Saudi Dental Journal (2019) 31, 157–164

King Saud University

Saudi Dental Journal

www.ksu.edu.sa
www.sciencedirect.com

REVIEW ARTICLE

Regional caries data availability in Saudi Arabia: Impact of socioeconomic factors and research potential

Asim Al-Ansari [a], Maha El Tantawi [a,*], Mohamed Mehaina [b], Muhanad Alhareky [a], Shazia Sadaf [c], Jehan AlHumaid [a], Adel AlAgl [a], Fahad Al-Harbi [d]

[a] *Department of Preventive Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia*
[b] *Alexandria and Mediterranean Research Center, Bibliotheca Alexandrina, Corniche, Alexandria 21526, Egypt*
[c] *Department of Dental Education, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia*
[d] *Department of Substitutive Dental Sciences, College of Dentistry, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia*

Received 18 November 2018; revised 3 January 2019; accepted 6 January 2019
Available online 14 January 2019

KEYWORDS

Data collection;
Information dissemination;
Epidemiological monitoring;
Geographic information systems;
Schools, dental;
Saudi Arabia

Abstract *Background and aims:* Monitoring oral diseases is needed to allocate resources, plan health services and train dental workforce. Caries is one of the oral diseases most commonly included in oral health surveillance systems. The present study assessed (1) caries data availability in the administrative regions of Saudi Arabia and (2) factors associated with this availability.

Methods: We collected caries data in the period 2008–2018 in Saudi Arabia (outcome variable). The explanatory variables included region-level factors: (a) socio-economic indicators (percentage of individuals with university education, percentage of category A governorates, percentage of owned houses, households with computers, internet and smart phones) and, (b) oral health research potential indicators (number of Dental Public Health (DPH) specialists, Ministry of Health (MoH) dentist to population ratio and number of dental schools). ArcGIS was used for data visualization and logistic regression was used for analysis.

Results: Twenty-two studies provided caries data for 46.2% of the regions which were inhabited by 84.7% of the population. Region-level data availability was associated with the number of dental

* Corresponding author.
E-mail address: maha_tantawy@hotmail.com (M. El Tantawi).
Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.sdentj.2019.01.004

schools (OR = 1.63) with 61.5% of the regions correctly classified. More regions were correctly classified when population to MoH dentist ratio (76.9%) and the number of DPH specialists (92.3%) were included.

Conclusions: Caries data were available for half of the administrative regions in Saudi Arabia and data availability was associated with higher number of dental schools. The presence of DPH specialist provided the critical mass to collect caries data.

Contents

1. Introduction

The availability of health-related data is important for planning workforce needs, health services, preventive programs and educational curricula (Miyazaki et al., 2017; World Health Organization, 2010; Yamalik et al., 2013) to achieve sustainable development goals (United Nation, 2014). One of the building blocks of a health system is a well-functioning health information system that monitors health (World Health Organization, 2007).

The biggest global oral health data source is the World Health Organization (WHO) Oral Health Data Bank which was established in the 1960s (World Health Organization, 2010). The databank includes data from national surveys such as those conducted in United States, United Kingdom, Australia, New Zealand, Germany, Finland and Brazil (Steele, 2012). The bulk of the data in the databank, however, comes from scientific publications based on smaller scale studies (World Health Organization, 2016). Oral health data is usually available at subnational level rather than on a national scale (Steele, 2012). Caries is a common indicator included in surveys and surveillance systems (Miyazaki et al., 2017; Ottolenghi et al., 2007) due to the feasibility and validity of its assessment (Ottolenghi et al., 2007). In 1980, the WHO databank included caries data for 107/173 (61.8%) countries. A higher percentage of countries is currently covered (World Health Organization, 2010). Evidence (El Tantawi et al., 2018) showed that only 88 countries (45.6% of the United Nations member states) have data about early childhood caries (ECC). Thus, lack of caries data is a public health issue of global importance.

In Saudi Arabia, no government body is assigned the task of collecting oral health data and in most cases, information about caries is available through published scientific publications without national oral health surveys; mostly due to logistic difficulties than lack of resources. It is not known to what degree the independent and uncoordinated research activities of dental academics might adequately and comprehensively assess caries levels in various regions in the country. The hypothesis of the study was that differences between regions in caries data availability are associated with the number of dental schools in these regions as an indicator of the impact of the dental academic sector to a greater degree than to socioeconomic differences among regions (the latter being an indicator of the ability of the region to commission oral health data collection). The specific objectives were to assess (1) caries data availability in the administrative regions of Saudi Arabia and (2) factors associated with this availability.

2. Material and methods

2.1. Data sources

Caries data were collected from the following sources: (a) previous reviews describing caries status in Saudi Arabia (Al-Ansari, 2014; Al Agili, 2013; Alayyan et al., 2017; Khan, 2014; Khan et al., 2013). These studies did not specifically report on early childhood caries (ECC) as defined by the American Academy of Pediatric Dentistry (2017). Therefore, we conducted a (b) search in PubMed about scientific papers addressing ECC in Saudi Arabia using the search terms (dental caries [MeSH] AND Saudi Arabia [MeSH]) and filtering by age/preschool children (2–5 years). We also searched (c) PubMed for studies about caries in Saudi Arabia after 2013, which was the last year covered by the five previously

Table 1 Indicators of region SES and oral health research potential in Saudi Arabia.

