

# Dental caries in Arab League countries: a systematic review and meta-analysis

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**Objective:** The aim of this review was to determine prevalence of dental caries in primary and permanent teeth in the 2-20-year-old population of the Arab league. **Methods:** A literature search was performed on Pubmed, Summon and Google Scholar using the key words 'Dental caries', 'dmft' and 'DMFT'. A total of 293 articles were found, of which 35 passed our inclusion criteria and were included in analysis. Tables were made separately for primary and permanent teeth; the age group for primary teeth was 2–12 years and for permanent teeth 6–20 years. **Results:** A meta-analysis was run by using data extracted from the studies included. Heterogeneity was tested by forest plot and chi-square test, and considerable heterogeneity was found. Mean decayed, missing and filled teeth (dmft) was 4.341 (95% CI 3.714, 4.969) and in permanent teeth (DMFT) was 2.469 (95% CI 2.019, 2.919) from a random effect model. Publication bias diagnostics suggested missing of four studies of primary teeth caries data and eight studies of permanent teeth caries data to obtain symmetry in the funnel plot. **Conclusion:** The incidence of caries in primary teeth was found to be high compared with caries in permanent teeth in the Arab League. This study does not provide a comprehensive picture of caries prevalence in the Arab League because in many of these countries only a few studies were performed. Therefore, these data cannot provide a complete picture of the prevalence of caries in those countries. Additional studies are needed to better evaluate the prevalence of caries in children and young adults in Arab League countries.

**Key words:** Dental caries, meta-analysis, dmft, DMFT

## INTRODUCTION

One of the most common infectious diseases is dental caries. More than 80% of the population living in high-income countries has been affected by caries<sup>1–3</sup>. However, in the high-income population there is only half the likelihood of having untreated teeth compared with low income families<sup>4</sup>. The prevalence of dental caries among preschool children was initially examined in the UK<sup>5,6</sup>. Since then, a number of studies have been performed in other parts of the developed world to determine the prevalence of caries<sup>7,8</sup>. This topic has now become a part of the studies which are being conducted in other parts of the world<sup>9–12</sup>.

Studies have been published on the prevalence of caries for several decades and researchers still take great interest in reviewing published studies. Several review articles have been published reporting on the caries burden during certain periods of time and in certain part of the world. Cleaton-Jones *et al.* in 1999 reported a trend of dental caries in Africa. They considered all studies on dental caries during

the previous 30 years<sup>13</sup>. Li *et al.*<sup>14</sup>, in 2012, studied the association between dental erosion and dietary factors using studies published during 1992–2011. Khan *et al.*<sup>15</sup>, in 2013, conducted a systematic review of all published articles during 1999–2008 that reported prevalence of dental caries in the population living in Saudi Arabia.

A meta-analysis is a procedure in which the results from the individual studies are combined to obtain a more valid and appropriate analysis than traditional reviews. The broad aim of a meta-analysis is to more powerfully estimate the true size effect as opposed to a less precise size effect resulting from a single study under a given single set of assumptions and conditions. In this study, we collected all the published articles reporting dental caries during 1999–2012 in Arab League countries. Countries in the Arab League are Algeria, Chad, Egypt, Ethiopia, Liberia, Mauritania, Morocco, Somalia, Sudan, Tunisia, Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen. A meta-analysis was performed to determine

the prevalence of caries in countries of the Arab League during the period 1999–2012.

## MATERIALS AND METHODS

The aim of the literature search was to discover published articles on dental caries during 1999–2012. PubMed, Summon and Google Scholar databases were used to search articles using the key words ‘Dental caries’, ‘dmft’ and ‘DMFT’. In August 2013, a literature search was started on dental caries in Arab League countries at the College of Dentistry, University of Dammam, Saudi Arabia. The objective of the study was to find mean decayed, missing and filled data in primary and permanent teeth in the young Arab League population. The literature search revealed 293 articles with the required key words.

The inclusion criteria were: (1) availability of dmft or DMFT values or both; (2) age range for primary teeth 2–12 years and for permanent teeth 6–20; (3) sample size must be separate if study contained different age groups. (Figure 1).

After employing the first inclusion criterion, 45 studies remained for further screening. Out of 45, remaining studies, eight failed to pass the second inclusion criterion<sup>16–23</sup> but only two articles failed the third inclusion criterion<sup>24,25</sup>. Information was gathered into two separate tables, the first was prepared for primary teeth caries (dmft) and other was prepared for permanent teeth caries (DMFT) (Tables 1 and 2). The pattern of information in articles was different: some revealed information about the prevalence of caries in primary teeth and few about the prevalence in permanent teeth, while some studied both primary and permanent teeth. Among 35 selected articles, 14 studied primary teeth caries and

10 revealed information on mean decayed, missing and filled teeth in permanent teeth; the remainder studied caries in both primary and permanent teeth.

