Determinants of dental caries in children in the Middle East and North Africa region: A systematic review based on literature published from 2000 to 2019

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Abstract

Background

Dental caries risk factors have been expanded to not only emphasize biology and dietary and oral habits but also broader social determinants such as socioeconomic factors and the utilization of health services. The aim was to review sociobehavioural/cultural and socioeconomic determinants of dental caries in children residing in the Middle East and North Africa (MENA) region.

Methods

A search was conducted in the PubMed/Medline database and Google Scholar to identify studies published from 2000–2019 covering children using key search terms. In the initial stages, titles, abstracts and, if needed, full articles were screened for eligibility. In the final stage, all included articles were reassessed and read, and relevant data were extracted.

Results

Out of 600 initial articles, a total of 77 were included in this review, of which 74 were cross-sectional, 2 were longitudinal and one was a case-control study. The studies included a total of 94,491 participants in 14 countries across the MENA region. A majority used the World Health Organization scoring system to assess dental caries. The caries prevalence ranged between 17.2–88.8%, early childhood caries between 3–57% and decayed missing filled teeth (dmft) varied between 0.6–8.5 across the various age groups. Increased age, low maternal education, low overall socioeconomic status, decreased frequency of tooth brushing, low parental involvement, poor oral habits, infant feeding practices and sugar were among the most prevalent determinants for increased risk of caries in the reviewed studies.

Conclusions

Dental caries was found to be high among children in many of the studies published from MENA. The key determinants of dental caries were found to include factors related to child characteristics, family background, oral hygiene and infant feeding and eating habits. The high dental caries prevalence emphasises the need to address the prevailing modifiable sociobehavioural and socioeconomic determinants by translating them into effective oral health prevention policies and programmes.

1. Background

Dental caries continues to be one of the most prevalent chronic diseases worldwide and a costly burden to healthcare services despite the availability of effective basic prevention measures [1]. Since the declaration of the Millennium Development Goals (MDGs) in 2000 and later the Sustainable Development Goals (SDGs), both of which allowed for tracking countries’ health profiles, the profile of the Middle East and North Africa (MENA) region has undergone notable changes [2]. In some MENA countries, political stability, economic growth and investments in healthcare systems have led to improvements in various health indicators, whereas some countries have been impacted by political unrest or war; subsequently, the region currently includes low-middle income, upper-middle income and high income countries [3, 4]. These societal changes have also contributed to an increased rate of non-communicable diseases and persistence of some communicable diseases, such as dental caries, due to a marked shift in lifestyle, increased food availability and a notable nutritional transition among citizens [4].

Globally, the profile of dental caries is also heterogeneous across developing and developed countries, with large disparities reported between and within groups [5, 6]. Principally, it has been claimed that dental caries is decreasing in most industrialized countries due to improvements in prevention programmes and increased access to dental health services, but conflicting results have shown that dental caries is still prevalent among underprivileged groups in many of these countries [5, 7, 8]. In most developing countries, dental caries levels were low until recent years, after which an increase has been observed due to growing consumption of sugars, inadequate exposure to fluorides and less access to oral healthcare services [5, 8, 9]. In the MENA region, trends in dental caries have shown a rapid increase in the incidence of the disease, with most caries remaining untreated [10]. Existing data from the Eastern Mediterranean Region (EMRO) from 20 countries show wide variations in dental caries with decayed, missing, and filled teeth scores (DMFT) among 12-year-olds ranging from 0.4–4.4 and a higher prevalence and severity of dental caries in the primary dentition than in the permanent dentition among 6-year-olds [10]. Furthermore, distinctions between dental caries experiences are present, with high rates of untreated caries in developing countries, which reflects the limited resources available and difficulties in accessibility and affordability to essential oral health care services [10, 11].

While determinants that contribute to the initiation and progression of dental caries are complex and multifactorial, understanding their role is crucial for establishing appropriate prevention and management strategies [12]. The determinants can be divided into biological, contextual/environmental, sociobehavioural/cultural and socioeconomic factors [13, 14]. Examples of biological determinants include host susceptibility and oral flora, and the contextual/environmental determinants include access to and utilization of dental healthcare services, oral health promotion programmes and fluoridation of water [15]. Moreover, examples of sociobehavioural/cultural determinants regarding dental caries include dental hygiene practices, consumption of sugars, lifestyle habits such as alcohol consumption and tobacco use [16]. To the best of our knowledge, there are no recent studies focusing on sociobehavioural/cultural and socioeconomic determinants of dental caries in children residing in the MENA region. Hence, the aim of the review was to address this gap in the literature.
The central questions for this review, which incorporated literature from 2000 to 2019 published from the MENA region were:

1. What sociobehavioural and socioeconomic variables have been studied within the context of dental caries prevalence in children aged 0–20 years?
2. What did the reviewed studies reveal about the influence of sociobehavioural and socioeconomic variables on the risk for dental caries in children?
3. What recommendations can be made for future research?

2. Methods

Electronic searches of databases (PubMed and Medline) and a specialized webpage (scholar.google.com) were used to explore determinants or prevalence of early childhood caries (ECC) or dental caries in children and young adults (age 0-20 years) residing in the MENA region. The World Atlas categorization of the MENA region was used, and accordingly, the following countries were included: Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, UAE and Yemen. Combinations of the following MeSH terms were used to identify relevant articles: “caries”, “children”, “determinants”, “behaviours”, “dietary causes”, “dietary habits”, “education, factors, income, socio, social determinants and geographic context (each of the individual countries, e.g., Egypt, Middle East and North Africa). An example of the search strategy used to search MEDLINE: (“determinant” [all fields] AND “caries” [all fields] AND “children” [all fields] AND “country name” [all fields]). Table 1 describes the search terms and examples of search strategies.

Screening process

A comprehensive literature search was performed and updated until June 2020. One author (AM) undertook the literature search in the specified search databases and a specialized webpage after which the two other authors (AE and MG) removed all the duplicates, identifying 600 articles. The titles and abstracts of the 600 articles were read by all authors and screened for relevance. AE and MG applied the inclusion and exclusion criteria, and when in doubt about the eligibility of an article, both independently read the abstract and, if necessary, the full-text article, after which it was discussed and full consensus was reached.

Duplicate references were checked and removed using Endnote bibliographic software [17].

Inclusion and exclusion criteria

After removal of duplicates, 600 articles were identified through all the search strategies. Thereafter, the initial screening process was conducted to include only articles in English published during January 2000-January 2019 within the MENA region. Following this, the titles, abstracts and, when needed, the articles’ full text were screened according to their relevance to the scope of this study, the study design, health and medical conditions in the studied population and finally the age group. Articles that were not relevant to sociocultural, sociobehavioural and socioeconomic determinants of dental caries, such as those examining microbiological and genetic predictors of dental caries, were outside the scope of this study and were therefore excluded. Original cross-sectional studies, case-control studies and longitudinal studies were included, whereas reviews, interventional studies, case reports and editorial commentaries were excluded. Furthermore, studies focusing on children/young adults with certain health and medical conditions (cardiovascular disease, diabetes, Down syndrome, etc.) were excluded. The final inclusion criterion that was applied was age, where articles reporting results from children, teenagers and young adults aged 0-20 years were included, whereas findings related to adults were excluded. A few relevant articles where the full-text articles were not accessible were also excluded. This resulted in 77 articles being included for this study, and 523 articles were excluded as described in Figure 1.

3. Results

Overall, 77 articles were included in this review from 14 countries: Egypt (n = 4) [18-21], Iran (n = 18) [22-39], Iraq (n=2) [40, 41], Jordan (n=4) [42-45], Kuwait (n= 3) [46-48], Lebanon (n=1) [49], Libya (n=2) [50, 51], Palestine (n=2) [52, 53], Qatar (n = 2) [54, 55], Saudi Arabia (n= 14) [56-69], Syria (n= 4) [70-73], Turkey (n=11) [74-84], UAE (n= 8) [85-92], and Yemen (n = 2) [93, 94]. No relevant published studies were found in Algeria, Bahrain, Morocco, Oman or Tunisia. The studies included a total of 94,491 participants between the ages of 12 months and 20 years. All the studies included both sexes, except four studies from Saudi Arabia where only males were included [59, 60, 62, 64]. The majority of the studies were cross-sectional studies (74 studies, 96.1%) but two longitudinal studies [76, 84] and one case-control study [40] were included. Approximately one-quarter of the studies (21/77) were published from 2000-2009, and the remaining 56 articles were published from 2010-2019. The majority of the included studies used the WHO indices (dmft, dmfs, DMFT, DMFS and their variations) as the scoring system. Other dental caries scoring systems, such as the American Association Paediatric Dentistry (AAPD), the Association of State and Territorial Dental Directors (ASTDD), the British Association for the Study of Community Dentistry (BASCD) and the International Caries Detection and Assessment System (ICADS), were also used for the assessment of ECC and dental caries.

Tables 2-5 show statistically significant determinants/risk factors contributing to dental caries derived from 76 studies. One article from Yemen, which assessed 90 children aged 5-15 years, found a dental caries prevalence of 40.7% and 75.0% in girls and boys, respectively. Since no significant associations with BMI, the investigated determinant, were found, the study is not presented in the tables [94]. Potential determinants that were investigated in the 76 studies that were found to be non-statistically significant by the authors of each of the articles were also not included in the tables. Moreover, for each study, the significant determinants/risk factors that had the highest level of statistical analysis are reported in the tables, i.e., if the author/s conducted either a univariate or bivariate analysis as the highest level of analysis, determinants that were found statistically significant for that analysis are reported in the tables. Finally, if the authors conducted a multivariate analysis as the highest level of analysis, only determinants that were found statistically significant in these analyses are reported in the tables, i.e., if determinants were statistically significant in univariate or bivariate analyses did not remain significant in a multivariate analysis, they are not included in the tables.

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3.1 Determinants related to child characteristics

Table 2 describes the statistically significant determinants contributing to dental caries that were related to children's sex, age and weight status. Increased age was associated with a higher risk of caries in 18 studies across eight countries (Table 2). Nine studies reported a higher risk of dental caries in males [18–21, 27, 35, 36, 47, 85], while females were reported to have a higher caries risk in six studies [26, 30, 31, 50, 55, 65]. Weight status was significantly associated with caries in nine studies, of which four studies reported positive associations between high BMI/overweight and caries [25, 30, 55, 56] and two studies reported an inverse association between BMI and dental caries [47, 59]. Two studies showed a positive association between low BMI/weight and caries [68, 79], and one study reported that normal weight children had a lower caries prevalence than either over- or underweight children [64].