Variables	Statistics	
Indicators of region SES		
% of category A governorates	Mean (SD)	46.13 (18.35)
% of university and higher educated individuals to total population	Mean (SD)	9.75 (2.01)
% of housing units that are owned	Mean (SD)	68.75 (10.01)
% of households that have computers	Mean (SD)	55.67 (9.84)
% of households connected to the internet	Mean (SD)	79.22 (9.57)
% of households with smartphones	Mean (SD)	43.15 (11.53)
Indicators of oral health research potential		
All dentists	Total	16,887
	Population to dentist ratio	1879.7
MoH dentists	Total	3377
	Population to dentist ratio	9399.6
DPH dentists	Total	136
Number of dental schools	Total	27
	Mean (SD)	2.1 (2.4)
	Median (min-max)	1 (0–8)

published reviews and used the search terms (dental caries [MeSH] AND Saudi Arabia [MeSH]) filtering by publication dates 2013–2018. The ECC studies were independently assessed by two investigators for inclusion (SS and MH) whereas MT and AA independently assessed the recent caries studies published after 2013 for inclusion. The same teams independently extracted relevant information. The criteria for studies to be included were: (1) non-clinical, population-based studies about caries, (2) conducted in Saudi Arabia, (3) published in the last 10 years (2008–2018), (4) including healthy populations and (5) specifying the place where data was collected so that it can be georeferenced. We categorized caries data based on age into groups (1) < 6 years (ECC among preschool children), (2) 6–12 years old (primary schoolchildren), (3) > 12–18 year old children (middle and high school), (4) > 18–60 (adults) and (5) > 60 (elderly).

After identifying the 13 administrative regions in Saudi Arabia according to the classification of the Saudi Ministry of Interior (2018), we collected the following data per region: (a) Indicators of socio-economic status, including: percentage of individuals with university and higher education to the total population (Legatum Institute, 2017) using the 2016 Demography Survey (Saudi General Authority for Statistics, 2016); percentage of category A governorates (Saudi Geological Survey Authority, 2012). Category A governorates have more services, road network coverage and higher economic level than category B governorates (Legatum Institute, 2017); percentage of housing units that are owned using the 2016 Demography Survey (Saudi General Authority for Statistics, 2016) based on similar use of this indicator to assess socioeconomic status (Gharipour et al., 2017); percentage of housing units with computers using the 2016 Demography Survey (Saudi General Authority for Statistics, 2016) following similar studies (Gharipour et al., 2017; Lear et al., 2014); percentage of housing units with internet access using the 2016 Demography Survey (Saudi General Authority for Statistics, 2016) based on similar studies (Hong et al., 2017; Katz et al., 2017); percentage of housing units with smart phones using the 2016 Demography Survey (Saudi General Authority for Statistics, 2016) based on similar use of the indicator (Heffner and Mull, 2017), and (b) Indicators of oral health research potential including: number of Dental Public Health (DPH) specialists (AlBaker et al., 2017); Ministry of Health (MoH) dentist-to-population ratio using the number of MoH dentists (Saudi Ministry of Health, 2016) and the total number of population in the 2016 Demography Survey (Saudi General Authority for Statistics, 2016), and number of dental schools using the report of the Saudi Commission for Health Specialties (2017).

We identified whether each region had/did not have available caries data and used ArcGIS (Esri Redlands, CA) to visualize caries data availability and the number of dental schools in the 13 regions. We used logistic regression analysis to assess the association at region level between caries data availability (outcome variable) and the number of dental schools in the region (as an explanatory variable) controlling one at a time for the effect of various indicators of region SES and oral health research potential. Statistical analysis was conducted using SPSS version 22.0. Significance level was set at the 5% level.

3. Results

The five previous reviews about caries in Saudi Arabia included 20 studies conducted in the period 2008–2018. Our search for ECC studies in the current study retrieved 35 studies of which five fulfilled the inclusion criteria. In addition, we also found 14 studies about caries in Saudi Arabia published after 2013 of which 10 were eligible (Fig. 1). After removing duplicates, 22 studies were left (Appendix). They included 11,422 individuals with age ranging from 2 to 72 years. Seventeen studies (77.3%) were conducted by authors from the academic sector including 8 institutions. Of the remaining 5 studies, two were authored by investigators from the Ministry of Health, one by authors from the Armed Forces Hospitals, one by an author from a non-Saudi dental school and another by an author from the private sector.

