**Prevalence of dental caries among children aged 5–15 years from 9 countries in the Eastern Mediterranean Region: a meta-analysis**

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## Abstract

**Background:** Dental caries affects all age groups, although children are affected to a greater extent. Several studies have assessed the prevalence of dental caries in the World Health Organization (WHO) Eastern Mediterranean Region. However, prevalence data for dental caries have not been pooled for all countries in the Region.

**Aims:** To estimate by meta-analysis the pooled prevalence of dental caries among children aged 5–15 years in the Region.

**Methods:** The study protocol was registered in PROSPERO with registration number CRD42016037157. Twenty-one studies (37 estimates) were identified through systematic search for articles published between 1 January 2005 and 5 July 2018. The required data from each article were extracted into the datasheet. A random-effects meta-analysis was performed for the overall age group and for age 5, 12 and 15 years individually.

**Results:** Data were available for only 9 of the 21 countries in the Region. Heterogeneity between studies was high ($I^2 > 98\%$). There was considerable variation among the countries for the prevalence of dental caries at different ages. The pooled prevalence for deciduous dentition in children aged 5 years was 65% (45–85%); 61% (50–72%) for permanent dentition in children aged 12 years; 70% (64–75%) for children aged 15 years; and 66% (59–73%) for children aged 6–15 years. The most common index used for oral examination to calculate caries experience was WHO Basic Oral Health Survey Criteria, 1997.

**Conclusions:** Dental caries continues to be an oral health concern among children in 9 countries in the Region.

**Introduction**

Dental caries has long been a global oral health burden (*1*). It not only affects oral health but also has a deleterious effect on overall health and quality of life (*2*), especially in underprivileged countries (*3*). The World Health Organization (WHO) reports that 60–90% of children are affected by dental caries (*4*). Dental caries affects all age groups, although children are affected to a greater extent than adults. Part of the solution to overcome this problem is to estimate the current burden accurately and plan for a comprehensive dental programme. The WHO Country Area Profile Program database maintains data on caries prevalence data. However, there are a few limitations: data are not available for all age groups and all the WHO countries; and if data are available, they are not updated on a regular basis. In the WHO Eastern Mediterranean Region, data are available but they are not updated on a regular basis (*5*). In 2018, Al Ayyan et al. conducted a meta-analysis of the Gulf countries in the Region, and found that prevalence of caries in deciduous teeth was 80.9% (*6*).

To obtain a complete picture of the dental caries situation among children in all the countries in the Region, a meta-analysis has been planned, which will provide evidence-based information, based upon which, appropriate health care policies can be developed. Along with prevalence, it is also essential to evaluate the various indices used in the published literature for assessing caries, as different indices give varying results within the same populations (*7*). For example, the International Caries Detection and Assessment System (ICDAS) considers even white spots as caries, while the traditional Decayed Missing and Filled (DMF) index ignores noncavitated enamel lesions, leading to underestimation of caries (*8*).

The aim of this review was to assess prevalence of caries among children aged 5–15 years by conducting a meta-analysis, and to identify the most common indices used for estimating caries prevalence in the Region.

**Methods**

This study was part of a bigger review that was conducted to estimate prevalence of caries across all WHO regions. The review protocol is registered in PROSPERO (registration number CRD42016037157). Here, we discuss only the meta-analysis pertaining to the Eastern Mediterranean Region.

*Literature search*

A literature search was conducted in PubMed and Google Scholar for the relevant articles using a preset search strategy. The keywords used were "Dental caries AND Prevalence AND Children AND (name of country)". Only articles published between 1 January 2005 and 5 July

2018 were considered. The search was carried out independently by 1 author (SK) and was verified by 2 others (PK and SHS). The inclusion criteria were: studies that were community based, cross-sectional, English language, and conducted among children aged 5–15 years. Only those studies providing data about children native to the countries of the Region were retrieved. Exclusion criteria were: studies that were conducted with a secondary objective to identify prevalence; studies on caries association and correlation with risk factors; studies on immigrants and special groups; studies including one gender only; and short communications and letters to the editor.

*Data extraction*

Study characteristics such as authors' names, year of publication, age/age group included, sample size, index used, prevalence of dental caries, type of dentition and risk factors for dental caries are summarized in Appendix 1 (*9–29*). The caries prevalence of permanent dentition (D) for the age group 6–15 years and caries prevalence of deciduous dentition(d)for the age group 5–15 years were calculated separately. The caries prevalence represented the D component and d component of the Decayed, Missing and Filled Teeth (DMFT) and dmft indices (DMFT is for permanent teeth and dmft for deciduous teeth). The D and d component of DMFS (Decayed, Missing and Filled Surface) and dmfs (deciduous teeth) were not considered. Caries prevalence data were extracted for individual ages. If individual age prevalence was not mentioned, the combined prevalence of age groups (e.g., 6–15 and 8–10 years) was considered. If prevalence was not mentioned but data about the D and d components, along with the total sample size, were available, the prevalence rate was calculated.