3.2 Determinants related to family background characteristics

Table 3 describes the statistically significant determinants related to family background, such as socioeconomic, sociodemographic, geographical location, school type (private or public), and parents’ education level, as potential risk factors contributing to dental caries. A total of 17 studies found negative associations with maternal education (13 studies), paternal education (2 studies), or education of both parents combined (2 studies) (Table 3).

Parents’ employment status was found to be either positively or negatively associated with caries in seven studies [21, 22, 32, 37, 38, 62, 80]. Although there was no coherent measurement of socioeconomic status between the reviewed studies, overall socioeconomic status (SES), income, affluence or access to dental insurance were found to have a negative association with dental caries in seven studies, whereas Bener et al. found a positive association between household income and dental caries in Qatar [55]. In addition, significant associations were found between family size, order and numbers of siblings, rural or urban residency, nationality and school type in various studies (Table 3).

3.3 Determinants related to oral hygiene

In the reviewed studies, oral hygiene and oral practices were measured directly using plaque or oral hygiene indices or indirectly using self-reports by parents/guardians or participants. Table 4 illustrates statistically significant oral hygiene-related determinants contributing to dental caries. In 11 studies, an association between the frequency of tooth brushing and dental experience was found with reduced dental caries prevalence among those who frequently brushed their teeth and vice versa. Some studies reported an association between parental-related factors such as supervision of tooth brushing (mainly in primary dentition), parental knowledge about oral hygiene, or parental caries status and the caries experience in their children (Table 4).

3.4 Determinants related to infant feeding and eating habits

Table 5 presents the statistically significant determinants/risk factors related to infant feeding and eating habits contributing to dental caries. Infant feeding practices such as breastfeeding, bottle feeding and mixed feeding were all positively associated with dental caries in different studies. Furthermore, four studies found a positive association between night feeding and caries [18, 19, 34, 83]. Other factors, such as bottle feeding on demand, sleeping with the bottle, sleeping next to the mother, using a (sweetened) dummy, or sharing a spoon with the mother, were also positively associated with caries (Table 5).

The consumption of sweet beverages such as soft drinks (3 studies), fruit juices (3 studies), fruit squashes (3 studies), tea with sugar (2 studies), flavoured milk (1 study) and sweet beverages in general (2 studies) was positively associated with caries (Table 5). Sugar-containing foods such as cakes, muffins, chocolates, sweets and similar foods were also positively associated with caries in six studies [20, 43, 67, 72, 88, 89]. Higher frequency and/or sweet food snacking/eating was positively associated with caries in six studies [49, 60, 86, 87, 91, 92], whereas one Lebanese study found that drinking milk as a snack was inversely associated with caries [49]. Other factors, such as cod liver intake, frequent consumption of nutritious food and no fruit consumption, were found to be negatively associated with caries, whereas sweet taste perception, low intake of nutrient-dense food and low dairy product consumption were positively associated with dental caries (Table 5).

5. Discussion

The purpose of this review study was to identify, gather, assess and summarize evidence from scientific studies to address sociobehavioural-cultural and socioeconomic determinants of dental caries among children residing in the MENA region. A structured approach was used to identify 77 relevant studies from 14 countries (Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Palestine, Qatar, Saudi Arabia, Syria, Turkey, UAE, and Yemen), whereas no relevant studies were found from Algeria, Bahrain, Morocco, Oman and Tunisia, highlighting a knowledge gap about children's dental status in these specific countries. This study showed a high caries prevalence in many studies regardless of age group or publication date, indicating a worsening dental health status in the MENA region compared to previous reports [95]. The most commonly reported socioeconomic/demographic and behavioural determinants of dental caries in children reported in this review included low parental education level, low household income, frequent consumption of sugars and/or poor dietary habits and poor oral habits, including tooth brushing, dental visits and parent engagement or knowledge on oral hygiene.

Over half of the reviewed articles originated from Iran (18 studies) [22–39], Saudi Arabia (14 studies) [56–69], Turkey (11 studies) [74–84], and the UAE (8 studies) [85–92], with the vast majority being cross-sectional, presenting a snapshot of the regional prevalence of dental caries rather than the development over time. However, based on the available literature from Iran, Saudi Arabia and Turkey, some dental caries patterns and/or trends could be observed. In 2004 and 2006, the dental caries prevalence among Iranian children below the age of 6 years was reported to be 17.2% and 3%–26%, respectively [23, 33]. In 2011, Amani et al. reported a prevalence of 49.3%, whereas studies published in 2017 or later showed a prevalence of 69.9% and 87%, respectively, indicating a clear trend towards an increased prevalence of dental caries among young children in Iran over the past 15 years [22, 29, 37]. Similar to a previous review study, an increased prevalence of caries has been shown over the past few decades in Saudi Arabia [96]. In this investigation, the four studies published in 2008–2018 reported the dental caries prevalence to be 49%–91.3% in different locations of Saudi Arabia [61, 62, 64, 67]. Likewise, in Turkey, high prevalence was also observed among children below the age of 6 years, where five out of the six studies published in 2003–2011 showed that at least three-quarters of
the children had dental caries [76, 79–82]. Similar to the findings in Saudi Arabia and Turkey, studies from many other MENA countries also reported a high prevalence of dental caries, indicating a concerning development regarding dental status in the region. Sheiham and Williams reported an increased prevalence of dental caries in many African and Middle Eastern countries, supporting these findings [97].

Increased age was identified as an independent risk factor for dental caries in several studies, probably reflecting the cumulative effect of the disease, which is on par with the literature [14, 98]. Although females may be expected to exhibit a higher caries rate due to earlier tooth eruption and thus longer exposure to cariogenic processes, variations in the associations between sex and dental caries were found in this study. Female sex was associated with a higher risk in six studies, whereas males were at a higher risk in eight of the studies. Others have attributed sex variations to differences in dietary and oral hygiene behaviours or utilization of oral health care [99, 100].

The role of parental variables that are directly associated with children's oral health, including sociodemographic characteristics, oral health behaviours, access to health services and other attributes, is evident in this study. In a recent study, this was validated through a conceptual model [101]. SES is generally measured by indicators of human capital, such as income, education, urban/rural living, and occupational nature, which offer advantages or disadvantages to individuals and families. In line with findings from other regions and despite the differences in measuring SES in the reviewed articles, socioeconomic factors were shown to have a significant impact on dental caries [14]. It was primarily mothers' level of education, but also other factors, such as parental occupation, unemployment, low-skilled occupation, low income, overall SES and school type, that were identified as determinants of caries (Table 2).

Most dietary determinants for caries were related to sugar intake: consumption, amount, frequency or timing of sweet beverages, snacks and/or food. The current findings in establishing sugar intake and SES factors as key determinants of dental caries in the region are consistent with those of studies in several other countries that have demonstrated socioeconomic gradients in sugar consumption and may prompt dietary recommendations in limiting added sugar intake and targeting SES disadvantaged groups in the region [102–104]. Moreover, other determinants were identified, such as a lack of an overall healthy diet or intake of certain nutritious foods, which again emphasizes the importance of promoting healthy eating habits and the need for dietary guidelines.

Regarding infant feeding practices, the findings in this study were inconclusive, indicating that both bottle feeding and breastfeeding were associated with higher caries prevalence in different studies [21, 44, 55, 60]. These findings are in contrast with those in a systematic review and meta-analysis that concluded that breast feeding seems to be protective against dental caries when compared to bottle feeding [105].

Tooth brushing as a determinant for caries was a distinct finding in this study; a reduced dental caries experience could be found among those who frequently brush their teeth and vice versa, and this was more apparent in the young age groups with primary dentition [20, 22, 37, 40, 55, 60, 66, 81, 89, 91]. Additional determinants related to tooth brushing included age of brushing initiation, frequency, adult supervision and the presence of visible plaque. These factors are all interrelated factors that could potentially also be linked to SES [106, 107].

In this review, the associations between determinants and dental caries were mainly projected from cross-sectional studies. These methodological choices, i.e., the study design (cross-sectional), sampling procedures (e.g., non–population based, convenience sampling), assessment setting and/or outcome measures may be an expected consequence of the relatively immature research infrastructure, limited resources in some of the MENA countries or may be related to social or political turmoil that some countries have experienced [41, 108]. Although cross-sectional studies may be a feasible option in such circumstances, they only provide a snapshot of risk factors that are associated with the outcome, but causal pathways cannot be determined since the exposure and outcome are measured simultaneously [109]. On the other hand, case-control and longitudinal studies offer greater scientific evidence through better control of possible methodological biases and data analysis, and over time, these types of studies will be needed to further develop and strengthen the research landscape [108].

The aforementioned imbalance in research output between countries hinders the establishment of a comprehensive dental caries profile of the MENA region. This imposes the need to increase dental caries research output in some countries and to devote more rigorous, unique (not repetitive), up-to-date and representative research from others. These steps can strengthen the ability to comprehensively assess trends and determinants of dental caries in the region, allow for cross-country comparisons and identify regional variations in the future.

The strengths of this study include the systematic approach employed in assessing 600 articles published during a period of 20 years focusing on children and young adults. Furthermore, this study focused mainly on modifiable determinants in a region with a young population, which can guide informed dental public health actions and thereby decrease health inequities. The results in this study were reported without assessing the strength/power of either the study design, sampling procedures or the statistical analysis of the included articles, which can be seen as a limitation. Furthermore, the methodological heterogeneity (study design, age group, exposure, outcome measurements, covariates, statistical analyses) among the studies included in this article may have influenced the interpretation of the results; hence, these findings need to be confirmed or rejected by future studies. However, addressing the broad sociobehavioural/cultural and socioeconomic determinants of dental caries offers an outlook of the determinants in a relatively understudied region.