The total population in Saudi Arabia was 31 million and the mean percentage of category A governorates in the 13 regions was 46.13% with 9.75% of the population having at least university education. Most of the housing units were owned (68.75%). Most households had computers (55.67%), were connected to the internet (79.22%) with lower percentage

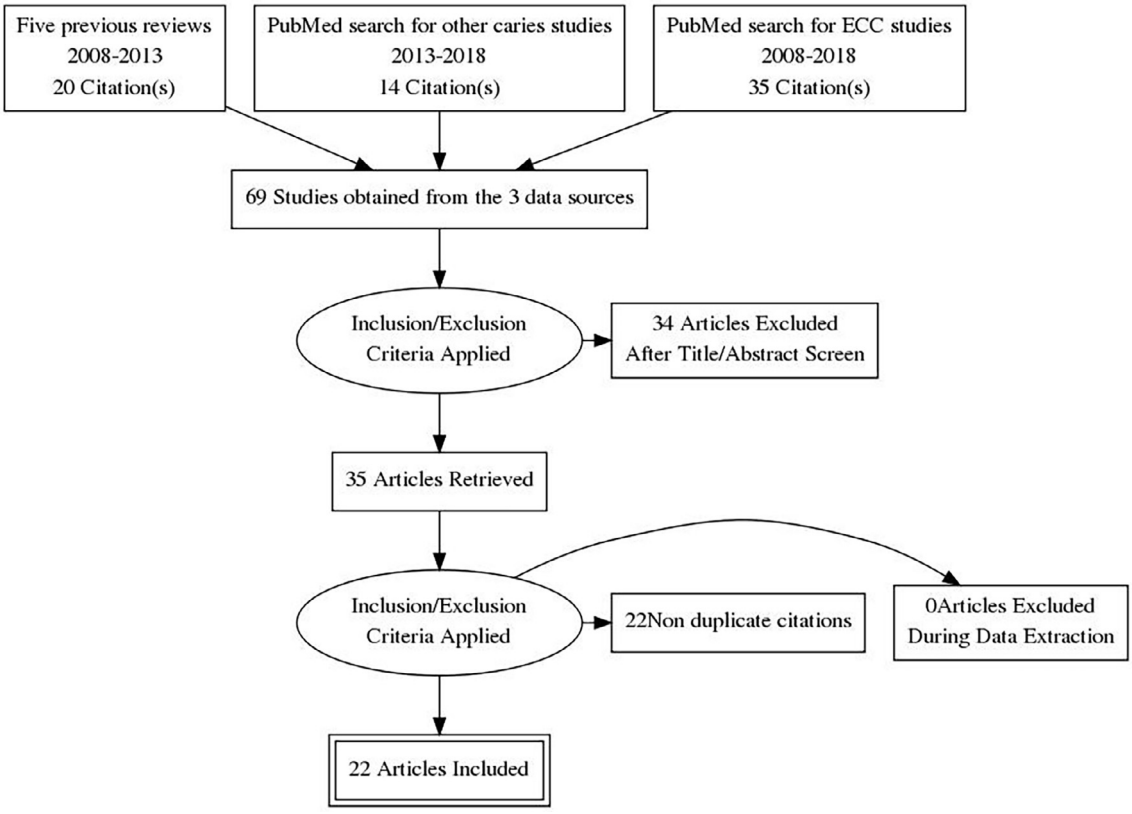

Fig. 1 PRISMA flow diagram for the flow of studies through the review.

of those with smart phones ownership (43.15%). In total, there were 16,887 dentists in the country, 3377 dentists employed by the MoH, 136 specialists and 27 dental schools (see Table 1).

Figs. 2 and 3 show that no caries data was available in the northern part of the country. The age group where data were most available was 6–12-year-old children followed by <6-year-old children. Fig. 3 shows that Riyadh, Makkah and Asir had caries data for ≥2 age groups. Seven regions (53.8%) had no caries data in any age group with a population in these regions = 4,855,997 representing 15.3% of the total population in Saudi Arabia. Six regions (46.2%) had caries data. These regions were inhabited by 84.7% of the population.

Fig. 4 shows that Riyadh region had the greatest number of dental schools among all 13 regions. The northern part of the country either had no dental schools or only one school in each region.

Table 2 show that regions with greater number of dental schools had higher odds of caries data availability (OR = 1.63) with the unadjusted model correctly classifying 61.5% of the regions. The percentage correctly classified did not change greatly when SES indicators were added to the model. A higher percentage of correctly classified regions was obtained when either one of the indicators of oral health research potential was added individually (76.9% for the model including population to MoH dentist ratio and 92.3% for the model adjusted for number of DPH specialists). In these models, regions with greater number of population to MoH dentist ratio or DPH personnel had 23–27% higher odds of caries data availability than other regions.

4. Discussion

Our study showed that in the last decade, there was information about caries in 46.2% of the administrative regions in Saudi Arabia with 84.7% of the population represented. Data availability was associated with the number of dental schools and DPH specialists. This sheds light on the role of the dental academic sector in filling the knowledge gap about caries in Saudi Arabia. It also shows that the presence of 136 DPH dentists provides a critical mass of specialists to support caries data availability. Our findings, thus, support the study hypothesis.