In some studies included, standard deviations were missing and so regression analysis was used to estimate missing values. Tables 1 and 2 were used separately and two equations were formulated. Weighted regression was used and sample sizes were used as weights. Five studies did not have standard deviation along with mean<sup>32,35,38,42,45</sup>, so the estimated line of regression for primary teeth data ( $SD = 2.015 + 0.30 \times \text{mean}$ ,  $r^2 = 0.835$ ) was used to obtain estimated standard deviations. Similarly, in the case of permanent teeth data (Table 2) a line of regression was ( $SD = -1.696 + 1.671 \times \text{mean}$ ,  $r^2 = 0.788$ ) used to estimate missing standard deviations<sup>35,42,45,47,58</sup>.

## Consideration of bias

A funnel plot shows the magnitude of effect of all the studies in order to address the issue of publication bias. Published effects may be larger than true effects because of effects that are larger simply because of sampling variation. There should be symmetry in the plot and means studies should fall equally on both sides of funnel plot<sup>26</sup>. A symmetrical funnel plot indicates no publication bias but for other situations this means that there is publication bias.

## RESULTS

Data were compiled into two different tables, Table 1 presents the studies reporting on the prevalence of caries in primary teeth and Table 2 presents the studies reporting on the prevalence caries in permanent teeth. The sum of sample sizes of those studies that were placed in Table 1 was 15,361 and for Table 2 the total was 24,364. The average sample size of the studies conducted on primary and permanent teeth caries were 512 and 902, respectively. A large proportion of studies were carried out in Saudi Arabia (about 52% of total studies included). Libya, Oman, Iraq, Yemen and Kuwait each had two studies published during the period considered. In Egypt, Sudan, Somalia, Syria, UAE and Jordan only one was publication was found. The remaining Arab League countries did not have any publications related to primary or permanent teeth caries.

Meta-analysis was used separately for primary and permanent teeth caries data. A forest plot in Figure 2 represents studies that had mean dmft values. Visual inspection of the forest plot indicates the presence of heterogeneity; a  $Q$  statistic (chi-square test) was used to authenticate the presence of heterogeneity. The test provided a significant  $P$ -value ( $<0.001$ ), which confirms that the heterogeneity and index of heteroge-

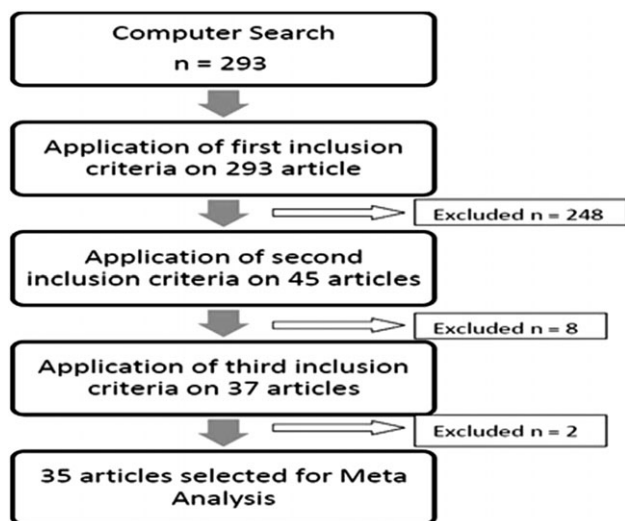


Figure 1. Flow diagram of literature search.

**Table 1** Studies and variables included after inclusion criteria (in chronological order) on reported prevalence of caries in primary teeth

Author	Country	Year	Sample	Age (years)	dmft	SD
Al-Banyan <i>et al.</i> <sup>27</sup>	Saudi Arabia	2000	272	5–12	3.8	3.2
Al-Malik <i>et al.</i> <sup>28</sup>	Saudi Arabia	2000	80	4–5	0.95	2.03
Khan <i>et al.</i> <sup>29</sup>	Saudi Arabia	2001	457	6–7	4.45	3.76
Wyne <i>et al.</i> <sup>30</sup>	Saudi Arabia	2001	1016	4.51	8.6	3.4
Wyne <i>et al.</i> <sup>31</sup>	Saudi Arabia	2001	77	4	0.91	2.42
Shyama <i>et al.</i> <sup>32</sup>	Kuwait	2001	832	3–12	5.4	3.63
Wyne <i>et al.</i> <sup>33</sup>	Saudi Arabia	2002	449	7–11	6.3	3.5
Wyne <i>et al.</i> <sup>34</sup>	Saudi Arabia	2002	322	3–5	2.92	3.51
Rodd <i>et al.</i> <sup>35</sup>	Somalia	2002	238	4–10	2.085	2.64
Sayegh <i>et al.</i> <sup>36</sup>	Oman	2002	569	4	3.1	3.9
Al-Malik <i>et al.</i> <sup>37</sup>	Saudi Arabia	2003	987	2–5	4.8	4.87
Paul <sup>38</sup>	Saudi Arabia	2003	103	5	7.1	4.14
Al-Dosari <i>et al.</i> <sup>39</sup>	Saudi Arabia	2004	249	6–7	6.53	4.3
Al-Dosari <i>et al.</i> <sup>39</sup>	Saudi Arabia	2004	182	6–7	6.35	3.83
Jamel <i>et al.</i> <sup>40</sup>	Iraq	2004	1047	6–7	2.3	2.4
Al-Malik <i>et al.</i> <sup>10</sup>	Saudi Arabia	2006	300	6–7	8.06	4.04
Hashim <i>et al.</i> <sup>41</sup>	United Arab Emirates	2006	1297	5–6	4.4	4.3
Al-Mutawa <i>et al.</i> <sup>42</sup>	Kuwait	2006	2298	5–6	4.6	3.39
Wyne <i>et al.</i> <sup>43</sup>	Saudi Arabia	2008	789	3–5	6.1	3.9
Al-Haddad <i>et al.</i> <sup>44</sup>	Yemen	2010	490	6–8	6.68	3.8
Al-Haddad <i>et al.</i> <sup>44</sup>	Yemen	2010	485	9–11	3.62	3.56
Al-Haddad <i>et al.</i> <sup>44</sup>	Yemen	2010	321	12–14	1.13	1.48
Farsi <sup>45</sup>	Saudi Arabia	2010	510	4–5	3.9	3.185
Hazza'a <i>et al.</i> <sup>46</sup>	Jordan	2011	36	4–8	1.44	1.33
Hazza'a <i>et al.</i> <sup>46</sup>	Jordan	2011	24	8–12	2.05	1.53
Al-Majed <i>et al.</i> <sup>47</sup>	Saudi Arabia	2011	522	8–10	4.96	3.03
Togoo <i>et al.</i> <sup>48</sup>	Saudi Arabia	2011	836	7–10	2.74	1.18
Al-Khadra <sup>49</sup>	Saudi Arabia	2011	57	3–6	4.71	0.27
Al-Khadra <sup>49</sup>	Saudi Arabia	2011	116	7–14	6.09	2.34
Qadri <i>et al.</i> <sup>50</sup>	Syria	2012	400	3–5	4.25	4.2