6. Conclusions

To conclude, dental caries prevalence was found to be high among children and young adults residing in many countries in the MENA region during the past 20 years. Despite heterogeneity in the study designs and assessment methods of dental caries, the main determinants of dental caries were found to include age, sex, mother's education, overall socioeconomic status, tooth brushing frequency, parents' oral habits/knowledge and sugar consumption. The high dental caries prevalence imposes the need to address the prevailing modifiable sociobehavioural and socioeconomic determinants by translating them into effective oral health prevention policies and programmes. Moreover, a special emphasis on standardizing regional oral health research would further enhance the knowledge and understanding of a major public health problem in the region.

Abbreviations
AAPD: American Association Paediatric Dentistry, ASTDD: Association of State and Territorial Dental Directors, BASCD: British Association for the Study of Community Dentistry, dmft/DMFT: decayed, missing, and filled (primary/permanent) teeth scores, EMRO: Eastern Mediterranean Region, ICADS: International Caries Detection and Assessment System, MDGs: Millennium Development Goals, MENA: Middle East and North Africa, SES: socioeconomic status, SDG: Sustainable Development Goals, WHO: World Health Organization

Declarations

Ethical approvals and consent to participate
Not applicable

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Competing interest
The authors of this article declare that they have no competing interests.

Availability of data and materials
The dataset generated and analysed for the current study is not publicly available, but data are available from the corresponding author on reasonable request.

Consent for publication
Not applicable

Authors’ contribution
AE and MG contributed to the design of the study, data collection, screening, data analysis, interpretations of results and writing of the manuscript. AM contributed to the screening and writing of the manuscript. All the authors read and approved the final manuscript.

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Tables

Table 1. Search terms and examples of search strategies using PubMed, Medline and Google scholar

| Search category | Search words                                                                 |
|-----------------|-----------------------------------------------------------------------------|
| Children        | Children                                                                    |
| Dental caries    | Caries                                                                      |
| Determinants    | Behaviours, Determinants, Dietary causes, Dietary habits, Education, Factors, Income, Socio, Social determinants |
| Geographic Context\* | Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, UAE, Yemen, Middle East, North Africa |

- Determinants AND caries AND children AND Middle East
- Factors AND caries AND children AND North Africa
- Behaviours AND caries AND children AND Algeria
- Socio AND caries AND children AND Bahrain
- Dietary causes AND caries AND children AND Egypt.
- Dietary habits AND caries AND children AND Iran
- Education AND caries AND children AND Iraq
- Income AND caries AND children and Jordan
- Social determinants AND caries AND children AND Kuwait

\*Countries being part of the Middle East and North Africa (MENA) according to the World Atlas categorization, 2018.

Table 2 Statistically significant determinants related to children’s sex, age and weight status contributing to dental caries
| Determinants | Association: Positive (+), negative (-) | Author/Study design | Country | Type of dentition | N | Age group (Gender) | Study setting | Scoring system | Type/s of statistical analysis | Dental caries scoring re |
|--------------|----------------------------------------|---------------------|---------|-------------------|---|-------------------|----------------|----------------|-----------------------------------|------------------------|
| Gender       |                                        |                     |         |                   |    |                   |                |                |                                   |                        |
| Male         | +                                      | Abbass et al. 2019 (1) (CS) | Egypt   | Primary Mixed Permanent | 369 | 3-18 y (M, F)     | Clinic | WHO (dmft, deft, DMFT) | Kruskal-Wallis, Spearman's | DCP=74% dmft=3.2:4.07 (SEM 3.21) DMFT=1.1 (1.56) |
| Male         | +                                      | Kabil & Eltawil, 2016 (2) (CS) | Egypt   | Primary           | 140 | 2-4 y (M, F)    | Clinic | WHO AAPD-ECC | Logistic regression | DMFT=9.1 |
| Male         | +                                      | Kabil & Eltawil, 2017 (3) (CS) | Egypt   | Primary           | 108 | 2-4 y (M, F)    | Clinic | WHO            | Logistic regression | ECCP=57%, ECCP=73% |
| Male         | +                                      | Abu Hamila, 2013 (4) (CS) | Egypt   | Primary           | 560 | 1-3.5 y (M, F) | Clinic | WHO (dmft)       | Chi-Square               | dmft=69.6 dmft=2.1 |
| Male         | +                                      | Bayat-Movahed et al. 2011 (5) (CS) | Iran    | Primary Permanent | 18946 | 3,6,9,12 y (M, F) | Community health centres | WHO (dmft, DMFT) | T-test Z-test | dmft= 1.9 dmft=5.0 dmft=3.6 dmft=0.6 DMFT=0.1 DMFT=0.1 DMFT=1.1 |
| Male         | +                                      | Sadeghi et al. 2011 (6) (CS) | Iran    | Permanent         | 747 | 12-15 y (M, F) | School | WHO (DMFT)     | T-test, Chi-Square       | Caries free DMFT=2.1 |
| Male         | +                                      | Saied-Moallemi et al. 2006 (7) (CS) | Iran    | Primary Permanent | 459 | 9 y (M, F)      | School | WHO (dmft, DMFT) | One-way ANOVA, Kruskal-Wallis, Mann-Whitney | dmft=4.2 dmft=3.4 DMFT=0.2 |
| Male         | +                                      | Goodson et al. 2013 (8) (CS) | Kuwait  | Primary Mixed Permanent | 8,319 | Mean age=11.36 y (grade 4 & 5) (M, F) | School | Percentage of decayed or filled teetha | Multivariate rank-based Wilcoxon regression Decayed c teeth (all l weights) =11.01% (0.11) Decayed c teeth (males)=1 (SEM 0.15) Decayed c teeth (females) (SEM 0.14) |
| Male         | +                                      | Hashim et al. 2006 (9) (CS) | UAE     | Primary           | 1036 | 5,6 y (M, F)    | School | WHO (dmft, dmfs) | Chi-Square, ZINB regression | DCP=76.1 dmft=4.4 |
| Gender | Study | Country | Age Group | Type of Study | Measurement | Statistical Tests | DCP | DMFT | 
|--------|-------|---------|-----------|---------------|--------------|-------------------|-----|------| 
| Female | Bashirian et al. 2018 (10) | Iran | Primary, Permanent | 7-12 y (M, F) | School | WHO (dmft, DMFT) | Multiple regression | 80.3 | 3.61 | 
| Female | Khani-Varzegani et al. 2017 (11) | Iran | Primary | 4-7 y (M, F) | School | WHO (dmft) | Multivariate analysis | 80.3 | 3.61 | 
| Female | Jahani et al. 2013 (12) | Iran | Primary, Permanent | 9 y (M, F) | School | WHO (dmft, DMFT) | Ordinal logistic regression | 75% | 3.61 | 
| Female | Farsi & Elkhodary 2017 (13) | KSA | Permanent | Mean Age=16.5 y (Grade 11) (M, F) | School | ASTDD (DT) | Mann-Whitney | 75% | 3.61 | 
| Female | Huew et al. 2011 (14) | Libya | Permanent | 12 y (M, F) | School | WHO (DMFT, DMFS) | Multivariate analysis | 75% | 3.61 | 
| Female | Bener et al. 2013 (15) | Qatar | Permanent | 6-15 y (M, F) | Clinic | WHO (DMFT) | Multivariate analysis | 75% | 3.61 | 
| Gender | Khadri et al. 2018 (16) | UAE | Permanent | 11-17 y (M, F) | School | WHO (DMFT) | Multivariate regression | 75% | 3.61 | 
| Age | Abbas et al. 2019 (1) | Egypt | Primary, Mixed, Permanent | 3-18 y, (M, F) | Clinic | WHO (dmft, deft, DMFT) | Kruskal-Wallis, Spearman's Chi-Square | 74% | 3.22 | 
| Age | Abu Hamila, 2013 (4) | Egypt | Primary | 1-3.5 y (M, F) | Clinic | WHO (dmft) | Chi-Square | 69% | 3.21 | 
| Age | Bashirian et al. 2018 (10) | Iran | Primary, Permanent | 7-12 y (M, F) | School | WHO (dmft, DMFT) | Multiple regression | 80.3 | 3.61 | 
| Age | Shaghaghian et al. 2018 (17) | Iran | Primary | 3-6 y, (M, F) | School | WHO (dmft) | Multivariate analysis | 69.9 | 3.85 | 
| Age | Khani-Varzegani et al. 2017 (11) | Iran | Primary | 4-7 y (M, F) | School | WHO (dmft) | Multivariate analysis | 88.8 | 3.85 | 
| Age | Eslamipour et al. 2010 | Iran | Permanent | 7-12 y (M, F) | School | WHO (DMFT) | Chi-Square, Binary | 88.8 | 3.85 |
| Age | Study | Country | Setting | Sample Size | Age Range | Clinical | WHO (dmft) | Logistic Regression | Outcome |
|-----|-------|---------|---------|-------------|-----------|----------|------------|-------------------|---------|
| +   | Mohebbi et al. 2006 (19) | Iran | Primary | 504 | 12-36 mo | (M, F) | Clinic | WHO (dmft) | Logistic regression | DMFT (11 = 4.94 (SD) |
|     |       |         |         |              |           |          |            |                   |         |
|     |       |         |         |              |           |          |            |                   |         |
|     | Askarizadeh & Siyonat, 2004 (20) | Iran | Primary | 620 | 2-6 y | (M, F) | School | WHO (dmft) | Chi-Square | DCP=17.2 |
|     |       |         |         |              |           |          |            |                   |         |
|     |       |         |         |              |           |          |            |                   |         |
|     | Sayegh et al. 2002c (21) | Jordan | Primary | 1140 | 4-5 y | (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% |
|     |       |         |         |              |           |          |            |                   |         |
|     | Al-Malik et al. 2002 (23) | KSA | Primary | 987 | 2-5 y | (M, F) | School | BASCD | Stepwise multiple logistic regression | DCP=73% |
|     |       |         |         |              |           |          |            |                   |         |
|     |       |         |         |              |           |          |            |                   |         |
|     | Wyne et al. 2001 (24) | KSA | Primary | 1016 | 2-6 y | (M, F) | School | WHO (dmft) | Logistic regression | DCP=27.3 |
|     |       |         |         |              |           |          |            |                   |         |
|     | Al-Mutawa et al. 2006 (25) | Kuwait | Primary | 4588 | 5,6,12,14 | (M, F) | School | WHO (dft, DMFT, DFS) | Multivariate analysis | dft=4.6 |
|     |       |         | Permanent |      |           |            |            |                   |         |
|     | Qadri et al. 2012 (26) | Syria | Primary | 400 | 3-5 y | (M, F) | School | ECC | Logistic regression | ECCP=48 |
|     |       |         |         |              |           |          |            |                   |         |
|     |       |         |         |              |           |          |            |                   |         |
| Age  | Country | Type | Total | Age Range | Setting | WHO Measures | Statistical Tests | Results |
|------|---------|------|-------|-----------|---------|---------------|------------------|---------|
| +    | İstanbul-Eroğlu et al. 2017 (27) Turkey Primary 395 36-71 mo, (M, F) School WHO (dmft, dmfs) Mann-Whitney, Kruskal-Wallis dmft = 4.7 dmfs= 8.0 |
| +    | Dogan et al. 2013 (28) Turkey Primary 3171 8-60 mo (M, F) Clinic WHO (dmft) Chi-Square ECCP=17. df=0.63 |
| +    | Namal et al. 2005 (29) Turkey Primary 598 3-6 y (M, F) School WHO (dmft) Multiple logistic regression df=74.1% |
| +    | Olmez et al. 2003 (30) Turkey Primary 95 9-57 mo (M, F) Clinic WHO (dmft) Chi-Square, Kruskal-Wallis DCP=75.5 df=6.2 |
| +    | Bener et al. 2013 (15) Qatar Permanent 1284 6-15 y (M, F) Clinic WHO (DMFT) Multivariate analysis DCP=73% DMFT=4.1 |
| -    | Khadri et al. 2018 (16) UAE Permanent 803 11-17 y (M, F) School WHO (DMFT) Multivariate regression DCP=75% DMFT=3.2 |
| +    | Hashim et al. 2006 (9) UAE Primary 1036 5,6 y (M, F) School WHO (dmft, dmfs) Chi-Square, ZINB regression DCP=76.1 dmft=4.4 dmfs=10.8 |