Our study showed that uncoordinated, individual oral health research activities represented the majority of the population in Saudi Arabia although not all its regions. Whether or not this is considered adequate coverage depends on the purpose for which the information would be used. For example, pooling caries prevalence values per age group may produce an overall estimate in the absence of a nationally representative oral health survey. This data, however, cannot inform the allocation of human and non-human oral health care resources among the thirteen regions because of the inadequate geographic coverage. The limited data availability in our study corroborates with the situation reported for groups of developing and developed countries (Dal Poz et al., 2009; Smith et al., 2005). For example, Kilpelainen et al. (2012) reported that in 31 European countries, the average availability score of the European Community Health indicators was 74%. Yamalik et al. (2013) reported that all ten developed

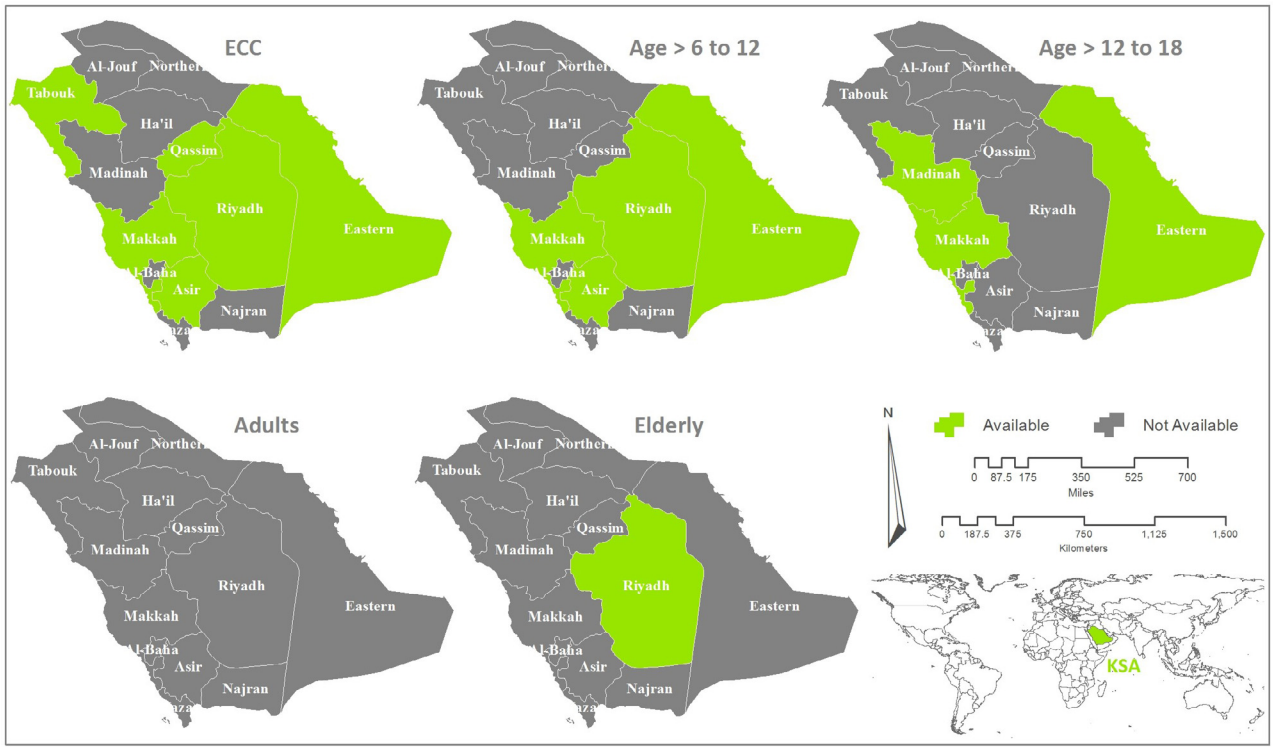

Fig 2 Availability of caries data in Saudi Arabia in 5 age groups (2008–2018).