dmft, decayed, missing and filled teeth.

**Table 2** Studies and variables included after inclusion criteria (in chronological order) on reported prevalence of caries in permanent teeth

Author	Country	Year	Sample	Age (years)	DMFT	SD
Abolfotouh <i>et al.</i> <sup>51</sup>	Saudi Arabia	2000	959	6–13	0.79	2.84
Al-Banyan <i>et al.</i> <sup>27</sup>	Saudi Arabia	2000	272	5–12	2	1.9
Al-Sharbati <i>et al.</i> <sup>52</sup>	Libya	2000	762	6–12	1.63	1.03
Wyne <i>et al.</i> <sup>31</sup>	Saudi Arabia	2001	76	9.7	0.72	1.96
Wyne <i>et al.</i> <sup>33</sup>	Saudi Arabia	2002	449	7–11	1.6	1.5
Rodd <i>et al.</i> <sup>35</sup>	Somalia	2002	238	11–14	1.37	0.59
Dosari <i>et al.</i> <sup>53</sup>	Saudi Arabia	2003	734	16.4	7.2	4.785
Al-Dosari <i>et al.</i> <sup>39</sup>	Saudi Arabia	2004	392	11–12	5.06	3.65
Al-Dosari <i>et al.</i> <sup>39</sup>	Saudi Arabia	2004	281	11–12	4.53	3.57
Jamel <i>et al.</i> <sup>40</sup>	Iraq	2004	1011	11–12	1.6	2.9
Jamel <i>et al.</i> <sup>40</sup>	Iraq	2004	939	14–15	1.9	1.8
Al-Ismaily <i>et al.</i> <sup>54</sup>	Oman	2004	2860	15	3.23	3.70
Al-Malik <i>et al.</i> <sup>10</sup>	Saudi Arabia	2006	300	6–7	0.41	0.86
Al-Mutawa <i>et al.</i> <sup>42</sup>	Kuwait	2006	2290	12–14	3.25	3.73
Ahmed <i>et al.</i> <sup>55</sup>	Iraq	2007	392	12	1.7	1.9
Farag <i>et al.</i> <sup>56</sup>	Egypt	2009	90	14–15	6.7	2.3
Nurelhuda <i>et al.</i> <sup>57</sup>	Sudan	2009	1109	12	0.49	1.06
Al-Haddad <i>et al.</i> <sup>44</sup>	Yemen	2010	474	6–8	1.17	1.52
Al-Haddad <i>et al.</i> <sup>44</sup>	Yemen	2010	492	9–11	2.3	1.63
Al-Haddad <i>et al.</i> <sup>44</sup>	Yemen	2010	507	12–14	3.22	1.92
Al-Dosari <i>et al.</i> <sup>58</sup>	Saudi Arabia	2010	3903	12–13	2.93	3.2
Al-Dosari <i>et al.</i> <sup>58</sup>	Saudi Arabia	2010	4467	15–18	4.08	5.12
Hazza'a <i>et al.</i> <sup>46</sup>	Jordan	2011	36	4–8	0.3	0.48
Hazza'a <i>et al.</i> <sup>46</sup>	Jordan	2011	24	8–12	0.95	0.78
Al-Khadra <sup>49</sup>	Saudi Arabia	2011	116	7–14	3.93	1.64
Huew <i>et al.</i> <sup>59</sup>	Libya	2012	791	12	1.68	1.86
Al-Otaibi <i>et al.</i> <sup>60</sup>	Yemen	2012	400	12	2.22	1.56

DMFT, decayed, missing and filled teeth.