**Weight status**

| Weight status | Country | Type | Total | Age Range | Setting | WHO Measures | Statistical Tests | Results |
|---------------|---------|------|-------|-----------|---------|---------------|------------------|---------|
| + Over weight | Jahani et al. 2013 (12) Iran Primary Permanent 845 9 y (M, F) School WHO (dmft/DMFT) Ordinal logistic regression Moderate DCP=50% children |
| + BMI         | Bagherian & Sadeghi, 2013 (31) Iran Primary 400 30-70 m (M, F) Not specified WHO (defs) Multiple logistic regression ECCP=55. S-ECCP=5 defs=8.37 11.2 |
| + BMI         | Abu El Qomsan et al. 2017 (32) KSA Permanent 386 6-12 y (M, F) School and Clinic WHO (DMFT, DT, FT) One-way ANOVA, Spearman's DT: Underweight (SD 1.48)
Normal weight=2.34)
Over weight (SD 2.39)
Obese=4.1 (2.57)
FT: Underweight (SD 0.68)
Normal weight=0.95)
Over weight (SD 0.70)
Obese=0.6 (1.18) |
| BMI | Weight status | Study | Location | Type | Sample Size | Age | Setting | Caries index | Analysis Method | Caries Prevalence |
|-----|--------------|-------|----------|------|-------------|-----|---------|--------------|----------------|-----------------|
| -   | Low BMI      | Alghamdi & Almahdy, 2017 (33) | KSA Permanent | 610 | 14-16 y (M) | School | Not specified DMFT | Logistic regression | DCP=54.1 |
| +   | Low BMI      | Quadri et al. 2017 (34) | KSA Primary, Permanent | 360 | 6-15 y (M, F) | School | WHO (dft/DMFT) | Logistic regression | dft/DMFT 2.52 (F), 1.88 (M) |
| -   | BMI          | Goodson et al. 2013 (8) | Kuwait Primary, Mixed, Permanent | 8,319 | Mean age=11.36 y (grade 4 & 5) (M, F) | School | Percentage of decayed or filled teeth | Multivariate rank-based Wilcoxon regression | Decayed teeth (all t weights) =11.01% (0.11) |
| +   | Under weight | Köksal et al. 2011 (35) | Turkey Primary, Permanent | 245 | 5-6 y (M, F) | Unclear | WHO (dmft, DMFT, dmfs) | Chi-Square, Mann-Whitney, Spearman's | DCP=85.9 |
|     |              | Bhayat et al. 2016 (36) | KSA Permanent | 402 | 12 y (M) | School | WHO (DMFT) | Linear regression | DCP=49% |
|     |              | Bener et al. 2013 (15) | Qatar Permanent | 1284 | 6-15 y (M, F) | Clinic | WHO (DMFT) | Multivariate analysis | DCP=73% |

AAPD American Association Paediatric Dentistry, BASCD British Association for the Study of Community Dentistry, CS Cross-sectional, CC Case control, DCP Dental caries prevalence, deft decayed, extracted due to caries and filled primary teeth, dfs decayed, filled surfaces in primary teeth, dft decayed, filled primary teeth, dmfs decayed, missing and filled surfaces in primary teeth, DMFS decayed, missing and filled surfaces in permanent teeth, dmft decayed, missing, filled primary teeth, DMFT decayed, missing, filled permanent teeth, ECC Early childhood caries, ECCP Early childhood caries prevalence, F Female, ICADS The international caries Detection and Assessment System, L Longitudinal, KSA Kingdom of Saudi Arabia, m months M Male, WHO World Health Organisation, SiC Significant caries index, SD Standard deviation, y years

*The author calculated this as follows the decayed or filled teeth (%)=100 x [(number of primary teeth with fillings) + (number of permanent teeth with fillings) + (number of decayed primary teeth) + (number of decayed permanent teeth)] / [(number of primary teeth) + (number of permanent teeth)].

*The children were categorized into three groups on the basis of WHO caries severity classification. Low caries level was defined as dmft/DMFT ≤ 2.6, moderate caries as dmft/DMFT of 2.7-4.4 and high caries as dmft/DMFT > 4.4.

*Sayegh et al. 2002 and Sayegh et al. 2005 seem to be based on the same study population and the results mentioned in this table, have been reported in both articles.

*Normal weight status-positive association to caries, whereas the caries prevalence was lower in under and overweight children.

Table 3 Statistically significant socio-economic, socio-demographic, school type and geographical-related determinants contributing to dental caries
| Determinants | Association: | Author | Country | Type of dentition | N | Age group (Gender) | Study setting | Scoring system | Type/s of statistical analysis | Dental caries/scoring results |
|--------------|-------------|--------|---------|-------------------|---|-------------------|-------------|--------------|-------------------------------|-----------------------------|
| Mother's education | - | Abu Hamila, 2013 (1) | Egypt | Primary | 560 | 1-3.5 y (M, F) | Clinic | WHO (dmft) | Chi-Square | ECCP=69.6% dmft=2.1-7.6 |
| Mother's education | - | Bashirian et al. 2018 (2) | Iran | Primary | 988 | 7-12 y (M, F) | School | WHO (dmft, DMFT) | ANOVA | DCP=80.36% dmft=3.61 DMFT=0.79 |
| Mother's education | - | Shaghaghian et al. 2018 (3) | Iran | Primary | 396 | 3-6 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=69.9% dmft=3.88 |
| Mother's education | - | Haghdoost et al. 2017 (4) | Iran | Primary | 8725 | 6 y (M, F) | Clinic | WHO | Linear regression, Logistic regression | DCP=87% |
| Mother's education | - | Khani-Varzegani et al. 2017 (5) | Iran | Primary | 756 | 4-7 y (M, F) | School | WHO (dmft) | Multivariate analysis | dmft median (25th-75th percentile): All=4(2-8) Males= 4(2-9) Females=5(2-8) |
| Mother's education | + | Alhabdan et al. 2018 (6) | KSA | Primary | 578 | 6-8 y (M, F) | School | WHO (dmft) | Adjusted Odds Ratios Multivariate model logistic regression | DCP=83% dmft=4.20 (SD 2.96) |
| Mother's education | - | Al-Meedani, 2016 (7) | KSA | Primary | 388 | 3-5 y (M, F) | School | WHO (dmft, dmfs) | Chi-Square Z-test | DCP=69% dmft=3.4 dmfs=6.9 |
| Mother's education | - | Quadri et al. 2015 (8) | KSA | Primary | 853 | 6-15 y (M, F) | School | WHO (dft, DMFT) | Multi regression | DCP=91.3% |
| Mother's education | - | Al-Malik et al. 2002 (9) | KSA | Primary | 987 | 2-5 y (M, F) | School | BASCD (dmft, dmfs) | Stepwise multiple logistic regression | DCP=73% Rampant caries=43% dmft=4.8 dmfs=12.7 |
| Mother's education | + | Azizi et al. 2014 (10) | Palestine | Primary | 1376 | 4-6 y (M, F) | Clinic | WHO (dmft) | Not indicated | DCP=76% dmft =2.46 |
| Mother's education | - | Ozer et al. 2011 (11) | Turkey | Primary | 226 | 3-6 y (M, F) | School | WHO (dmft, AAPD) | Bivariate analysis | ECCP=46.9% dmft=2.87 |
| Mother's education | - | Namal et al. 2009 (12) | Turkey | Primary | 542 | 5-6 y (M, F) | School | WHO (dmft) | Multiple logistic | DCP=76.8% |
| Mother's education | Elamin et al. 2018 (13) | UAE | Primary | 186 | 1.5-4 y (M, F) | School WHO (dmft) | T-test, Pearson-s | DCP: 41% dmft:1.7±2.81 |
|---------------------|-------------------------|-----|---------|-----|---------------|------------------|------------------|----------------------|
| Mother's occupation (Employed) | Abu Hamila, 2013 (1) | Egypt | Primary | 560 | 1.35 y (M, F) | Clinic WHO (dmft) | Chi-Square | ECPP=69.6% dmft:2.1-7.6 |
| Mother's occupation (Not employed) | Amin & Al-Abad, 2008 (14) | KSA | Permanent | 1115 | 10-14 y (M) | School WHO | Stepwise logistic regression | DCP=68.9% |
| Mother's caries experience | Kabil & Eltawil, 2016 (15) | Egypt | Primary | 140 | 2-4 y (M, F) | Clinic WHO (DMFT) AAPD | Logistic regression | DMFT=9.96 |
| Mother’s current caries experience | Kabil & Eltawil, 2017 (16) | Egypt | Primary | 108 | 2-4 y (M, F) | Clinic WHO | Logistic regression | ECPP=57% (2-3yrs), 73% (3-4yrs) |