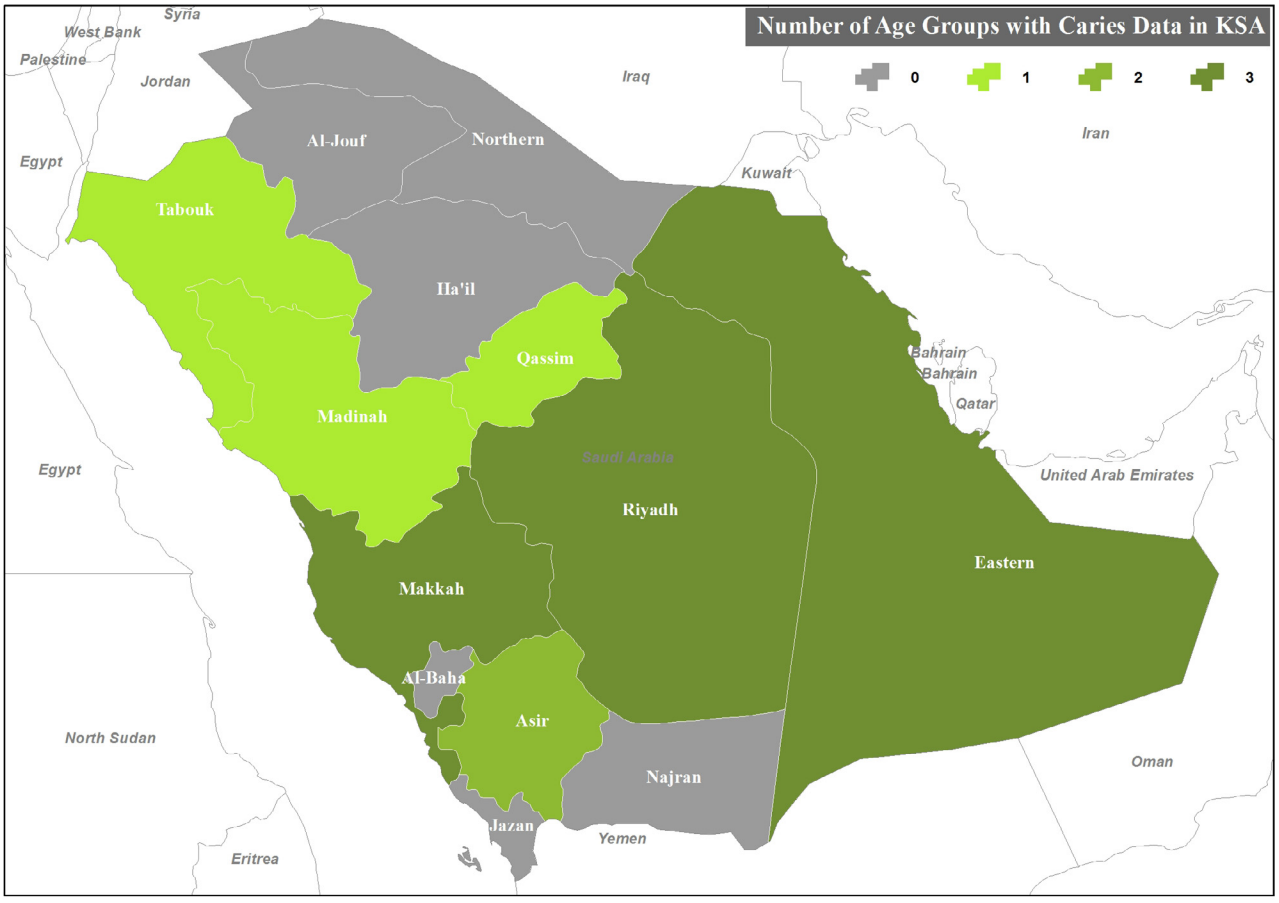

Fig. 3 Number of age groups with caries data in the 13 regions in Saudi Arabia (2008–2018).

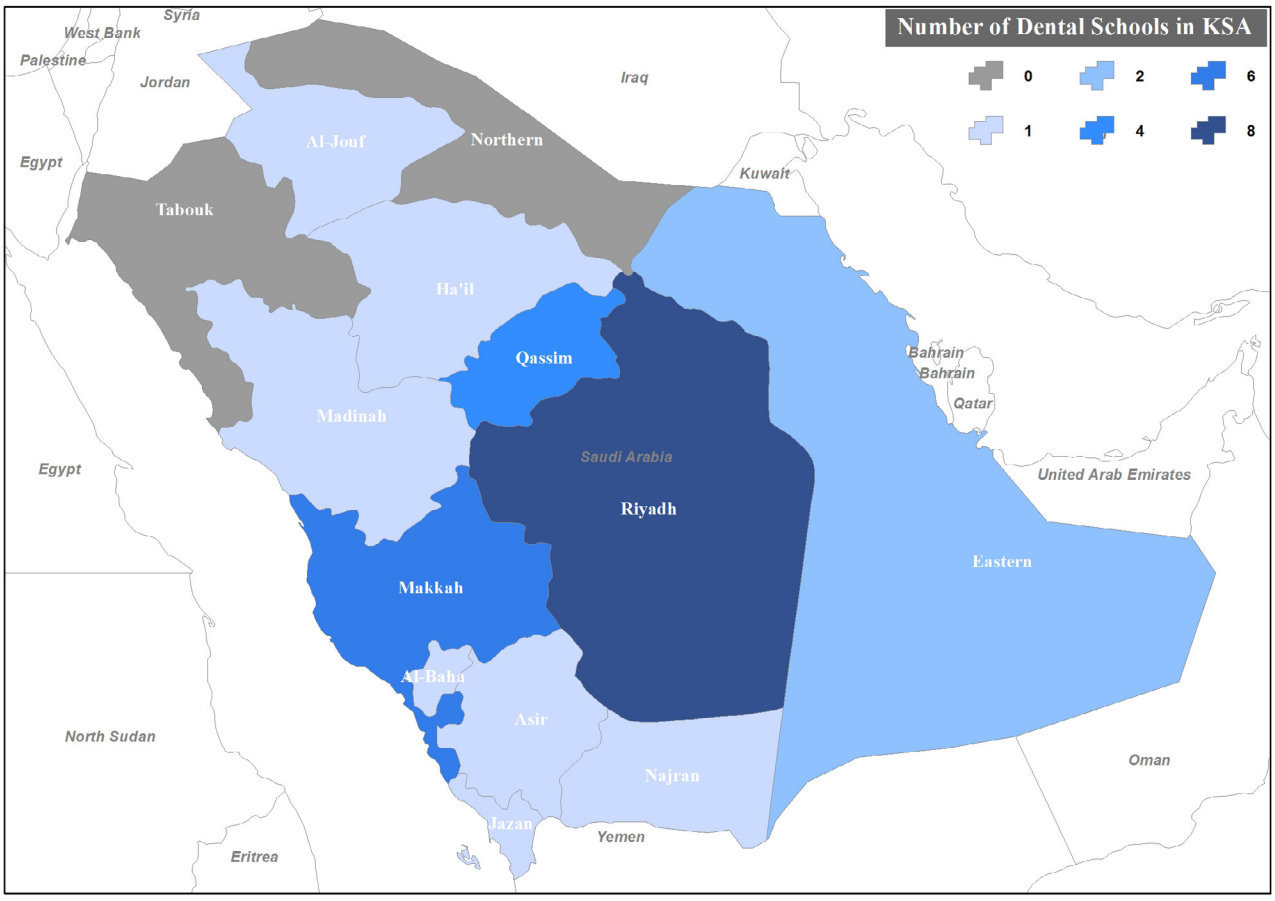

Fig. 4 Distribution of dental schools among the 13 regions in Saudi Arabia, 2018.