*Quality Assessment*

The quality assessment of the included studies was performed based on the criteria reported by Kale et al. (*30*).

*Statistical analysis*

A random-effects meta-analysis was performed to estimate the pooled prevalence and 95% confidence intervals (CIs) and were depicted by means of forest plots. Heterogeneity was quantified using $I^2$ statistics. Separate meta-analyses were performed for ages 5, 12 and 15 years and overall for 6–15 years. All analyses were performed using STATA version 12.

**Results**

A total of 259 articles from PubMed and 12 from Google Scholar were retrieved initially (Figure 1). After reviewing the titles of the articles, 133 were excluded, as they did not fit the selection criteria. After reading through the abstracts of the remaining articles,17 more were excluded. An in-depth reading of the remaining articles led to the exclusion of 7 more, for reasons such as not mentioning the prevalence, inclusion of children aged > 15 years, and providing prevalence of deciduous and permanent dentition together. Ultimately, 21 articles

with 37 estimates were considered for meta-analysis. Relevant literature was only found for 9 of the 21 countries currently in the Eastern Mediterranean Region [Islamic Republic of Iran, Iraq, Yemen, Jordan, Libya, United Arab Emirates (UAE), Bahrain, Lebanon and Egypt). For children aged 5 years there were 4 estimates; for children aged 12 years there were 11 estimates; for children aged 15 years there were 7 estimates; and for children aged 6–15 years there were 33 estimates available. Only 2 studies that were reported by Ahmadzadeh et al. (*15*) and Hamza (*17*) were found to have moderate quality as per quality assessment criteria (*30*). All other studies were of high quality and none was of low quality.

The heterogeneity between the studies was high ($I^2 > 98\%$) and therefore an aggregate data random-effect model was adopted for the meta-analysis. The pooled prevalence for deciduous dentition for children aged 5 years was 65% (95% CI: 45–85%) (Figure 2); 61% (95% CI: 50–72%) for permanent dentition in children aged 12 years (Figure 3); 70% (95% CI: 64–75%) for children aged 15 years (Figure 4); and 66% (95% CI: 59–73%) for children aged 6–15 years (Figure 5). Based on the data extracted from each included study, the index information was obtained (Appendix 1). The number of times the index was used was totalled to meet the second objective. The most common index used for evaluating dental caries experience was the WHO Basic Oral Health Criteria, 1997 (used in 13 studies), followed by the DMFT index, 1937 (3 studies), WHO Basic Oral Health Criteria, 1987 (3 studies) and WHO Basic Oral Health Criteria, 2013 (2 studies).

**Discussion**

Several studies have been conducted in the Eastern Mediterranean Region to assess the prevalence of dental caries. However, there has been no effort to pool the prevalence data for all the countries in the Region. Hence, this meta-analysis was conducted to obtain prevalence data for dental caries in children aged 5–15 years in the Region, and to establish the most frequently used index for assessing caries in these studies. The pooled prevalence obtained for children aged 5 years was 65%. This is lower than the prevalence of 80.95% in Gulf countries reported by Al Ayyan et al. (*6*). Despite the fact that it is lower than the previously reported prevalence, it still does not meet the target set of 50% caries free by WHO in 2000 (*31*). Our review had data from only 4 studies of deciduous teeth, while the review by Al Ayyan et al. (*6*) included 34 studies from 1992–2016. This might explain the variation in prevalence. Three of the 4 estimates in the present study were from the UAE and the other was from Yemen. The reason reported for dental caries in these studies was the negative attitude of parents towards their children's dental health.

For the children aged 12 years, the pooled prevalence was 61%. This result was obtained by pooling the prevalence from the Islamic Republic of Iran, Jordan, Yemen, Libya, United Arab Emirates, Iraq, Bahrain and Lebanon. Dental caries in this age group was attributed to low socioeconomic status, low parental education, consumption of refined food and poor access to dental services. Two studies (*13*, *19*) reported low socioeconomic status to be the reason

for high prevalence of caries, whereas another (*28*) reported it as a reason for low prevalence of caries.