**Father’s attributes**

| Father’s education | Babaei et al. 2019 (17) | Iran | Primary & Permanent molar teeth | 739 | 6-7 y (M, F) | School CAST index | Multivariate logistic regression | Permanent molars: Healthy status in 89.3–93.7% of the teeth. |
|-------------------|------------------------|-----|-----------------------------|-----|---------------|-------------------|-----------------------------|----------------------------------|
| Father’s education | Bayat-Movahed et al. 2011 (18) | Iran | Permanent | 18946 | 3,6,9,12 y (M, F) | Community health centres WHO (dmft, DMFT) | T-test, Z test | dmft= 1.9 (3y) dmft=5.0 (6y) dmft=3.6 (9y) dmft=0.6 (12y) DMFT=0.2 (6y) DMFT=0.9 (9y) DMFT=1.9 (12y) |
| Father’s Education | Huw et al. 2011 (19) | Libya | Permanent | 791 | 12 y (M, F) | School WHO (DMFT, DMFS) | Multivariate analysis | DCP=57.8% DMFT=1.78 |
| Father's Education | Father's Occupation | Father's occupation | Father's occupation | Parents attributes | Parents attributes | Parents attributes |Parents attributes |
|--------------------|---------------------|----------------------|----------------------|-------------------|-------------------|--------------------|-------------------|
| Unclear            | +                   | +                    | +                    | -                | +                | -                  | +                |
| Khadri et al. 2018 (20) | Shagaghian et al. 2018 (3) | Namal et al. 2005 (21) | Amanlou et al. 2011 (22) | Abbass et al. 2019 (23) | Sistani et al, 2017 (24) | Al-Mendalawi & Karam, 2014 (26) | Ahmed et al. 2007 (25) |
| UAE Permanent      | Iran Primary        | Turkey Primary       | Iran Primary         | Egypt Primary. Mixed, Permanent | Iran Primary | Iraq Primary | Iraq Primary |
| 803                | 396                 | 598                  | 205                  | 369               | 2080              | 684                | 392               |
| 11-17 y (M, F)     | 3-6 y (M, F)        | 3-6 y (M, F)         | 3-6 y (M, F)         | 3-18 y (M, F)     | 3-6 y (M, F)      | <6 y (M, F)       | 12 y (M, F)       |
| School WHO (DMFT)  | School WHO (dmft)   | School WHO (dft)     | School WHO (DMFT)    | WHO (dmft, deft, DMFT) | WHO (dmft) | WHO (DMFT) | WHO (DMFT) |
| Multivariate       | Multivariate        | Multiple logistic    | Stepwise multiple    | Kruskal-Wallis, Spearman's | T-test, ANOVA | Chi-Square      |                |
| regression         | analysis            | regression           | regression           |                   |                   |                    |                  |
| DCP=75% DMFT=3.19 (SD 2.9) | DCP=69.9% dmft=3.88 | DCP=74.1%             | DCP=49.3%            | DCP=74% dmft=3.23 (SC 4.07) | dmft=4.21 (SD 3.21) | DMFT=1.04 (SD 1.56) | DCP=62% DMFT=1.7 |
|                    |                     |                      |                      |                   |                   |                    |                  |
| Parents' education (primary dentition) | Parents' education level | Socio-economic factors | Parents' Education | Parents Education | Parents' employment status | Parents' employment status | |
| -                  | -                   | +                    | -                   | -                | -                | -                  | -                |
| Abbass et al. 2019 (23) | Sistani et al, 2017 (24) | Al-Mendalawi & Karam, 2014 (26) | Rajab et al. 2014 (27) | Sistani et al, 2017 (24) | -                | -                  | -                |
| Egypt Primary. Mixed, Permanent | Iran Primary | Iraq Primary | Jordan Primary | Iran Primary | -                | -                  | -                |
| 369                | 2080                | 684                  | 2496 (6 y)          | 2080              |                  |                   |                  |
| 3-18 y (M, F)      | 3-6 y (M, F)        | <6 y (M, F)          | 6 y, 12 y (M, F)    | 3-6 y (M, F)      |                  |                   |                  |
| Clinic WHO (dmft, deft, DMFT) | School WHO (dmft) | WHO (DMFT) | WHO (dmft, DMFT) | WHO (dmft) |                  |                   |                  |
|                   |                     |                      | Multivariate        |                   |                  |                    |                  |
|                   |                     |                      | analysis            |                   |                  |                    |                  |
|                   |                     |                      | linear regression   |                   |                  |                    |                  |
|                   |                     |                      |                   |                   |                  |                    |                  |
| DCP=76.4% (6 y)    | DCP=45.5% (1 y)     | DCP=71.9% (6 y)      | DCP=76.4% (6 y)     | DCP=71.9% (6 y)   | DCP=76.4% (6 y)  | DCP=76.4% (6 y)  |                   |
|                   |                    |                    |                   |                   |                   |                   |                   |
| Parents' employment status | Parents' employment status | Socio-economic factors | Parents' Education | Parents Education | Parents' employment status | Parents' employment status | |
| -                  | -                   | +                    | -                   | -                | -                | -                  | -                |
| Khodadadi et al. 2016 (28) | Sistani et al, 2017 (24) | Al-Mendalawi & Karam, 2014 (26) | Rajab et al. 2014 (27) | Sistani et al, 2017 (24) | -                | -                  | -                |
| Iran Primary       | Iran Primary        | Iraq Primary         | Jordan Primary      | Iran Primary     | -                | -                  | -                |
| 384                | 2080                | 684                  | 2496 (6 y)          | 2080              |                  |                   |                  |
| 21-84 mo (M, F)    | 3-6 y (M, F)        | <6 y (M, F)          | 6 y, 12 y (M, F)    | 3-6 y (M, F)      |                  |                   |                  |
| Not specified      | WHO (dmft)          | WHO (DMFT)           | WHO (dmft, DMFT)    | WHO (dmft)       |                  |                    |                  |
| Multiple regression |                     |                      |                      |                   |                  |                    |                  |
|                   |                     |                      |                      |                   |                  |                    |                  |
| DCP=8.2            |                     | ECCP varied between 51.1%-71.9% during 2007-2015 | DCP=71.9% (6 y) | DCP=71.9% (6 y) | DCP=76.4% (6 y)  |                   |                   |
|                   |                     | dmft=4.01 (SC 3.89)  |                   |                   |                   |                   |                   |
|                   |                     |                    |                   |                   |                   |                   |                   |

| Socio-economic status | Abbass et al. 2019 (23) | Egypt | Primary, Mixed, Permanent | 369 | 3-18 y (M, F) | Clinic | WHO (dmft, deft, DMFT) | Kruskal-Wallis, Spearman's | DCP=74% dmft=3.23 (SC 4.07) deft=4.21 (SD 3.21) DMFT=1.04 (SD 1.56) |
|---|---|---|---|---|---|---|---|---|---|
| Family affluent scale | Khani-Varzegani et al. 2017 (5) | Iran | Primary | 756 | 4-7 y (M, F) | School | WHO Multivariate analysis | dmft median (25th-75th percentile): All=4(2-8) Boys=4(2-9) Girls= 5(2-8) |
| Income | Al-Mendalawi & Karam, 2014 (26) | Iraq | Primary | 684 | <6 y (M, F) | Clinic | WHO (DMFT)* | DMFT=2.03 |
| Low family income | Alhabdan et al. 2018 (6) | KSA | Primary | 578 | 6-8 y (M) | School | WHO (dmft) | Adjusted Odds Ratios, Multivariate model logistic regression | DCCP=83% dmft 4.20 (SD 2.96) |
| Lack of dental insurance | Alhabdan et al. 2018 (6) | KSA | Primary | 578 | 6-8 y (M) | School | WHO (dmft) | Adjusted Odds Ratios, Multivariate model logistic regression | DCCP=83% dmft 4.20 (SD 2.96) |
| Socio-Economic Status | Alghamdi & Almahdy, 2017 (29) | KSA | Permanent | 610 | 14-16 y (M) | School | Not specified (DMFT) Logistic regression | DCP=54.1% |
| Socio-Economic Status | Rajab et al. 2014 (27) | Jordan | Primary Permanent | 2496 | 6 y, 12 y (M, F) | School | WHO (dmft, DMFT) | Multivariate analysis linear regression | DCP=76.4% (6 y) DCP=45.5% (1 y) dmft=3.3 (6 y) DMFT=1.1 (12 y) |
| Household income | Bener et al. 2013 (30) | Qatar | Permanent | 1284 | 6-15 y (M, F) | Clinic | WHO (DMFT) | Multivariate analysis | DCP=73% DMFT=4.5 |
| House Hold Income | Hashim et al. 2011 (31) | UAE | Primary | 1036 | 3-6 y (M, F) | School | WHO Logistic regression | Severe ECCP=31.1% |
| Family demographic | Varied | Abu Hamilia, 2013 (1) | Egypt | Primary | 560 | 1-3.5 y (M, F) | Clinic | WHO (dmft) | Chi-Square | ECCP=69.6% dmft=2.1-7.6 |
| Number of Siblings | Shagaghian et al. 2018 (3) | Iran | Primary | 396 | 3-6 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=69.9% dmft=3.88 |
| Large family size | Al-Meedani, 2016 (7) | Iraq | Primary | 684 | 0-6 y | Clinic | WHO Chi-Square | DCP=69% |
| Large family size | + | Amin & Al-Abed, 2008 (14) | KSA | Permanent | 1115 | 10-14 y (M) | School | WHO | Stepwise logistic regression | DMFT=3.4, DMFS=6.9 |
| Nationality (Emirati) | + | Elamin et al. 2018 (13) | UAE | Primary | 186 | 1.5-4 y (M, F) | School | WHO | T-tests, Pearson’s | DCP=41%, DMFT=1.7 (SD 2.81) |
| Geographical Location | Varied (CS) | Al Mutawa et al. 2010 (32) | Kuwait | Primary | 1277 | 4 & 5 y (M, F) | School | WHO | T-test, Chi Square | dft/dfs=3.7/6.4 (4 y) |
| Geographical Location | Varied (CS) | Ballouk & Dashash 2019 (33) | Syria | Primary | 1500 | 8-12 y (M, F) | School | WHO | ANOVA, Chi-Square | DCP=79.1%, DMFT=2.47 (SD 2.94) |
| Rural living | + | Al-Mendalawi & Karam, 2014 (26) | Iraq | Primary | 684 | <6 y (M, F) | Clinic | WHO | DMFT (6y) | DMFT=2.03 |
| Rural living | + | Elamin et al. 2018 (13) | UAE | Primary | 186 | 1.5-4 y (M, F) | School | WHO | T-test, Pearson’s | DCP=41%, DMFT=1.7 (SD 2.81) |
| Urban living | + | Bayat-Movahed et al. 2011 (18) | Iran | Primary | 18946 | 3,6,9,12 y (M, F) | Community health centres | WHO | T-test, Z-test | DMFT=85% (12 y) |
| Semi-urban living | + | Al Darwish et al. 2014 (34) | Qatar | Permanent | 2113 | 12-14 y (M, F) | School | WHO | Multinomial logistic regression, Adjusted Odds Ratio | DCP=85% (12 y) =4.62 (SD 3.2) |
| Public Schools | + | Farsi & Elkhodary 2017 (35) | KSA | Permanent | 801 | Mean age=16.5 y (Grade 11) (M, F) | School | ASTDD (DT) | Mann-Whitney | DT boys=3.9 (SD 3.5) |
| Public Schools | + | Al-Malik et al. 2002 (9) | KSA | Primary | 987 | 2-5 y (M, F) | School | BASCD (DMFT) | Stepwise multiple logistic regression | DCP=73%, Rampant caries=43% |