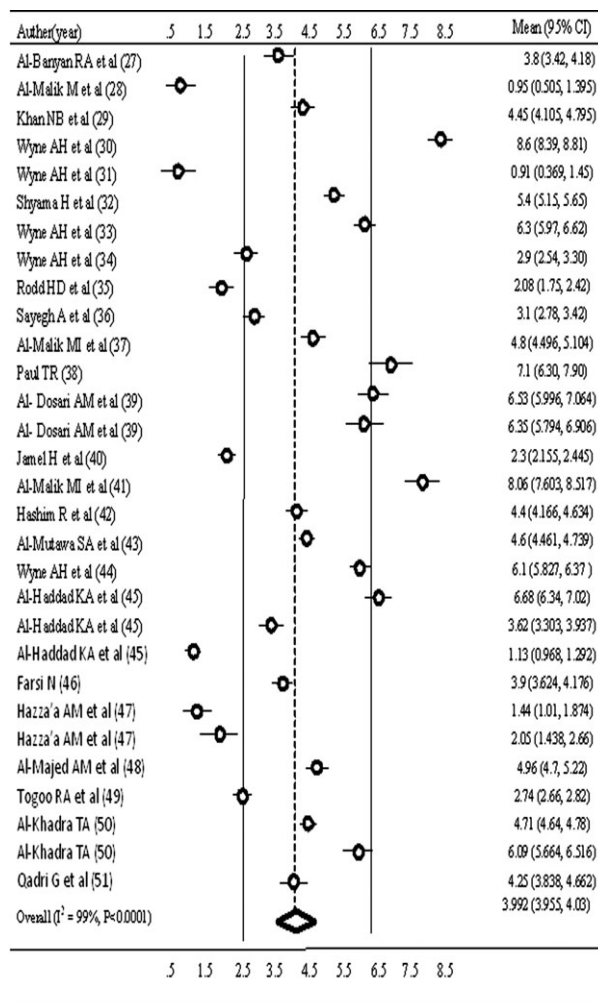


Figure 2. Study-specific and summary effect estimates [mean and 95% confidence interval (CI)] for mean decayed, missing and filled teeth (dmft) in studies, 1999–2012.

neity was also considered and that high heterogeneity was found ( $I^2 > 90\%$ ). A random effect model was used to find mean dmft by employing Table 1. The average of dmft was estimated as 4.34 (95% CI 3.714, 4.969). Analysis was performed again over the data set that had mean DMFT values (Figure 3). Heterogeneity was checked first by forest plot and then by a chi-square test. Visual inspection of forest plot and chi-square ( $P < 0.001$ ) gave adequate evidence of heterogeneity in the data set and the index of heterogeneity was also very high ( $I^2 > 90\%$ ). Therefore, the random effect model was used to estimate mean DMFT and this was found to be 2.469 (95% CI 2.019, 2.919).

Sources of heterogeneity were tested by stratification of the data. Groups were made from year of publication, sample size and age of study population (Table 3). Stratification was done for both Table 1 and Table 2 and effects were estimated. Heterogeneity was found in every strata, mean decayed, missing and

filled (dmft/DMFT) was calculated separately by random effect model for each group made using the variables (year of publication, sample size and age). However, the mean of each group was closer to overall mean except the mean prevalence of caries in permanent teeth of 12- to 18-year-olds. The mean DMFT in the 12- to 18-year-old population was 1.77 (95% CI 1.36, 2.18) while the prevalence of caries in permanent teeth was 2.469 despite the age of study group.

Funnel plot and statistical tests were employed to check for the possibility of publication bias. The shape of funnel plot should be symmetrical in the absence of publication bias. In other cases, asymmetry in the shape of the funnel plot shows potential publication bias. The funnel plot for the primary dentition shows a symmetrical shape at the top and middle of the plot but slight asymmetry can be found in the bottom of the plot (Figure 4). Statistical tests were used (Egger's and Begg's test) for confirmation. Insig-