Among children aged 15 years, the prevalence of dental caries was 70%. This was contributed by studies from the Islamic Republic of Iran, UAE, Bahrain and Lebanon. Poor oral hygiene practices among children, consumption of cariogenic diet and low socioeconomic status were the reported factors for the presence of dental caries.

The most common dental caries indices used were WHO criteria 1987, 1997 and 2013 and the DMFT index proposed by Klein, Palmer and Knutson (1937). Castro et al. (*8*) conducted an interview to investigate the population-based caries detection methods and reported that DMFT index was the most known and used index. However, 95.7% were dissatisfied with the index yet continued to use it. It is recommended that researchers use the WHO Basic Oral Health Survey criteria for assessing caries, which will provide global uniformity and aid effective comparison.

Overall, the pooled prevalence of permanent dentition in children aged 6–15 years was 66%. There was huge variation among the prevalence rates, with the lowest of 22% reported by Said-Moallemi et al. (*11*) and the highest of 94% reported by Doumit and Doughan (*21*). The reasons for high prevalence of caries were low socioeconomic status, cariogenic diet, low parental education, less accessibility to dental care services, and dental health negligence. The reasons for low prevalence of caries were widespread use of fluoridated toothpaste (*18*) and implementation of a national oral health programme (*11*). This variation can be attributed to different geographic locations, differences in the individuals included in the study, variation in sample size, and the use of different indices for assessing caries. Oral health policies, community water fluoridation and oral hygiene products also play a role in the variation among countries. Low levels of water fluoridation are found in most provinces in the Islamic Republic of Iran and only 22% of the Libyan population receive fluoridated water (*32*). Until 2003, the United Nations had imposed sanctions on the amount of food provided to Iraq, which included freely available sugar (*33*), but after 2003 the amount of sugar increased and thus consumption of sugar also increased, which is one of the key causative factors of caries. No literature was found with respect to the oral health policies of the countries included in this analysis.

There were some limitations to our meta-analysis. First, only 2 databases were searched. Second, only English-language articles were selected. In cases where a combined prevalence (deciduous + permanent) was mentioned, such studies were excluded. Caries prevalence should be reported separately for deciduous and permanent dentition, which aids effective meta-analysis. The meta-analysis was intended to cover the Eastern Mediterranean Region; however, data were only available from 9 countries (Islamic Republic of Iran, Iraq, Yemen, Jordan, Libya, UAE, Bahrain, Lebanon and Egypt). No information was available for countries

like Djibouti and Oman. However, for other countries in the Region, some oral health information was available but these articles were not selected as they did meet the inclusion criteria.

## Conclusion

Within the limitations of this meta-analysis, it can be concluded that dental caries in children is still a major problem in the 9 countries studied in the Region. More studies reporting dental caries from all the countries in the Region are required to obtain an accurate picture of dental caries prevalence among children in the Region.

**Funding:** None.
**Competing interests:** None declared.

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**Appendix 1. Characteristics of the included studies**

| Study ID | Author and publication year | Country | Sample size (age/age group) | Dental caries index | Caries prevalence (dentition) | Caries attributable factors |
|---|---|---|---|---|---|---|
| 1 | Ahmed Naseeb, 2016[9](A) | Bahrain | 810 (12 yr) | WHO 2013, DMFT | 70% (P) | |
| 2 | Ahmed Naseeb, 2016 (B) | Bahrain | 428 (15 yr) | WHO 2013, DMFT | 75% (P) | Intake of fermentable carbohydrates |
| 3 | El Shazly& Hala, 2016[10] | Egypt | 1283 (13 yr) | Klein, Palmer and Knutson for DMFT | 62.8% (P) | Low socioeconomic condition, faulty food habits |
| 4 | Saied-Moallemi et al., 2006[11] | Islamic Republic of Iran | 459 (9 yr) | WHO 1997, DMFT | 22% (P) | Low caries due to implementation of comprehensive national oral health programme including fluoride mouth rinse and oral health education |
| 5 | Meyer-Lueckel et al., 2006[12](ii)(A) | Islamic Republic of Iran | 103 (6 yr) | Klein, Palmer and Knutson for DMFT | 83% (P) | Socioeconomic background, dietary sources of fluoride, and urbanization |
| 6 | Meyer-Lueckel et al., 2006 (ii)(B) | Islamic Republic of Iran | 93 (6 yr) | Klein, Palmer and Knutson for DMFT | 81% (P) | |