Table 2 Association between the number of dental schools in an administrative region in Saudi Arabia and caries data availability (logistic regression).

	OR (95% CI)	% correctly classified
Unadjusted	1.63 (0.79, 3.36)	61.5%
Adjusted for % of category A governorates	1.62 (0.78, 3.38)	61.5%
Adjusted for % of university and higher educated individuals	1.70 (0.79, 3.65)	61.5%
Adjusted for % of owned residences	1.55 (0.72, 3.35)	69.2%
Adjusted for % with computers	1.50 (0.69, 3.28)	61.5%
Adjusted for % connected to the internet	1.94 (0.80, 4.69)	69.2%
Adjusted for % with smartphones	1.83 (0.79, 4.25)	69.2%
Adjusted for population to MoH dentist	1.23 (0.28, 5.41)	76.9%
Adjusted for the number of DPH	1.27 (0.04, 39.88)	92.3%

OR: odds ratio, CI: confidence interval.

countries had data about ECC and caries in the 1st permanent molars in children compared to 7/12 (58.3%) and 10/12 (83.3%) respectively of developing countries. El Tantawi et al. (2018) reported that 73% of 193 countries had no data about ECC in children younger than 3 years and 46% had no ECC data about 3–5-year-old children.

Our study showed that most caries studies included in this report were by authors from the academic sector and that the odds of caries data availability increased as the number of dental schools increased. This finding agrees with previous reports showing that the academic sector has the skills and experience to conduct health needs assessment (Smith et al., 2005). For example, in the national Brazilian oral health survey, SBBrasil 2010, health departments and universities collaborated to assess oral diseases and socioeconomic indicators (Moysés et al., 2013; Roncalli, 2010). However, the academics' efforts in the Brazilian context were structured and coordinated at the national level. A more limited scale of action was reported in urban areas in Dublin, Ireland where the department of public health and primary care in Trinity College Dublin was commissioned to conduct oral health surveys (Smith et al., 2005). The largest oral health data repository, the WHO Oral Health Databank (Malmo University, 2010) presents another example of input from the academic sector. It

was built in collaboration with Lund and Malmo universities in Sweden. Our findings disagree with other oral health surveillance models where the academic sector had a limited role. For example, in the US, the national oral health surveillance system (NOHSS) is operated by a governmental body, the Center for Disease Control and a professional association, the Association for State and Territorial Dental Directors (Center for Disease Control and Prevention, 2017). Data availability varies by state and indicator (Malvitz et al., 2009).

Our findings show that including MoH or DPH dentists improved the accuracy of classifying the administrative regions based on caries data availability. This agrees with El Tantawi et al. (2018) who reported higher odds of ECC data availability in countries with higher number of dentists: 1000 population ratio. It also agrees with previous research showing that human resources needed to establish surveillance systems or conduct national surveys may limit or promote health data availability (Dal Poz et al., 2009). The higher percentage of regions correctly classified in the case of DPH compared to MoH dentists can be explained by the fact that epidemiologic studies are usually conducted by DPH specialists.

Our study has implications for oral health policy planning in countries without national oral health surveys or oral health surveillance systems. In most countries, health care systems face competing demands that necessitate prioritization among sectors (Kandelman et al., 2012) and economic factors may affect caries data availability (El Tantawi et al., 2018). Dental schools can help fill the knowledge gap about oral diseases by collecting data in their surrounding communities using standardized data collection methods, forms, formal training and calibration (Yamalik et al., 2013). Coordinated efforts of dental schools are also needed to address data ownership issues and make data available to stakeholders (Harbers et al., 2015). National dental journals can support dental academics by dedicating sections to publish descriptive studies reporting on oral health status of regions where no previous data exist. As more dental schools collaborate, better chances of publication would be secured because of the increased geographic coverage and improved representativeness. This coordination may help build capacity for oral health assessment and address the deficiency of funds (Karamouzian et al., 2016). There is a need to initiate a dialogue on the future of oral health surveillance in Saudi Arabia and whether it should be the responsibility of the Ministry of Health, the Saudi Dental Society or a consortium of Saudi dental schools. Such surveillance may include a clinical component coordinated by one of these bodies or it may use indicators obtained through self-reporting by a number of questions added to the Saudi Health Interview Survey (Saudi Ministry of Health, 2017).

Our study is limited by its design which is liable to ecologic fallacy. In addition, the number of administrative regions in the country might have reduced the study power. In other countries with different roles of oral health care agencies, or fewer dental schools, the impact of the academic dental sector on data availability may differ.