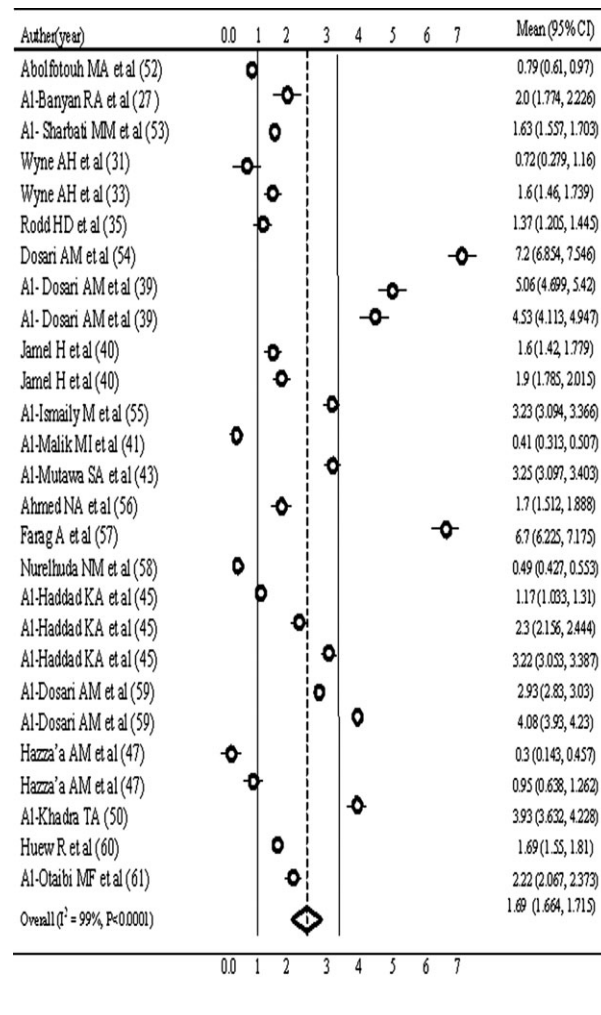


Figure 3. Study-specific and summary effect estimates [Mean and 95% confidence interval (CI)] for mean decayed, missing and filled teeth (DMFT) in studies 1999–2012.

nificant results from both tests (Egger's test  $P = 0.2$  and Begg's test  $P = 0.2$ ) indicate no publication bias. The trim and fill method suggested the inclusion of four studies to obtain symmetry in the funnel plot and reduced the effect estimate from 4.341 to 3.8 in the random effect. Asymmetry was found in the funnel plot for the permanent dentition (Figure 5), Egger's and Begg's test also confirmed the presence of publication bias. Significant results were obtained from both Begg's test ( $P = 0.56$ ) and Egger's test ( $P = 0.0016$ ). The trim and fill method also suggested inclusion of eight more studies to obtain symmetry in the funnel plot and the effect estimate was slightly reduced from 2.469 to 1.47 in the random effect model.

## DISCUSSION

A number of studies have been conducted to determine the prevalence of caries burden in Arab League

countries but there was no comprehensive review of such published literature. The purpose of this study was to review the published data related to Arab League countries and analyse this to determine the caries burden in primary and permanent teeth from 1999 to 2012. A total of 35 studies were found that were relevant for analysis: 14 studies were on primary teeth caries, 10 were on permanent teeth caries and 11 studies had been performed to reveal information about caries in both primary and permanent teeth. The prevalence of caries in primary teeth from a random effect model was found to be 4.341 (95% CI 3.714, 4.969) and in permanent teeth it was 2.469 (95% CI 2.019, 2.919).

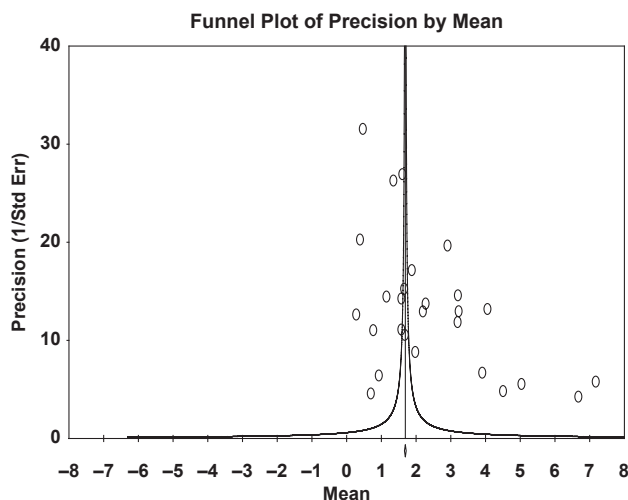
Reviews of literature related to caries burden have also been performed in some other countries. A systematic review of the articles on the prevalence of caries in Saudi Arabia was performed by Khan *et al.*<sup>15</sup>. The aim of that study was to review articles related to dental caries published in 1999–2008. The study found that a



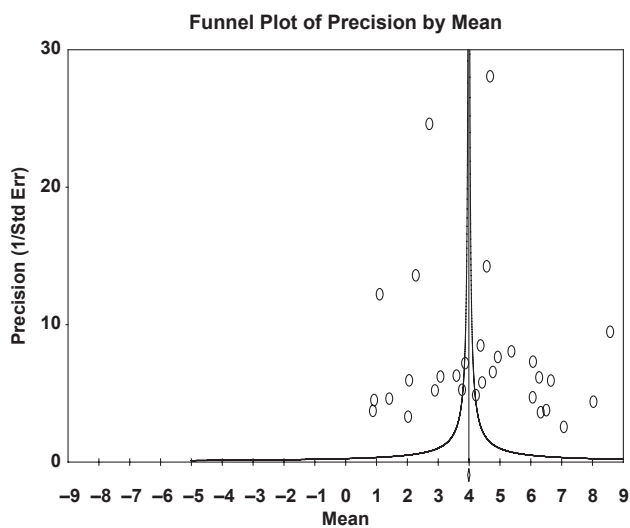
**Table 3** Prevalence of caries in primary and permanent teeth from main and stratified meta analysis in 1999–2012