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| 7 | Meyer-Lueckel et al., 2006 (ii)(C) | Islamic Republic of Iran | 51 (6 yr) | Klein, Palmer and Knutson for DMFT | 88% (P) | |
| 8 | Meyer-Lueckel et al., 2006 (ii)(D) | Islamic Republic of Iran | 106 (9 yr) | Klein, Palmer and Knutson for DMFT | 77% (P) | |
| 9 | Meyer-Lueckel et al., 2006 (ii)(E) | Islamic Republic of Iran | 90 (9 yr) | Klein, Palmer and Knutson for DMFT | 70% (P) | |
| 10 | Meyer-Lueckel et al., 2006 (ii)(F) | Islamic Republic of Iran | 80 (9 yr) | Klein, Palmer and Knutson for DMFT | 72% (P) | |
| 11 | Meyer-Lueckel et al., 2007[13](i)(A) | Islamic Republic of Iran | 115 (12 yr) | Klein, Palmer and Knutson for DMFT | 45% (P) | |
| 12 | Meyer-Lueckel et al., 2007 (i)(B) | Islamic Republic of Iran | 89 (12 yr) | Klein, Palmer and Knutson for DMFT | 55% (P) | |
| 13 | Meyer-Lueckel et al., 2007 (i) (C) | Islamic Republic of Iran | 80 (12 yr) | Klein, Palmer and Knutson for DMFT | 45% (P) | Socioeconomic class, parental education, consumption of refined carbohydrates |
| 14 | Meyer-Lueckel et al., 2007(i)(D) | Islamic Republic of Iran | 129 (15 yr) | Klein, Palmer and Knutson for DMFT | 74% (P) | |
| 15 | Meyer-Lueckel et al., 2007 (i)(E) | Islamic Republic of Iran | 100 (15 yr) | Klein, Palmer and Knutson for DMFT | 66% (P) | |

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|---|---|---|---|---|---|---|
| 16 | Meyer-Lueckel et al., 2007 (i)(F) | Islamic Republic of Iran | 80 (15 yr) | Klein, Palmer and Knutson for DMFT | 49% (P) | |
| 17 | Hamissi et al., 2008[14] | Islamic Republic of Iran | 390 (15 yr) | WHO 1997, DMFT | 75% (P) | Oral hygiene habits, socioeconomic conditions and cariogenic diet |
| 18 | Ahmadzadeh et al., 2015[15](A) | Islamic Republic of Iran | 220 (6–8 yr) | WHO 1997, DMFT | 25.9% (P) | |
| 19 | Ahmadzadeh et al., 2015(B) | Islamic Republic of Iran | 104 (9–10 yr) | WHO 1997, DMFT | 71.2% (P) | Sugar consumption and poor dental health |
| 20 | Ahmadzadeh et al., 2015 (C) | Islamic Republic of Iran | 84 (11–12 yr) | WHO 1997, DMFT | 83.3% (P) | |
| 21 | Ahmed, 2007[16] | Iraq | 392 (12 yr) | WHO 1997, DMFT | 62% (P) | ? |
| 22 | Hamza, 2012 [17] | Iraq | 390 (12 yr) | WHO 1997, DMFT | 55.4% (P) | ? |
| 23 | EL-Qaderi and Taani, 2006[18] | Jordan | 1362 (14–15 yr) | WHO 1987, DMFT | 76% (P) | Low caries compared to previous study due to widespread use of fluoridated toothpaste and improvement in oral hygiene habits |

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|---|---|---|---|---|---|---|
| | | | | | | High caries associated with poor access to dental services, self-care practices, dental attitudes and consumption of sweetsand sugary drinks. Caries high in low and middle socioeconomic classes as compared to upper class |
| 24 | Rajab et al., 2014[19] | Jordan | 2560 (12 yr) | WHO 1997, DMFT | 45.5% (P) | |
| 25 | Smadi et al., 2016[20] | Jordan | 1286 (6–12 yr) | WHO 1997, DMFT | 78.7% (P) | Oral health negligence, lack of dental care services |
| 26 | Doumit and Doughan, 2018[21] (A) | Lebanon | 480 (6–8 yr) | WHO 1997, DMFT | 94.43% (P) | |
| 27 | Doumit and Doughan, 2018 (B) | Lebanon | 480 (12 yr) | WHO 1997, DMFT | 86.92% (P) | ? |
| 28 | Doumit and Doughan, 2018 (C ) | Lebanon | 480 (15 yr) | WHO 1997, DMFT | 77.65% (P) | |