**School type**
| Private schools | - | Sgan-Cohen et al. 2015 (36) | Palestine | Permanent | 286 | 12 y (M, F) | School | WHO (DMFT) | Multivariate analysis | DMFT =1.98 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Public schools | + | Cinar & Murtomaa, 2011 (37) | Turkey | Permanent | 611 | 10-12 y (M, F) | School | WHO (DMFS) | T-test, Chi-Square, Logistic regression | DMFS=4.44 (public school), DMFS=2.64 (private school) |
| Public schools | + | Cinar & Murtomaa, 2008 (38) | Turkey | Permanent | 611 | 10-12 y (M, F) | School | WHO (DMFT) | T-test, Logistic regression | DMFT= 2.93 |

AAPD American Association Paediatric Dentistry, BASCD British Association for the Study of Community Dentistry, CS Cross-sectional, CC Case control, DCP Dental caries prevalence, deft decayed, extracted due to caries and filled primary teeth, dfs decayed, filled surfaces in primary teeth, dft decayed, filled primary teeth, dmfs decayed, missing and filled surfaces in primary teeth; DMFS decayed, missing and filled surfaces in permanent teeth, dmft decayed, missing, filled primary teeth, DMFT decayed, missing, filled permanent teeth, ECC Early childhood caries, ECCP Early childhood caries prevalence, F Female, ICADS The international caries Detection and Assessment System, L Longitudinal, KSA Kingdom of Saudi Arabia, m months M Male, WHO World Health Organisation, SiC Significant caries index, SD Standard deviation, y years

aThe CAST index scoring system is as follows: “0: sound”, “1: sealant”, “2: restoration”, “3: enamel lesions”, “4, 5: dentine lesions”, “6: pulp involvement”, “7: abscess/fistula”, “8: tooth loss”. If a situation did not match any codes from 0 to 8, a code 9 was assigned. The codes 0–2, 3, 4–5, 6–7, and 8 were considered as “healthy”, “pre-morbidity”, “morbidity”, “serious morbidity”, and “mortality”, respectively.
bThe authors describe their scoring as WHO (DMFT) whereas it should be noted that the age group is 3-6 year olds where normally WHO (dmft) is being used.
cData was collected during 9 years. In each year data was collected in a new sample.
dThe mean FT score was significantly higher for children having mothers with higher education, fathers with higher education and for residents of higher socio-economic areas, as compared to their counterparts in the opposite groups.
eThe authors describe their scoring as WHO(DMFT) whereas it should be noted that the age group is 0-6 year olds where normally WHO (dmft) is being used.
fThe SES level was based on the level of parental education and its type, guardians’ occupation and address.
gSES score based on parental education and suburban location of residence.
hSES score based on school type: low SES: deprived areas and refugee camps, medium SES: state schools, high SES: private schools.
iThe sibling order impacts dental caries status: 84.44%, 74.37%, 40.19% and 77.65% of only, eldest, middle and youngest child/ren had dental caries, respectively.
jDental caries prevalence differed between the 6 different regions/governorates in Kuwait but the characteristics of the regions are not described.
kDental caries prevalence differed between different parts/regions in Damascus but the characteristics of the regions are not described.
lA comparative study with Finland.

Table 4 Statistically significant dental related determinants/risk factors contributing to dental caries
| Determinants                  | Association: Positive (+), Negative (-) | Author, year (Study design) | Country | Type of dentition | N  | Age group (gender)* | Study setting | Scoring system | Type/s of statistical analysis | Dental caries/scoring system |
|------------------------------|------------------------------------------|-----------------------------|---------|-------------------|----|--------------------|---------------|----------------|--------------------------------|-------------------------------|
| Tooth brushing frequency     |                                          |                             |         |                   |     |                    |               |                |                                |                               |
| Tooth brushing-frequent      |                                          | Abbas et al. 2019 (1) (CS)  | Egypt   | Primary, Mixed, Permanent | 369 | 3-18 y (M, F)      | Clinic        | WHO (dmft, deft, DMFT) | Kruskal-Wallis, Spearman's    | DCP=74% dmft=3.23 (SD 4.07)   |
|                             |                                          |                             |         |                   |     |                    |               |                |                                | deft=4.21 (SD 3.21)           |
|                             |                                          |                             |         |                   |     |                    |               |                |                                | DMFT=1.04 (SD 1.56)           |
| Tooth brushing-frequent      |                                          | Amanlou et al. 2011 (2) (CS)| Iran    | Primary, Permanent | 205 | 3-6 y (M, F)       | School        | WHO (DMFT)²  | Stepwise multiple regression  | DCP=49.3% DMFT=0.99 (SD 0.13) |
| Tooth brushing-frequent      |                                          | Shaghaghian et al. 2018 (3)| Iran    | Primary, Permanent | 396 | 3-6 y (M, F)       | School        | WHO (dmft)   | Multivariate analysis         | DCP=69.9% dmft=3.88           |
| Tooth brushing-frequent      |                                          | Al-Mendalawi & Karam, 2014 (4) (CC) | Iraq | Primary, Permanent | 684 | <6 y (M, F)        | Clinic        | WHO (dmft)   | Chi-Square                   | dmft=2.03                     |
| Tooth brushing-frequent      |                                          | Bener et al. 2013 (5) (CS) | Qatar   | Permanent         | 1284| 6-15 y (M, F)      | Clinic        | WHO (DMFT)   | Multivariate analysis         | DCP=73% DMFT=4.5              |
| Tooth brushing-frequent      |                                          | Namal et al. 2009 (6) (CS) | Turkey  | Primary           | 542 | 5-6 y (M, F)       | School        | WHO (dmft)   | Multiple logistic regression  | DCP=76.8% dmft=3.74 (SD 3.49) |
|                              |                                          |                             |         |                   |     |                    |               |                |                                | SIC=7.75 (SD 2.56)           |
| Tooth brushing-frequent      |                                          | Tulunoglu et al. 2007 (7) (L) | Turkey | Primary           | 733 | 6-8 y (M, F)       | School        | WHO (dfs, DFS) | Chi-Square                   | dfs Baseline: GlI:2.79, GiII:3.12, GiII: 2.9 |
|                              |                                          |                             |         |                   |     |                    |               |                |                                | Dfs Final: Gl: 2.14, Gi: 3.79, GiII: 3.69 |
|                              |                                          |                             |         |                   |     |                    |               |                |                                | DFS Baseline: Gl: 0.16, Gi: 0.20, GiII: 0.15 |
|                              |                                          |                             |         |                   |     |                    |               |                |                                | DFS Final: Gl: 0.79, Gi: 0.80, GiII: 1.46 |
| Tooth brushing-frequent      |                                          | Elamin et al. UAE Primary   | Egypt   | Primary           | 186 | 1.5-4 y (M, F)     | School        | WHO T-test, |                                | DCP: 41%                      |
| Oral hygiene and practices attributes | 2018 (8) | (M, F) | (dmft) | Pearson’s | dmft = 1.7 (SD 2.81) |
|--------------------------------------|----------|--------|--------|-----------|---------------------|
| Tooth brushing - frequent            | Kowash et al. 2017(9) UAE Primary 4-6 y School WHO Chi-Square EccP = 74.1% dmft = 3.01 Sic = 13.3 |
| Tooth brushing - irregular or no brushing | Alhabdan et al. 2018 (10) KSA Primary 6-8 y School WHO Adjusted Odds Ratios, Multivariate model logistic regression DCP: 83% dmft = 4.20 (SD 2.96) |
| Tooth brushing - irregular or no brushing | Paul, 2003 (11) KSA Primary 5 y Clinic WHO Chi-Square DCP: 83.5% dmft = 7.1 (SD 5.7) |
| Tooth brushing initiation age         | Alhabdan et al. 2018 (10) KSA Primary 6-8 y School WHO Adjusted Odds Ratios, Multivariate model logistic regression DCP: 83% dmft = 4.20 (SD 2.96) |
| Tooth brushing with adult help & aid  | Al-Malik et al. 2002 (12) KSA Primary 2-5 y School BASCD Stepwise multiple logistic regression DCP = 73% EccP = 43% dmft = 4.8 dmfs = 12.7 |
| Tooth brushing initiation - late      | Al-Malik et al. 2002 (12) KSA Primary 2-5 y School BASCD Stepwise multiple logistic regression DCP = 73% EccP = 43% dmft = 4.8 dmfs = 12.7 |
| Tooth brushing initiation - late      | Al-Malik et al. 2002 (12) KSA Primary 2-5 y School BASCD Stepwise multiple logistic regression DCP = 73% EccP = 43% dmft = 4.8 dmfs = 12.7 |
| Tooth brushing with use of fluoridated toothpaste | Alghamdi & Almahdy, 2017 (14) KSA Permanent 14-16 y School Not specified Logistic regression DCP = 54.1% |
| Oral hygiene^c (CAST score of ≥ 3 in primary molar teeth) | Babaei et al. 2019 (15) Iran Primary & Permanent molar teeth 6-7 y School CAST index^d Multivariate logistic regression Permanent molars: Healthy status in 89.3–93.7% of the teeth. Primary molars: Morbidity status in 25.3 to 31.2% of the teeth |
Serious morbidity status with Pulp involvement in 2.9-10.5% of the teeth and abscess/fistula in <1% of the teeth