	Random effect model, mean (95% CI)
Primary teeth	
Overall dmft	4.341 (3.714, 4.969)
Study year	
1999–2005	4.37 (3.1, 5.64)
2006–2012	4.31 (3.55, 5.08)
Sample size	
<512	4.16 (3.32, 5.0)
More than 512	4.69 (3.52, 5.88)
Age group	
2–7	4.49 (3.72, 5.26)
7–14	4.15 (2.96, 5.34)
Permanent teeth	
Overall DMFT	2.469 (2.019, 2.919)
Study year	
1999–2005	2.62 (2.039, 3.205)
2006–2012	2.347 (1.65, 3.039)
Sample size	
<912	2.54 (2.049, 3.04)
More than 912	2.28 (1.28, 3.287)
Age group	
6–12	2.82 (2.16, 3.48)
12–18	1.77 (1.36, 2.18)

dmft, decayed, missing and filled primary teeth; DMFT, decayed, missing and filled permanent teeth.



**Figure 5.** Mean decayed, missing and filled teeth (DMFT) according to precision of the mean DMFT in studies 1999–2012.



**Figure 4.** Mean decayed, missing and filled teeth (dmft) according to precision of the mean dmft in studies 1999–2012.

high prevalence of caries was found in primary teeth (mean dmft 5.38) compared with permanent teeth (mean DMFT 3.34)<sup>15</sup>. Cleaton-Jones and Bonecker<sup>61</sup> also researched to find trend in caries in 5–6-year-old and 11–13-year-old Latin American and Caribbean populations. They also found that primary teeth were affected by caries more than permanent teeth. Some

review studies not only discussed the prevalence of caries but also the factors associated with caries. Mau-pome *et al.*<sup>62</sup> studied the association between asthma and caries. Soft drinks may also cause dental problems<sup>63</sup>, as all food and drinks having pH below 5.0–5.7 provoke erosion effects<sup>64</sup>.

This study has some limitations. The period covered in the study was 1999–2012, and a study with a long period of data collection may have an effect on the results. In addition, in this study, only prevalence of dental caries was studied and the factors associated with caries were not considered for analysis. However, the current systematic review revealed that the prevalence of caries in primary teeth was higher than in permanent teeth. In addition, more than half of the studies recruited for this systematic review were performed in Saudi Arabia. The African countries of the Arab League were least focused on by researchers. Furthermore, in many countries only one or two studies were performed during the 14-year period considered. This systematic review indicates a real need to perform repeated studies, as in Saudi Arabia, to create an accurate picture of the prevalence of caries in Arab League countries. as the results presented in this study may not give the true picture of the burden of caries in the population.

**Acknowledgement**

I thank Prof. Dr Nazeer Khan, director of the research department at Dow University of Health Sciences, Pakistan, for providing his expert opinions and continuous support. And I also thank to Dr Imran Alam Moheet and Faraz Ahmed Farooqi for their expertise and for their valuable help.

**Conflict of interest**

None declared.