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|---|---|---|---|---|---|---|
| 29 | Huew et al., 2011[22] | Libya | 791 (12 yr) | WHO 1997, DMFT | 57.8% (P) | Less exposure of fluoride due to limited toothbrushing, poor oral hygiene, consumption of sugar, lack of dental hygienist and oral health education programmes |
| 30 | El-Nadeef et al., 2009[23](i)(A) | United Arab Emirates | 1323 (12 yr) | WHO 1987, DMFT | 54% (P) | ? |
| 31 | El-Nadeef et al., 2009 (i)(B) | United Arab Emirates | 1328 (15 yr) | WHO 1987, DMFT | 65% (P) | ? |
| 32 | Hashim et al., 2010[24] | United Arab Emirates | 524 (5 yr) | WHO 1997, dmft | 72.9% (D) | ? |
| 33 | El-Nadeef et al., 2010[25] (ii) | United Arab Emirates | 1340 (5 yr) | WHO 1997, dmft | 83% (D) | ? |
| 34 | Al Mashhadani et al., 2017[26] | United Arab Emirates | 2237 (12–14 yr) | WHO 2013, DMFT | 41.6% (P) | Poor oral hygiene practice, lack of supervision while toothbrushing |

| 35 | AlKhayat, 2018[27] | United Arab Emirates | 716 (5 yr) | WHO 1987, dmft | 42.2% (D) | Negative attitude of parent towards children's dental health |
|---|---|---|---|---|---|---|
| 36 | Al-Otaibi et al., 2012[28] | Yemen | 400 (12 yr) | WHO 1997, DMFT | 90.2% (P) | Students with low socioeconomic conditions had least caries compared with studentswith medium socioeconomic status |
| 37 | Al-Mikhlafi et al., 2017[29] | Yemen | 202 (5 yr) | WHO1997, dmft | 62% (D) | ? |

*D = deciduous dentition prevalence, P = permanent dentition prevalence, ? = factors not mentioned. (A–F) are same studies representing different age/age group data. (i, ii) represent two different studies reported by the same author in the same year.*

**Figure 1. PRISMA flow chart showing the article selection process**

**Figure 2. Dental caries prevalence (deciduous dentition) in children aged 5 years in the Eastern Mediterranean Region.** (A) and (ii) as in footnote to Table 1. CI = confidence interval; ES = estimate; $I^2$ = heterogeneity.

**Figure 3. Dental caries prevalence (permanent dentition) in children aged 12 years in the Eastern Mediterranean Region.** (A–C) as in footnote to Table 1. CI = confidence interval; ES = estimate; $I^2$ = heterogeneity.