| Oral Hygiene-poor | + | Mohebbi et al. 2006 (16) | Iran | Primary | 504 | 12-36 mo (M, F) | Clinic | WHO (dmft) | Logistic regression |
|-------------------|---|-------------------------|------|---------|-----|---------------|-------|------------|---------------------|

| Oral hygiene-poor | + | Al-Mutawa el al. 2006 (17) | Kuwait | Primary | 4588 | 5,6,12,14 y (M, F) | School | WHO (dft, DMFT, DFS) | Multivariate analysis |
|-------------------|---|--------------------------|--------|---------|-----|-----------------|-------|----------------|---------------------|

| Oral hygiene-poor | + | Amin & Al-Abad, 2008 (18) | KSA | Permanent | 1115 | 10-14 y (M) | School | WHO | Stepwise logistic regression |
|-------------------|---|--------------------------|-----|---------|-----|-------------|-------|----|---------------------------|

| Oral hygiene-poor | + | Dashash & Blinkhorn, 2012 (19) | Syria | Primary | 727 | 5 y (M, F) | School | WHO (dmft, DMFT) | Multiple logistic regression |
|-------------------|---|-------------------------------|-------|---------|-----|-----------|-------|----|--------------------------|

| Oral hygiene-poor | + | Jaghasi et al. 2012 (20) | Syria | Not specified | 504 | 6-12y (M, F) | School | WHO | Logistic regression |
|-------------------|---|---------------------------|-------|-------------|-----|-----------|-------|----|---------------|

| Oral practices-poor | + | Kowash et al. 2017 (9) | UAE | Primary | 540 | 4-6 y (M, F) | School | WHO (dmft) | Chi-Square |
|---------------------|---|-----------------------|-----|---------|-----|-------------|-------|----|-------------|

| Not feeling embarrassed when smiling | - | Ahmed et al. 2007 (21) | Iraq | Permanent | 392 | 12 y (M, F) | School | WHO (DMFT) | ANOVA |
|-------------------------------------|---|---------------------|-------|---------|-----|-----------|-------|----|-------------|

| Permanent dentition | + | Al-Mutawa el al. 2006 (17) | Kuwait | Primary | 4588 | 5,6,12,14 y (M, F) | School | WHO (dft, DMFT, DFS) | Multivariate analysis |
|---------------------|---|-------------------------|-------|---------|-----|-----------------|-------|------------|---------------------|

ECCP:
- 12-15 mo=3%
- 16-19 mo=9%
- 20-25 mo=14%
- 26-36 mo=33%

dmft:
- <0.1 (12-15 mo)
- dmft=0.2 (16-19 mo)
- dmft=0.4/5 (20-25 mo)
- dmft=1.27 (26-36 mo)
### Dental services visits attributes

| Attribute | Study | Country | Sample | Age | Setting | Basis | Method | Result |
|-----------|-------|---------|--------|-----|---------|-------|--------|--------|
| DFS=3.4 (12 y) | Kabil & Eltawil, 2017 (22) | Egypt | Primary | 108 | 2-4 y | Clinic | WHO | Logistic regression | ECPP=57% (2-3 yrs), 73% (3-4 yrs) |
| DFS=5.2 (14 y) | Kabil and Eltawil, 2016 (23) | Egypt | Primary | 140 | 2-4 y | Clinic | WHO | AAPD-ECC | DMFT=9.96 |
| Dental visits-regular | Alhumaid et al. 2018 (24) | KSA | Primary | 921 | 6-12 y | School | Basic screening survey | Multivariate analysis | DCP=63.5% |
| Dental services - not attending for preventive measures | Dashash & Blinkhorn, 2012 (19) | Syria | Primary | 727 | 5 y | School | WHO (dmft, DMFT) | Multiple logistic regression | DCP=61% dmft=3.27 (SD 3.71) |
| Dental visits- for pain complaints/dental problems | Shagaghian et al. 2018 (3) | Iran | Primary | 396 | 3-6 y | School | WHO | Multivariate analysis | DCP=69.9% dmft=3.88 |
| Dental visits- for pain complaints/dental problems | Alhabdan et al. 2018 (10) | KSA | Primary | 578 | 6-8 y | School | WHO (dmft) | Adjusted Odds Ratios, Multivariate model logistic regression | DCP: 83% dmft=4.20 (SD 2.96) |
| Dental visits | Unclear | Khadri et al. 2018 (25) | UAE | Permanent | 803 | 11-17 y | School | WHO (DMFT) | Multivariate regression | DCP=75% DMFT=3.19 (SD 2.9) |

### Parental oral health status and knowledge attributes

| Attribute | Study | Country | Sample | Age | Setting | Basis | Method | Result |
|-----------|-------|---------|--------|-----|---------|-------|--------|--------|
| Parental dental caries status | Yazdan et al. 2018 (26) | Iran | Primary | 258 | 5-15 y | Clinic | WHO (dmft, DMFT) | Pearson's | dmft=6.33 (SD3.80) DMFT=1.48 (SD1.90) |
| Parental knowledge on oral hygiene | Yazdan et al. 2018 (26) | Iran | Primary | 258 | 5-15 y | Clinic | WHO (dmft, DMFT) | Pearson's | dmft=6.33 (SD3.80) DMFT=1.48 (SD1.90) |
| Mother's caries experience | Kabil & Eltawil, 2016 (23) | Egypt | Primary | 140 | 2-4 y | Clinic | WHO (DMFT) AAPD | Logistic regression | DMFT=9.96 |
| Mother's current caries experience | Kabil & Eltawil, 2017 (22) | Egypt | Primary | 108 | 2-4 y | Clinic | WHO | Logistic regression | ECPP=57% (2-3yrs), 73% (3-4yrs) |
| Parental knowledge on oral hygiene | Kowash et al. 2017 (9) | UAE | Primary | 540 | 4-6 y | School | WHO (dmft) | Chi-Square | ECPP=74.1% dmft=3.01 SiC=13.3 |
AAPD American Association Paediatric Dentistry, BASCD British Association for the Study of Community Dentistry, CS Cross-sectional, CC Case control, DCP Dental caries prevalence, deft decayed, extracted due to caries and filled primary teeth, dfs decayed, filled surfaces in primary teeth, dft decayed, filled primary teeth, dmfs decayed, missing and filled surfaces in primary teeth; DMFS decayed, missing and filled surfaces in permanent teeth;

dmft decayed, missing, filled primary teeth, DMFT decayed, missing, filled permanent teeth, ECC Early childhood caries, ECCP Early childhood caries prevalence, F Female, ICADS The international caries Detection and Assessment System, L Longitudinal, KSA Kingdom of Saudi Arabia, m months M Male, WHO World Health Organisation, SiC Significant caries index, SD Standard deviation, y years

a The authors describe their scoring as WHO(DMFT) whereas it should be noted that the age group is 3-6 year olds where normally WHO (dmft) is being used.
b Based on the baseline assessment the participants were categorized into; Group I having sufficient oral health behaviours, Group II having moderate oral health behaviours and Group III having insufficient oral health behaviours and then the participants were followed for a 2-year period.
c Oral hygiene measured by Oral Health index-Simplified (OHI-S)
d The CAST index scoring system is as follows: “0: sound”, “1: sealant”, “2: restoration”, “3: enamel lesions”, “4, 5: dentine lesions”, “6: pulp involvement”, “7: abscess/fistula”, “8: tooth loss”. If a situation did not match any codes from 0 to 8, a code 9 was assigned. The codes 0–2, 3, 4–5, 6–7, and 8 were considered as “healthy”, “pre-morbidity”, “morbidity”, “serious morbidity”, and “mortality”, respectively

