive-maps/Pages/default.aspx#/.](https://www.moh.gov.sa/eServices/interactive-maps/Pages/default.aspx#/)

### Competing interests

The authors have no conflicts of interest to declare.

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This research didn't receive funding.

### Author's Contributions

A.A. was the principal investigator for this study, proposed the study design, reviewed the literature, analysed the data, interpreted the results, and wrote the manuscript draft. A.T.A. and E.K. revised and critically commented on the manuscript draft and approved the final draft of the manuscript. And M.T. analysed the data, revised and critically commented on the manuscript draft and approved the final draft of the manuscript.

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## References

1. Penchansky R, Thomas JW. The Concept of Access: Definition and Relationship to Consumer Satisfaction Original Articles The Concept of Access. 1981;19(2):127–40.
2. Ishfaq M, Lodhi BK. Role of GIS in social sector planning: Can developing countries benefit from the examples of primary health care (PHC) planning in Britain? *Journal of Community Health*. 2012;37(2):372–82.
3. Willie-Stephens J, Kruger E, Tennant M. Public and private dental services in NSW: a geographic information system analysis of access to care for 7 million Australians. *N S W Public Health Bull*. 2014;24(4):164–70.
4. Aqeeli A, Alsharif AT, Kruger E, Tennant M. Factors Influencing Children's Regular Attendance at Dental Clinics in Al Madinah, Saudi Arabia. *Saudi Journal of Health Systems Research*. 2021;1–7.
5. Alsharif A. The protective role of resilience in emotional exhaustion among dental students at clinical levels. *Psychology Research and Behavior Management*. 2020;13:989–95.
6. General Authority for Statistics in Kingdom of Saudi Arabia. Population Characteristics surveys 2017 [Internet]. [cited 2020 Apr 20]. Available from: <https://www.stats.gov.sa/en/5655>
7. UNICEF. Saudi Arabia Country Profile [Internet]. Available from: [https://data.unicef.org/wp-content/uploads/country\\_profiles/Saudi Arabia/country\\_profile\\_sau.pdf](https://data.unicef.org/wp-content/uploads/country_profiles/Saudi Arabia/country_profile_sau.pdf)
8. The Ministry of Health. Interactive map of health services [Internet]. Available from: <https://www.moh.gov.sa/eServices/interactive-maps/Pages/default.aspx#/>
9. Alsharif AT. Georeferencing of Current Dental Service Locations to Population Census Data: Identification of Underserved Areas in Al Madina, Saudi Arabia. *SAGE Open*. 2020;10(4).
10. Alsaigh E, Kruger E, Tennant M. Improving iraqi school dental services: A gis-based study of service location optimisation. *Community Dental Health*. 2020;37(3):180–4.
11. Md Bohari NF, Kruger E, John J, Tennant M. Analysis of dental services distribution in Malaysia: a geographic information systems – based approach. *International Dental Journal*. 2019;69(3):223–9.
12. Arenson M, Hudson PJ, Lee N, Lai B. The Evidence on School-Based Health Centers: A Review. *Global Pediatric Health*. 2019;6:2333794X1982874.
13. Ha DH. Oral health of Australian Indigenous children compared to non-Indigenous children enrolled in school dental services. *Australian Dental Journal*. 2014;59(3):395–400.
14. World Health Organization. WHO | Promoting Oral Health in Africa [Internet]. Who. 2016. 126 p. Available from: [http://www.who.int/oral\\_health/publications/promoting-oral-health-africa/en/%0Ahttp://www.afro.who.int/](http://www.who.int/oral_health/publications/promoting-oral-health-africa/en/%0Ahttp://www.afro.who.int/)
15. The Ministry of Health. Statistical Year Book [Internet]. 2015. Available from: <https://www.moh.gov.sa/en/ministry/statistics/book/pages/default.aspx>

16. Alshahrani A, Raheel S. Health-care System and Accessibility of Dental Services in Kingdom of Saudi Arabia: An Update. *Journal of International Oral Health*. 2016;8(8):883–7.
17. Al-Jaber A, Da'ar OB. Primary health care centers, extent of challenges and demand for oral health care in Riyadh, Saudi Arabia. *BMC Health Services Research* [Internet]. 2016;16(1):1–8. Available from: <http://dx.doi.org/10.1186/s12913-016-1876-6>