**Figure 4. Dental caries prevalence (permanent dentition) in children aged 15 years in the Eastern Mediterranean Region.** (B–F) as in footnote to Table 1. CI = confidence interval; ES = estimate; $I^2$ = heterogeneity.
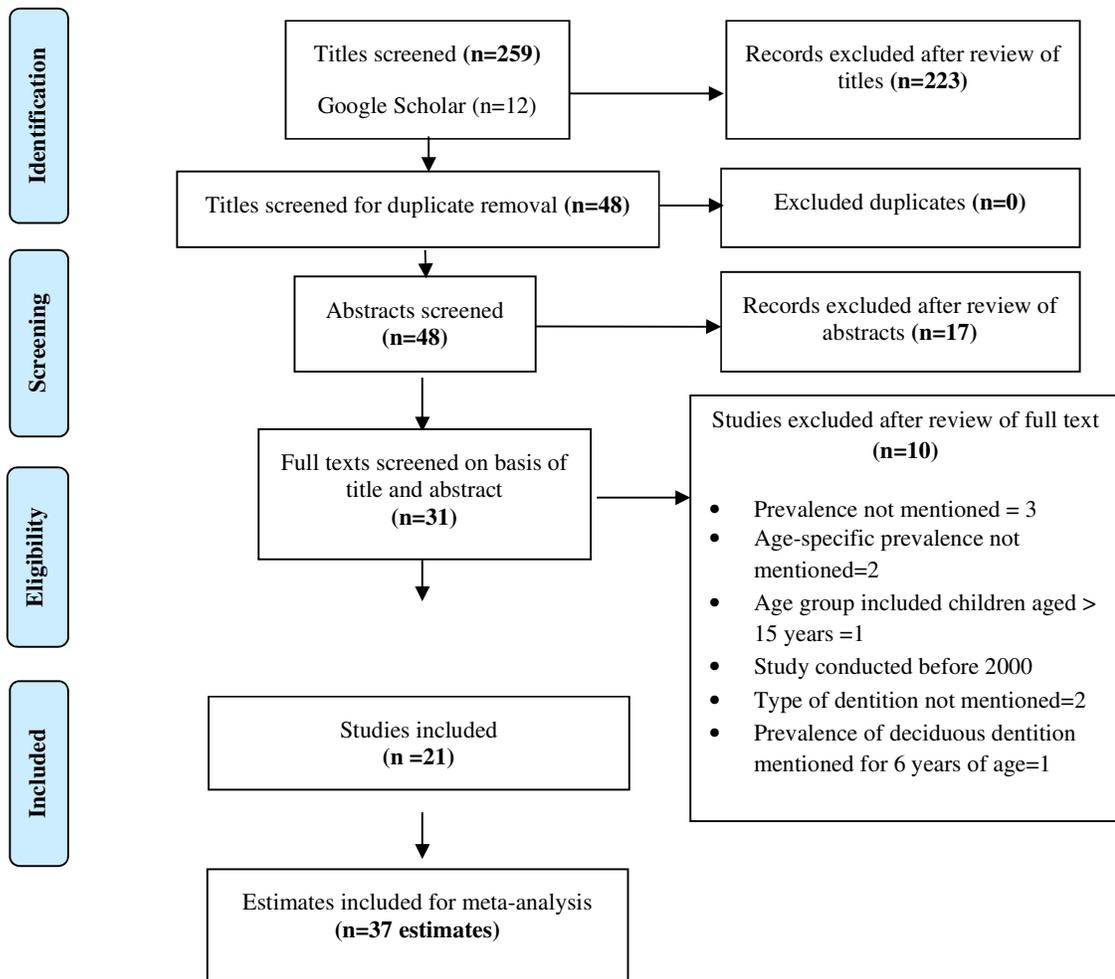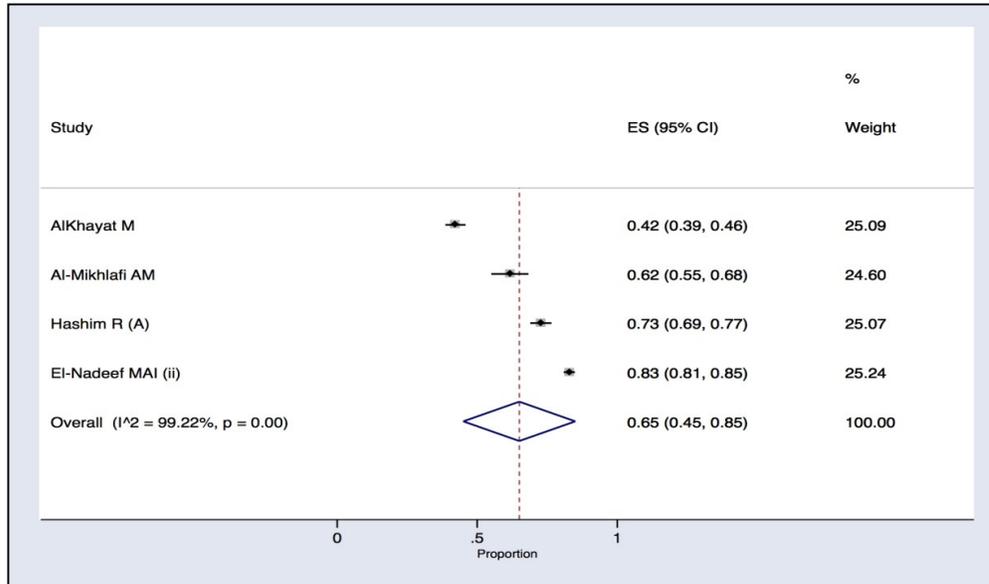