**REFERENCES**

- Fedorowicz Z, Nasser M, Wilson N. Adhesively bonded versus non-bonded amalgam restorations for dental caries. *Cochrane Database Syst Rev* 2009 (4). Art. No.: CD007517. doi: 10.1002/14651858.CD007517.pub2.
- Griffin SO, Gray SK, Dolores MM *et al.* Caries risk in formerly sealed teeth. *J Am Dent Assoc* 2009 140: 415–423.
- Dye BA, Tan S, Smith V *et al.* Trends in oral health status: United States, 1988–1994 and 1999–2004. *Vital Health Stat* 2007 11: 1–92.
- Yengopal V, Harneker SY, Patel N *et al.* Dental fillings for the treatment of caries in the primary dentition. *Cochrane Database Syst Rev* 2009 15: 2.
- Goose DH. Infant feeding and caries of the incisors: an epidemiological approach. *Caries Res* 1967 1: 167–173.
- Goose DH. Infant feeding methods and dental caries. *J Public Health Dent* 1968 82: 72–76.
- Verrips GH, Frencken JE, Kasbeek H *et al.* Risk indicators and potential risk factors for caries in 5 years olds of different ethnic groups in Amsterdam. *Community Dent Oral Epidemiol* 1992 20: 256–260.
- Tsubouchi J, Tsubouchi M, Maynard R *et al.* A study of dental caries and risk factors among native American infants. *J Dent Child* 1995 62: 283–287.
- Farsi N. Dental caries in relation to salivary factors in Saudi population groups. *J Contemp Dent Pract* 2008 9: 16–23.
- Al-Malik MI, Rehbini YA. Prevalence of dental caries, severity, and pattern in age 6- to 7-year-old children in a selected community in Saudi Arabia. *J Contemp Dent Pract* 2006 7: 46–54.
- Hobdell M, Tsakos G, Sprod A *et al.* Using an oral health-related quality of life measure in three cultural settings. *Int Dent J* 2009 59: 381–388.
- Sufia S, Chaudhry S, Izhar F *et al.* Dental caries experience in preschool children: is it related to a child's place of residence and family income? *Oral Health Prev Dent* 2011 9: 375–379.
- Cleaton Jones P, Fatti P. Dental caries trends in Africa. *Community Dent Oral Epidemiol* 1999 27: 316–320.
- Li H, Zou Y, Ding G. Dietary factors associated with dental erosion: a meta-analysis. *PLoS ONE* 2012 7: e42626.
- Khan SQ, Khan NB, Arrejaie AS. Dental caries. A meta analysis on a Saudi population. *Saudi Med J* 2013 34: 744–749.
- Doughan B, Kassak K, Bourgeois DM. Oral health status needs of 35–44-year olds in Lebanon. *Int Dent J* 2000 50:395–399.
- Honkala E, Honkala S, Shyama M *et al.* Field trial on caries prevention with xylitol candies among disabled school students. *Caries Res* 2006 40: 508–513.
- Khan N, Al-Zarea B, Al-Mansour M. Dental caries, hygiene, fluorosis and oral health knowledge of primary school teachers of Riyadh, Saudi Arabia. *Saudi Dent J* 2001 13: 128–132.
- Khan N, Al-Shaafi M, Al-Garawi Z. Dental caries, fluorosis and knowledge of school teachers of Riyadh, Saudi Arabia. *Pakistan Oral Dent J* 2000 20: 52–60.
- Al-Ghannam N, Khan NB, Al-Shammery AR *et al.* Trends in dental caries and missing teeth in adult patients in Al-Ahsa, Saudi Arabia. *Saudi Dent J* 2005 17: 57–62.
- Ryalat S, Sawair F, Baqain Z *et al.* Effect of oral disease on mothers giving birth to preterm infants. *Med Princ Pract* 2011 20: 556–561.
- Khalifa N, Allen PF, Abu-bakr NH *et al.* A survey of oral health in a Sudanese population. *BMC Oral Health* 2012 12: 5.
- Al-Dajani M. Comparison of dental caries prevalence in patients with cleft lip and/or palate and their sibling controls. *Cleft Palate Craniofac J* 2009 46: 529–531.
- Wyne AH, Al-Qahtani Z. Caries experience and oral hygiene status of blind, deaf and mentally retarded female children in Riyadh, Saudi Arabia. *Odontostomatol Trop* 2004 27: 37–40.
- Dashash M, Blinkhorn A. The dental health of 5 year-old children living in Damascus, Syria. *Community Dent Health* 2012 29: 209–213.
- Light RJ, Pillemer DB. *Summing Up: The Science of Reviewing Research*. Cambridge, MA: Harvard University Press; 1984.
- Al-Banyan RA, Echeverri EA, Narendran S *et al.* Oral health survey of 5-12-years-old children of national guard employees in Riyadh, Saudi Arabia. *Int J Paediatr Dent* 2000 10: 39–45.
- Al-Malik M, Holt RD. The prevalence of caries and of tooth tissue loss in a group of children living in a social welfare institute in Jeddah, Saudi Arabia. *Int Dent J* 2000 50: 289–292.
- Khan NB, Al Ghannam NA, Al Shammery AR *et al.* Caries in primary school children prevalence severity and pattern in al Asha, Saudi Arabia. *Saudi Med J* 2001 13: 71–72.
- Wyne A, Darwish S, Adenubi J *et al.* The prevalence and pattern of nursing caries in Saudi Arabia preschool children. *Int J Paediatr Dent* 2001 11: 361–364.
- Wyne A, al-Dlaigan Y, Khan N. Caries prevalence oral hygiene and orthodontic status of Saudi Bedouin children. *Indian J Dent Res* 2001 12: 194–198.
- Shyama M, Al-Mutawa SA, Morris RE *et al.* Dental caries experience of disabled children and young adults in Kuwait. *Community Dent Health* 2001 18: 181–186.
- Wyne AH, Al-Ghorabi BM, Al-Asiri YA *et al.* Caries prevalence in Saudi primary schoolchildren of Riyadh and their teachers' oral health knowledge attitude and practices. *Saudi Med J* 2002 23: 77–81.
- Wyne AH, Al-Ghannam NA, Al-Shammery AR *et al.* Caries prevalence severity and pattern in pre-school children. *Saudi Med J* 2002 23: 580–584.
- Rodd HD, Davidson LE, Bateman PM *et al.* Caries experience and dental attendance of Somali children living in a British city. *Eur J Paediatr Dent* 2002 3: 210–216.
- Sayegh A, Dini EL, Holt RD *et al.* Caries in preschool children in Amman, Jordan and the relationship to socio-demographic factors. *Int Dent J* 2002 52: 87–93.
- Al-Malik MI, Holt RD, Bedi R. Prevalence and patterns of caries rampant caries and oral health in two- to five-year-old children in Saudi Arabia. *J Dent Child (Chic)* 2003 70: 235–242.
- Paul TR. Dental health status and caries pattern of preschool children in Al-Khari Arabia. *Saudi Med J* 2003 24: 1347–1351.
- Al Dosari AM, Wyne AH, Akpata ES *et al.* Caries prevalence and its relation to water fluoride levels among schoolchildren in central province of Saudi Arabia. *Int Dent J* 2004 54: 424–428.
- Jamel H, Plasschaert A, Sheiham A. Dental caries experience and availability of sugars in Iraqi children before and after the United Nations sanctions. *Int Dent J* 2004 54: 21–25.
- Hashim R, Thomson WM, Ayers KMS *et al.* Dental caries experience and use of dental services among preschool children in Ajman, UAE. *Int J Paediatr Dent* 2006 16: 257–262.
- Al-Mutawa SA, Shyama M, Al-Duwairi Y *et al.* Dental caries experience of Kuwaiti schoolchildren. *Community Dent Health* 2006 23: 31–36.
- Wyne AH. Caries prevalence severity and pattern in preschool children. *J Contemp Dent Pract* 2008 9: 24–31.