## Figures

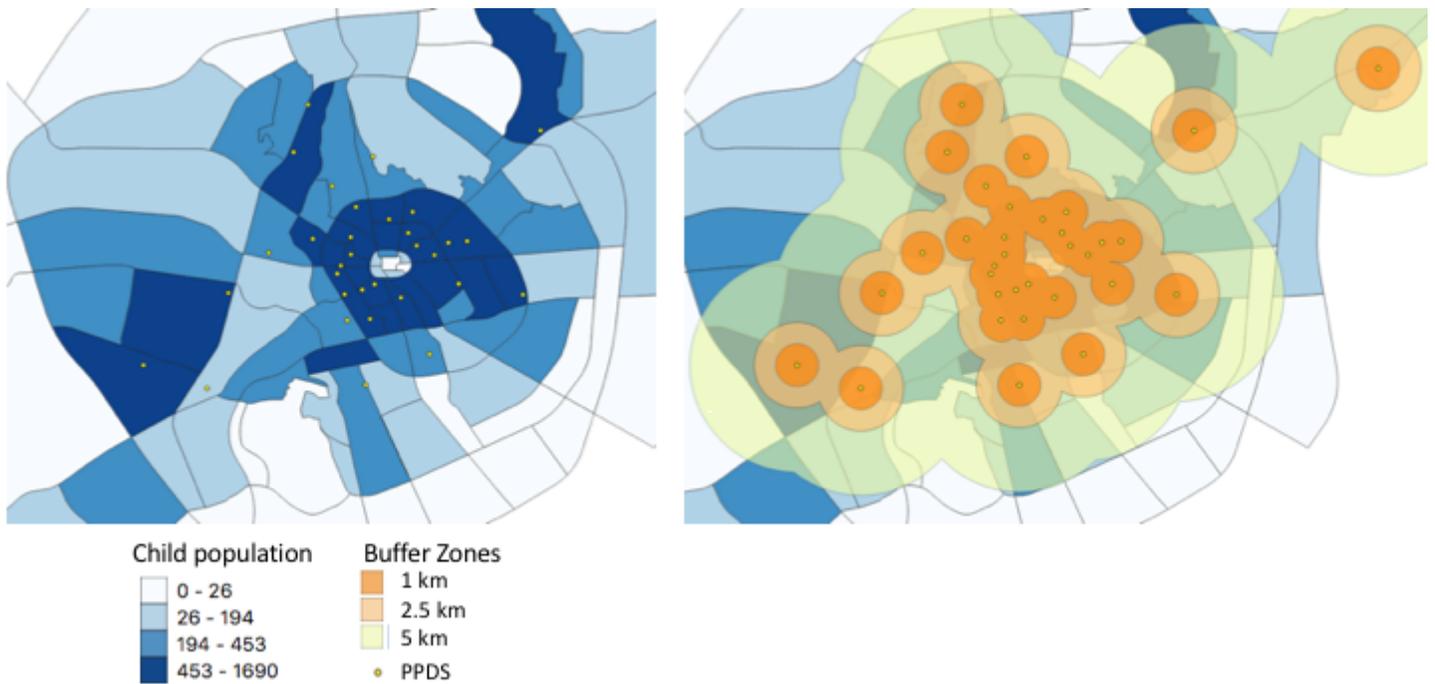
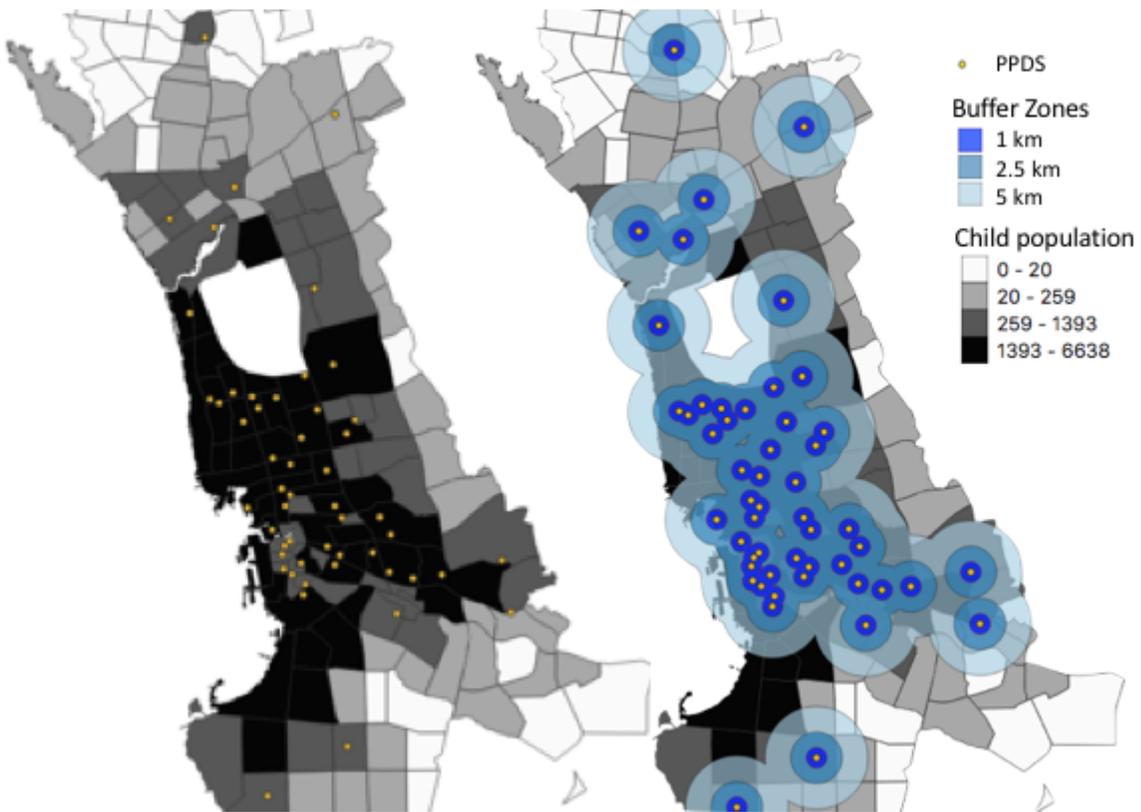


Figure 1

Access to primary public dental services in Al-Madinah with 1, 1.2 and 2.5 km.



**Figure 2**

Access to primary public dental services in Jeddah with 1, 1.2 and 2.5 km.