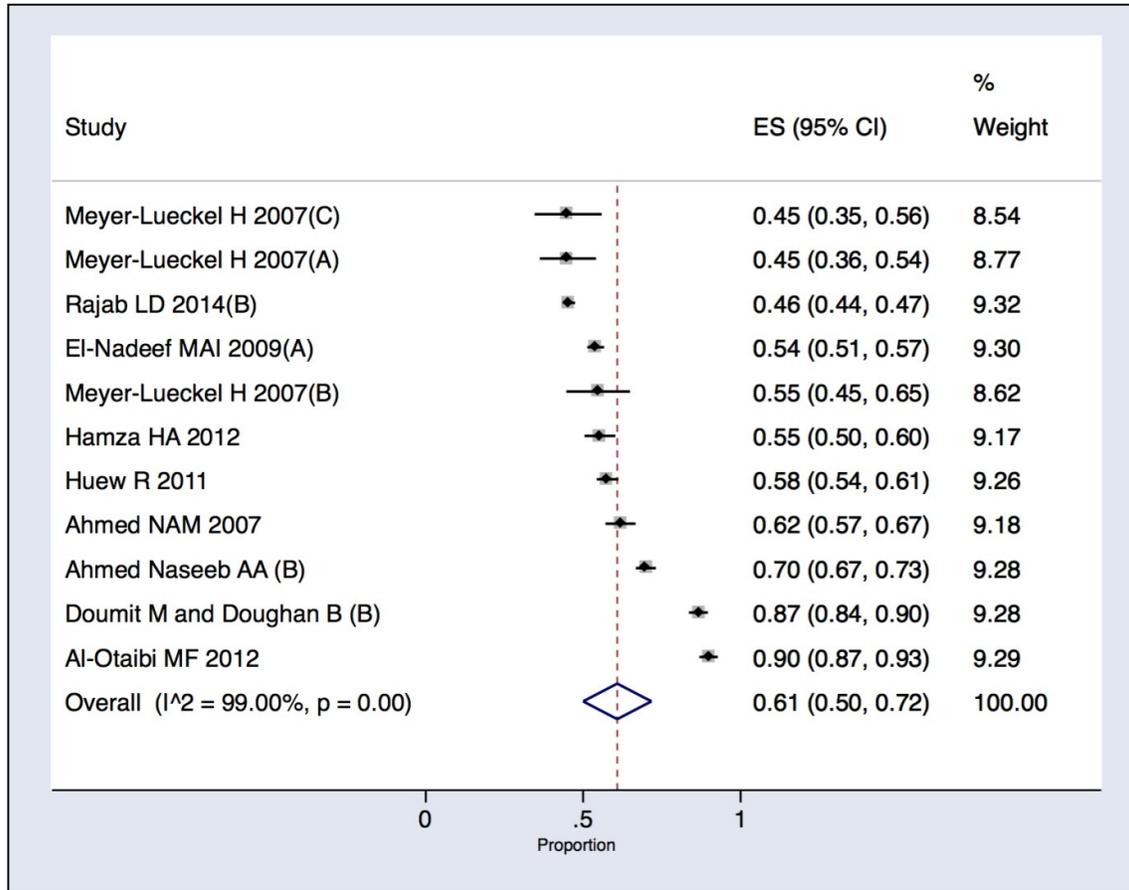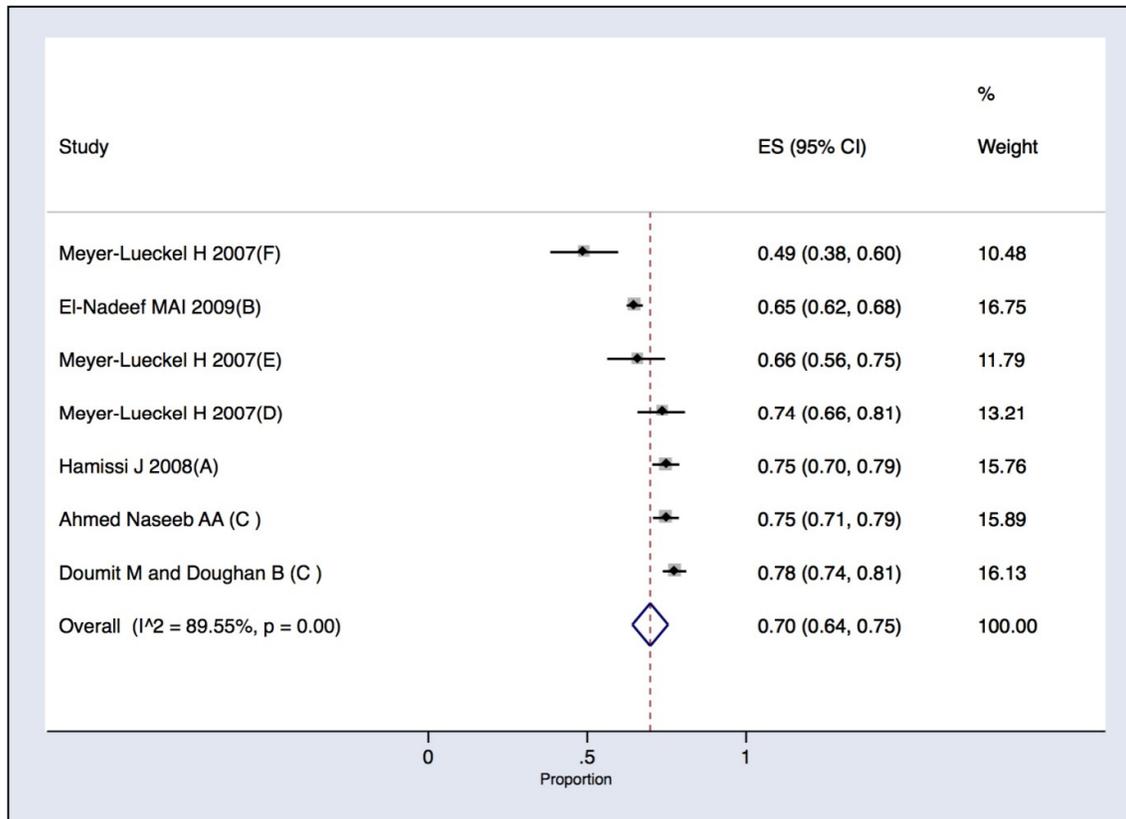
**Figure 5. Dental caries prevalence (permanent dentition) in children aged 6–15 years in the Eastern Mediterranean Region.** (A–F) and (i and ii) as in footnote to Table 1. CI = confidence interval; ES = estimate; I² = heterogeneity.