5. Conclusion

Data about caries level is available for most of the population in Saudi Arabia and for about half the administrative regions. The dental academic sector can help address gaps in this area through planning coordinated research activities assessing caries levels in various regions in Saudi Arabia. This solution may apply in other countries with similar large geographic spread and low population density. In the absence of oral health surveillance systems, the academic sector involvement in oral health surveillance may ensure the presence of data to help in planning of oral health initiatives.

Ethical statement

The study was based on literature review and therefore does not require ethical approval

Acknowledgement

None.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The Authors declare that thy have no conflict of interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2019.01.004.

References

Al Agili, D.E., 2013. A systematic review of population-based dental caries studies among children in Saudi Arabia. Saudi Dent. J. 25, 3–11. https://doi.org/10.1016/j.sdentj.2012.10.002.

Al-Ansari, A., 2014. Prevalence, severity, and secular trends of dental caries among various Saudi populations: a literature review. Saudi J. Med. Med. Sci. 2, 142–150. https://doi.org/10.4103/1658-631X.142496.

Alayyan, W., Al Halabi, M., Hussein, I., Khamis, A., Kowash, M., 2017. A systematic review and meta-analysis of school children's caries studies in Gulf Cooperation Council states. J. Int. Soc. Prev. Community Dent. 7, 234–241. https://doi.org/10.4103/jispcd.JISPCD_237_17.

AlBaker, A.A., Al-Ruthia, Y.S.H., AlShehri, M., Alshuwairikh, S., 2017. The characteristics and distribution of dentist workforce in Saudi Arabia: a descriptive cross-sectional study. Saudi Pharm. J. 25, 1208–1216. https://doi.org/10.1016/j.jsps.2017.09.005.

American Academy of Pediatric Dentistry, R.C., 2017. Policy on Early Childhood Caries (ECC): classifications, consequences, and preventive strategies. Pediatr. Dent. 39, 59–61.

Center for Disease Control and Prevention, 2017. Oral health data: National Oral Health Surveillance System (NOHSS) [WWW Document]. <https://www.cdc.gov/oralhealthdata/overview/nohss.html> (accessed 9.2.18).

Dal Poz, M.R., Gupta, N., Quain, E., Soucat, A.L.B., 2009. Handbook on Monitoring and Evaluation of Human Resources for Health: With Special Applications for Low- and Middle-income Countries. World Health Organization, Geneva, Switzerland.

El Tantawi, M., Folayan, M.O., Mehaina, M., Vukovic, A., Castillo, J. L., Gaffar, B.O., Arheiam, A., Al-Batayneh, O.B., Kemoli, A.M.,

Schroth, Lee, G.H.M., 2013. Prevalence and data availability of early childhood caries in 193 United Nations Countries, 2007–2017. Am. J. Public Health 108, 1066–1072. https://doi.org/10.2105/AJPH.2018.304466.

Gharipour, M., Sadeghi, M., Nouri, F., Nezafati, P., Qader, S.S., Taheri, M., Maghroun, M., Abdalvand, A., Soleimani, B., Sarrafzadegan, N., 2017. Socioeconomic determinants and metabolic syndrome: results from the Isfahan Healthy Heart Program. Acta Biomed. 87, 291–1198.

Harbers, M.M., Verschuuren, M., de Bruin, A., 2015. Implementing the European Core Health Indicators (ECHI) in the Netherlands: an overview of data availability. Arch. Public Heal. 73, 9. https://doi.org/10.1186/s13690-014-0058-4.

Heffner, J.L., Mull, K.E., 2017. Smartphone ownership among US adult cigarette smokers: 2014 Health Information National Trends Survey (HINTS) data. J. Med. Internet Res. 19,. https://doi.org/10.2196/jmir.7953 e305.

Hong, Y.A., Zhou, Z., Fang, Y., Shi, L., 2017. The digital divide and health disparities in China: evidence from a national survey and policy implications. J. Med. Internet Res. 19,. https://doi.org/10.2196/jmir.7786 e317.

Kandelman, D., Arpin, S., Baez, R.J., Baehni, P.C., Petersen, P.E., 2012. Oral health care systems in developing and developed countries. Periodontology 2000 (60), 98–109. https://doi.org/10.1111/j.1600-0757.2011.00427.x.

Karamouzian, M., Madani, N., Doroudi, F., Haghdoost, A.A., 2016. Improving the quality and quantity of HIV data in the Middle East and North Africa: key challenges and ways forward. Int. J. Heal. Policy Manag. 6, 65–69. https://doi.org/10.15171/ijhpm.2016.112.

Katz, V.S., Gonzalez, C., Clark, K., 2017. Digital inequality and developmental trajectories of low-income, immigrant, and minority children. Pediatrics 140, S132–S136. https://doi.org/10.1542/peds.2016-1758R.

Khan, S.Q., 2014. Dental caries in Arab League countries: a systematic review and meta-analysis. Int. Dent. J. 64, 173–180. https://doi.org/10.1111/idj.12092.

Khan, S.Q., Khan, N.B., Arrejaie, A.S., 2013. Dental caries. A meta analysis on a Saudi population. Saudi Med. J. 34, 744–749.

Kilpelainen, K., Tuomi-Nikula, A., Thelen, J., Gissler, M., Sihvonen, A.-P., Kramers, P., Aromaa, A., 2012. Health indicators in Europe: availability and data needs. Eur. J. Public Health 22, 716–721. https://doi.org/10.1093/eurpub/ckr195.