44. Al-Haddad KA, Al-Hebshi NN, Al-Ak'hali MS. Oral health status and treatment needs among school children in Sana'a City, Yemen. *Int J Dent Hyg* 2010 8: 80–85.
45. Farsi N. Developmental enamel defects and their association with dental caries in preschoolers in Jeddah, Saudi Arabia. *Oral Health Prev Dent* 2010 8: 85–92.
46. Hazza'a AM, Rawashdeh MA, Al-Nimri K *et al.* Dental and oral hygiene status in Jordanian children with cleft lip and palate: a comparison between unilateral and bilateral clefts. *Int J Dent Hyg* 2011 9: 30–36.
47. Al-Majed AM. Dental caries and its association with diet among female primary school children in Riyadh city. *Pak Oral Dent J* 2011 31: 314–320.
48. Togoo RA, Yaseen SM, Zakirulla M *et al.* Prevalence of first permanent molar caries among 7–10 years old school going boys in Abha city, Saudi Arabia. *J Int Oral Health* 2011 3: 29–34.
49. Al-Khadra TA. Prevalence of dental caries and oral hygiene status among Down's syndrome patient's in Riyadh-Saudi Arabia. *Pak Oral Dent J* 2011 3: 115–117.
50. Qadri G, Nourallah A, Splieth CH. Early childhood caries and feeding practices in kindergarten children. *Quintessence Int* 2012 43: 503–510.
51. Abolfotouh MA, Hassan KH, Khattab MS *et al.* Dental caries experience in relation to wasting and stunted growth among schoolboys in Abha, Saudi Arabia. *Ann Saudi Med* 2000 20: 360–363.
52. Al-Sharbaty MM, Meidan TM, Sudani O. Oral health practices and dental caries among Libyan pupils, Benghazi (1993–94). *East Mediterr Health J* 2000 6: 997–1004.
53. Al Dosari AM, Wyne AH, Khan NB *et al.* Caries prevalence in secondary school children in Riyadh and Qaseem. *Saudi Dent J* 2003 15: 96–99.
54. Al-Ismaily M, Al-Busaiby K, Al-Khussaiby A. The progression of dental disease in Omani schoolchildren. *Int Dent J* 2004 54 (6 Suppl 1): 409–410.
55. Ahmed NA, Astrøm AN, Skaug N *et al.* Dental caries prevalence and risk factors among 12-years old schoolchildren from Baghdad, Iraq: a post war survey. *Int Dent J* 2007 57: 36–44.
56. Farag A, van der Sanden WJ, Abdelwahab H *et al.* 5-Year survival of ART restorations with and without cavity disinfection. *J Dent* 2009 37: 468–474.
57. Nurelhuda NM, Trovik TA, Ali RW *et al.* Oral health status of 12-year-old school children in Khartoum state, the Sudan; a school-based survey. *BMC Oral Health* 2009 9: 15.
58. Al-Dosari AM, Akpata ES, Khan N. Association among dental caries experience, fluorosis and fluoride exposure from drinking water sources in Saudi Arabia. *J Public Health Dent* 2010 70: 220–226.
59. Huew R, Waterhouse P, Moynihan P *et al.* Dental caries and its association with diet and dental erosion in Libyan school-children. *Int J Paediatr Dent* 2012 22: 68–76.
60. Al-Otaibi MF, Al-Mamari F, Baskaradoss JK. Oral health status of 12-year-old school children in Yemen. A cross-sectional survey. *Eur J Paediatr Dent* 2012 13: 324–328.
61. Bonecker M, Cleaton-Jones P. Trend in dental caries in Latin America and Caribbean 5–6 and 11–13 years old children: a systematic review. *Community Dent Oral Epidemiol* 2003 31: 152–157.
62. Maupome G, Shulman JD, Medina-Solis CE *et al.* Is there a relationship between asthma and dental caries? A critical review of the literature. *J Am Dent Assoc* 2010 141: 1061–1074.
63. Shashikiran ND, Reddy VV, Raju PK. Effect of antiasthmatic medication on dental disease: dental caries and periodontal disease. *J Indian Soc Pedod Prev Dent* 2007 21: 207–211.
64. Li H, Ding G. Dietary factors associated with dental erosion: a meta-analysis. *PLoS One* 2012 7: e42626.

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