| Study | ES (95% CI) | % Weight |
|---|---|---|
| Saied-Moallemi Z | 0.22 (0.18, 0.26) | 3.09 |
| Ahmadzadeh J (A) | 0.26 (0.21, 0.32) | 3.05 |
| Al Mashhadani SS (B) | 0.42 (0.40, 0.44) | 3.11 |
| Meyer-Lueckel H (i) (C) | 0.45 (0.35, 0.56) | 2.88 |
| Meyer-Lueckel H (i)(A) | 0.45 (0.36, 0.54) | 2.95 |
| Rajab LD (B) | 0.46 (0.44, 0.47) | 3.11 |
| Meyer-Lueckel H (i)(F) | 0.49 (0.38, 0.60) | 2.87 |
| El-Nadeef MAI (i)(A) | 0.54 (0.51, 0.57) | 3.10 |
| Meyer-Lueckel H (i)(B) | 0.55 (0.45, 0.65) | 2.90 |
| Hamza HA | 0.55 (0.50, 0.60) | 3.07 |
| Huew R | 0.58 (0.54, 0.61) | 3.09 |
| Ahmed NAM | 0.62 (0.57, 0.67) | 3.07 |
| Hewida M. El Shazly and Hala M. Gabr | 0.63 (0.60, 0.65) | 3.10 |
| El-Nadeef MAI (i)(B) | 0.65 (0.62, 0.68) | 3.10 |
| Meyer-Lueckel H (i)(E) | 0.66 (0.56, 0.75) | 2.94 |
| Meyer-Lueckel H (ii)(E) | 0.70 (0.60, 0.78) | 2.93 |
| Ahmed Naseeb AA (B) | 0.70 (0.67, 0.73) | 3.10 |
| Ahmadzadeh J (B) | 0.71 (0.62, 0.79) | 2.96 |
| Meyer-Lueckel H (ii)(F) | 0.73 (0.62, 0.81) | 2.92 |
| Meyer-Lueckel H (i)(D) | 0.74 (0.65, 0.80) | 3.00 |
| Ahmed Naseeb AA (C) | 0.75 (0.71, 0.79) | 3.08 |
| Hamissi J | 0.75 (0.71, 0.79) | 3.08 |
| EL-Qaderi SS and Taani DQ | 0.76 (0.74, 0.78) | 3.11 |
| Meyer-Lueckel H (ii)(D) | 0.77 (0.69, 0.84) | 2.98 |
| Doumit M and Doughan B (C) | 0.78 (0.74, 0.81) | 3.09 |
| Smadi L | 0.79 (0.76, 0.81) | 3.11 |
| Meyer-Lueckel H (ii)(B) | 0.81 (0.71, 0.87) | 2.98 |
| Meyer-Lueckel H (ii)(A) | 0.83 (0.74, 0.89) | 3.00 |
| Ahmadzadeh J (C) | 0.83 (0.74, 0.90) | 2.98 |
| Doumit M and Doughan B (B) | 0.87 (0.84, 0.90) | 3.10 |
| Meyer-Lueckel H (ii)(C) | 0.88 (0.77, 0.94) | 2.95 |
| Al-Otaibi MF | 0.90 (0.87, 0.93) | 3.10 |
| Doumit M and Doughan B (A) | 0.94 (0.92, 0.96) | 3.11 |
| Overall (I^2 = 99.06%, p = 0.00) | 0.66 (0.59, 0.73) | 100.00 |