Lear, S.A., Teo, K., Gasevic, D., Zhang, X., Poirier, P.P., Rangarajan, S., Seron, P., Kelishadi, R., Tamil, A.M., Kruger, A., Iqbal, R., Swidan, H., Gomez-Arbelaez, D., Yusuf, R., Chifamba, J., Kutty, V.R., Karsidag, K., Kumar, R., Li, W., Szuba, A., Avezum, A., Diaz, R., Anand, S.S., Rosengren, A., Yusuf, S.Prospective Urban Rural Epidemiology (PURE) study, 2014. The association between ownership of common household devices and obesity and diabetes in high, middle and low income countries. Can. Med. Assoc. J. 186, 258–266. https://doi.org/10.1503/cmaj.131090.

Legatum Institute, 2017. Rankings: The Legatum Prosperity Index 2017 [WWW Document]. <https://www.prosperity.com/rankings> (accessed 9.2.18).

Malmo University, 2010. About CAPP: Oral health database [WWW Document]. <https://www.mah.se/CAPP/About-CAPP/> (accessed 9.2.18).

Malvitz, D.M., Barker, L.K., Phipps, K.R., 2009. Development and status of the National Oral Health Surveillance System. Prev. Chronic Dis. 6, A66.

Miyazaki, H., Jones, J.A., Beltrán-Aguilar, E.D., 2017. Surveillance and monitoring of oral health in elderly people. Int. Dent. J. 67, 34–41. https://doi.org/10.1111/idj.12348.

MoI, Ministry of Interior, 2018. Emirates [WWW Document]. URL <https://www.moi.gov.sa/wps/portal/Home/emirates/!ut/p/z1/04_Sj9CPykssy0xPLMnMz0vMAfIjo8ziLQPdnT08TIy83Q0dzQwcPc2N_A08TQ3dPY30wwkpiAJKG-AAjgZA_VFgJc7ujh4m5j4GBhY-7qYGno4eoUGWgcbGBo7GUAV4zCjIjTDIdFRUBAApuVo7/dz/d5/L2dJQSEvUUt3QS80TmxFL1o2XzBJNDRIMT-QyS0dBREI> (accessed 9.2.18).

Moysés, S.J., Pucca Junior, G.A., Paludetto Junior, M., de Moura, L., 2013. Progresses and challenges to the Oral Health Surveillance Policy in Brazil. Rev. Saude Publica 47 (Suppl. 3), 161–167.

Ottolenghi, L., Muller-Bolla, M., Strohmenger, L., Bourgeois, D., 2007. Oral health indicators for children and adolescents: European perspectives. Eur. J. Paediatr. Dent. 8, 205–210.

Roncalli, A.G., 2010. The SB Brasil 2010 Project: a key strategy for developing an oral health surveillance model. Cad. Saude Publica 26 (429), 428.

Saudi General Authority for Statistics, 2016. Demography survey 2016. Riyadh. <https://www.stats.gov.sa/sites/default/files/en-demographic-research-2016_2.pdf> (accessed 9.2.18).

Saudi Geological Survey Authority, 2012. Saudi Arabia: Facts and Numbers. Riyadh. <www.sgs.org.sa> (accessed 9.2.18)

Saudi Ministry of Health, 2016. Statistical Yearbook – 2016. Riyadh. <https://www.moh.gov.sa/en/Ministry/Statistics/Book/Pages/default.aspx> (accessed 9.2.18).

Saudi Ministry of Health, 2017. Health Information Survey. <https://www.moh.gov.sa/en/Ministry/Statistics/Pages/healthinformatics.aspx> (accessed 17.12.18).

SCHS, Saudi Council for Health Specialties, 2017. Workforce needs over the next 10 years. Riyadh.

Smith, S.M., Long, J., Deady, J., O'Keeffe, F., Handy, D., O'Dowd, T., 2005. Adapting developing country epidemiological assessment techniques to improve the quality of health needs assessments in developed countries. BMC Health Serv. Res. 5, 32. https://doi.org/10.1186/1472-6963-5-32.

Steele, J., 2012. The future for oral health surveillance. Commun. Dent. Oral Epidemiol. 40, 75–81. https://doi.org/10.1111/j.1600-0528.2012.00724.x.

United Nation, 2014. Sustainable Development Knowledge Platform [WWW Document]. <https://sustainabledevelopment.un.org/?page=view&nr=164&type=230> (accessed 9.1.18).

World Health Organization, 2007. Strengthening health systems to improve health outcomes: WHO's framework for action. <http://www.who.int/healthsystems/strategy/everybodys_business.pdf> (accessed 9.2.18).

World Health Organization, 2010. WHO |Oral health information systems [WWW Document]. WHO. <http://www.who.int/oral_health/action/information/surveillance/en/index1.html> (accessed 9.1.18).

World Health Organization, 2016. Oral health databases [WWW Document]. <http://www.who.int/oral_health/databases/en/> (accessed 9.1.18).

Yamalik, N., Ensaldo-Carrasco, E., Bourgeois, D., 2013. Oral health workforce planning. Part 1: data available in a sample of FDI member countries. Int. Dent. J. 63, 298–305.