Table 5 Statistically significant nutrition-related determinants contributing to dental caries
| Determinants | Association: Positive (+), Negative (-) | Author (Study design) | Country | Type of dentition | N | Age group (Gender) | Study setting | Scoring system | Type/s of statistical analysis | Dental caries/ scoring results |
|--------------|--------------------------------------|-----------------------|---------|------------------|---|-------------------|--------------|--------------|-----------------------------|-----------------------------|
| Beverages    |                                      |                       |         |                  |    |                   |              |              |                            |                            |
| Soft drinks  | +                                    | Chedid et al. 2011 (1) | Lebanon | Primary          | 99 | 2-4 y (M, F)      | Clinic       | WHO          | Pearson's                   | DCP=74.7%                   |
|              |                                       |                       |         |                  |    |                   |              | (DFS score | and bite wing radiographs) |                            |
| Soft drinks  | +                                    | Alhabdan et al. 2018 (2) | KSA     | Primary          | 578| 6-8 y (M)         | School       | WHO          | Adjusted Odds Ratios,      | DCCP: 83%                   |
|              |                                       |                       |         |                  |    |                   |              | (dmft)       | Multivariate model logistic regression | dmft=4.20 (SD 2.96) |
| Soft drinks  | +                                    | Hashim et al. 2009 (3) | UAE     | Primary          | 1036| 5-6 y (M, F)     | School       | WHO          | Adjusted Risk Ratio,       | dmft=4.5                    |
|              |                                       |                       |         |                  |    |                   |              | (dmft)       | Bivariate analysis         |                            |
| Soft drinks  | +                                    | Al-Malik et al. 2002 (4) | KSA     | Primary          | 987 | 2-5y (M, F)       | School       | BASCD        | Stepwise multiple logistic regression | DCP=73% |
| Fruit juice- | before bed                           |                        |         |                  |    |                   |              | (dmft, deft, DMFT) |                           | Rampant caries=43%          |
| Citrus juice- | frequent consumption                 |                        | Egypt   | Primary, Mixed, Permanent | 369 | 3-18 y (M, F)     | Clinic       | WHO          | Kruskal-Wallis, Spearman's | DMFT=1.04 (SD 1.56)         |
| Fruit squash- | frequent consumption                 |                        | Libya   | Permanent        | 791 | 12 y (M, F)       | School       | WHO          | Multivariate stepwise       | DCP=57.8%                   |
| Fruit squash- | frequent consumption                 |                        | Jordan  | Primary          | 1140| 4-5 y (M, F)      | School       | WHO (dmft)   | Multivariate analysis      | DCP=74%                   |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft, DMFT) |                           | dmf=4.21 (SD 3.21)          |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | DCP=1.04 (SD 1.56)         | DCP=57.8%                   |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | Multivariate analysis      | DCP=67% |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft, DMFT) |                           | dmf=4.21 (SD 3.21)          |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | DCP=1.04 (SD 1.56)         | DCP=57.8%                   |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | Multivariate analysis      | DCP=74%                   |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | DCP=1.04 (SD 1.56)         | DCP=57.8%                   |
| Soft drinks  | +                                    | Sayegh et al. 2002 (7) | Jordan  | Primary          | 1140| 4-5 y (M, F)      | School       | WHO (dmft)   | Multivariate analysis      | DCP=73%                   |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | ECP=43%                   | dmf=4.8                     |
| Fruit squash- | frequent consumption                 |                        |         |                  |    |                   |              | (dfmft, deft) | dmf=12.7                  |                            |
| Tea with sugar| +                                    | Sayegh et al. 2005 (8) | Jordan  | Primary          | 1140| 4-5 y (M, F)      | School       | WHO (dmft)   | Multivariate analysis      | DCP=67%                   |

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| Source | Type of Analysis | Countries | Study Design | Age | Site | WHO Indicator | Adjusted Odds Ratio | DC/DCP | dmft Mean (SD) |
|--------|-----------------|-----------|-------------|-----|------|---------------|---------------------|-------|---------------|
| **Tea with sugar** | + | Hashim et al. 2009 | UAE Primary | 5-6 y (M, F) | School | WHO (dmft) | Adjusted Risk Ratio, Bivariate analysis | DCCP=83% dmft=4.03 (SD 2.96) |
| **Flavoured milk** | + | Alhabdan et al. 2018 | KSA Primary | 6-8 y (M) | School | WHO (dmft) | Adjusted Odds Ratios, Multivariate model logistic regression | DCP=75% DMFT=3.19 (SD 2.9) |
| **Sweetened beverages** | + | Elamin et al. 2018 | UAE Primary | 1.5-4 y (M, F) | School | WHO (dmft) | T-test, Pearson's | DCP: 41% (SD 2.81) |
| **Sweetened beverages** | Unclear | Khadi et al. 2018 | UAE Permanent | 11-17 y (M, F) | School | WHO (DMFT) | Multivariate regression | DCP=75% DMFT=3.19 (SD 2.9) |
| **Sweetened beverages** | + | Ahmed et al. 2007 | Iraq Permanent | 12 y (M, F) | School | WHO (DMFT) | ANOVA | DCP=62% DMFT=1.7 |

**Sugar rich food**

| Source | Type of Analysis | Countries | Study Design | Age | Site | WHO Indicator | Adjusted Odds Ratio | DC/DCP | dmft Mean (SD) |
|--------|-----------------|-----------|-------------|-----|------|---------------|---------------------|-------|---------------|
| **Sugar containing foods** | + | Quadri et al. 2015 | KSA Primary Permanent | 6-15 y (M, F) | School | WHO | Multi regression | DCP=91.3% |
| **Sugar containing foods** | + | Abbass et al. 2019 | Egypt Primary Mixed, Permanent | 3-18 y (M, F) | Clinic | WHO (dmft, deft, DMFT) | Kruskal-Wallis, Spearman's | DCP=74% dfmt=3.23 (SD 4.07) deft=4.21 (SD 3.21) DMFT=1.04 (SD 1.56) |
| **Sugar containing foods** | + | Jaghasi et al. 2012 | Syria Not specified | 6-12 y (M, F) | School | WHO | Logistic regression | DCP=85% |
| **Sugar containing foods** | + | Hashim et al. 2009 | UAE Primary | 5-6 y (M, F) | School | WHO (dmft) | Adjusted Risk Ratio, Bivariate analysis | DCP: 41% (SD 2.81) |
| **Sugar containing foods** | + | Elamin et al. 2018 | UAE Primary | 1.5-4 y (M, F) | School | WHO (dmft) | T-test, Pearson's | DCP: 41% (SD 2.81) |
| **Sugar containing foods** | + | Sayegh et al. 2002 | Jordan Primary | 4-5 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% dmft > 4 (SD 31%) |
| Snacks and meal frequency |
|---------------------------|
| Sweet snacks\(^a\) and beverages + Kowash et al. 2017 UAE Primary 540 4-6 y (M, F) School WHO (dmft) Chi-Square ECCP=74.1% dmft=3.01 SiC=13.3 |
| Sweet snacks\(^a\) and beverages + Kowash, 2015 (15) UAE Primary 176 1.5-5 y (M, F) Clinic BASCD (dmft, dmfs) Descriptive statistics dmft=10.9 dmfs=32.1 |
| Sweet snacks\(^a\) and beverages + Hashim et al. 2011 (16) UAE Primary 1036 3-6 y (M, F) School WHO (ECC) Logistic regression Severe ECCP=31.1% |
| Sweet snacks\(^a\)-frequent consumption + Alhabdan et al. 2018 (2) KSA Primary 578 6-8 y (M) School WHO (dmft) Adjusted odds ratios, Multivariate model logistic regression DCCP=83% dmft= 4.20 (SD 2.96) |
| Snacks-frequency consumption + Hashim et al. 2013 (17) UAE Primary 1036 5-6 y (M, F) School WHO (dmft) Adjusted Risk Ratio, Bivariate analysis dmft=4.5 |
| Snacks + Chedid et al. 2011 (1) Lebanon Primary 99 2-4 y (M, F) Clinic WHO (DFS score and bite/wing radiographs) Pearson's DCP=74.7% |
| Milk-as snack - Chedid et al. 2011 (1) Lebanon Primary 99 2-4y (M, F) Clinic WHO (DFS score and bite/wing radiographs) Pearson's DCP=74.7% |
| Main meal consumption Unclear Khadri et al. 2018 (10) UAE Permanent 803 11-17 y (M, F) School WHO (DMFT) Multivariate regression DCP=75% DMFT=3.19 (SD 2.9) |
| Eating frequently (>5 times daily) + Hashim et al. 2009 (3) UAE Primary 1036 5-6 y (M, F) School WHO (dmft) Adjusted Risk Ratio, Bivariate analysis dmft=4.5 |
| Other eating related factors |
| No fruit consumption - Alhabdan et al. 2018 (2) KSA Primary 578 6-8 y (M) School WHO (dmft) Adjusted Odds Ratios Multivariate model logistic regression DCCP=83% dmft 4.20 (SD 2.96) |
| Sweet taste perception + Ashi et al. 2017 (18) KSA\(^f\) Permanent 225 15-15 y (M, F) School ICDAS, (DMFS) One-way ANOVA DMFS= 2.99 LSD |
| Low dietary score\(^g\) + Al-Otaibi et al. 2012 (19) Yemen Not specified 400 12 y (M, F) School WHO (DMFT) Multivariate logistic regression, DCP=90.2% DMFT=2.22 |
| Low nutrient food\(^n\)-frequent consumption | + | Inan-Eroglu et al. 2017 (20) | Turkey | Primary | 395 | 36-71 m (M, F) | School | WHO (dmft, dmfs) | Mann-Whitney, Kruskal-Wallis | dmft =4.7 | dmfs= 8.0 |
| Dairy products\(^n\)-low consumption | + | Jaghasi et al. 2012 (13) | Syria | Not specified | 504 | 6-12 y (M, F) | School | WHO | Logistic regression | DCP=85% |
| Cod liver intake | - | Bener et al. 2013 (21) | Qatar | Permanent | 1284 | 6-15 y (M, F) | Clinic | WHO (DMFT) | Multivariate analysis | DCP=73% | DMFT=4.5 |
| Nutritious food\(^n\)-frequent consumption | - | Abbass et al. 2019 (5) | Egypt | Primary. Mixed, Permanent | 369 | 3-18 y (M, F) | Clinic | WHO (dmft, deft, DMFT) | Kruskal-Wallis, Spearman's | DCP=74%, dmft=3.23 (SD 4.87) | deft=4.21 (SD 3.21) | DMFT=1.04 (SD 1.56) |

### Infant feeding practices

| Feeding type | + | Abu Hamila, 2013 (22) | Egypt | Primary | 560 | 1-3.5 y (M, F) | Clinic | WHO (dmft) | Chi-Square | ECCP=69.6% | dmft range =2.1-7.6 |
| Breastfeeding: Long duration | + | Sayegh et al. 2002\(^b\) (23) | Jordan | Primary | 1140 | 4-5 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% | dmft >4 in 31% |
| Breastfeeding: On demand feeding | + | Sayegh et al. 2002\(^b\) (23) | Jordan | Primary | 1140 | 4-5y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% | dmft >4 in 31% |
| Formula feeding | + | Alhabdan et al. 2018 (2) | KSA | Primary | 578 | 6-8 y (M) | School | WHO (dmft) | Adjusted Odds Ratios, Multivariate model logistic regression | DCP=83% | dmft= 4.20 (SD 2.96) |
| Formula feeding | + | Bener et al. 2013 (21) | Qatar | Permanent | 1284 | 6-15 y (M, F) | Clinic | WHO (DMFT) | Multivariate analysis | DCP=73% | DMFT=4.5 |
| Formula feeding + | Qadri et al. 2012 (24) | Syria | Primary | 400 | 3-5 y (M, F) | School | ECC WHO (dmft, dmfs) | Logistic regression | ECCP=48% DCP=70% dmft=4.25 (SD 4.24) |
| Night feeding - bottle + | Mohebbi, 2008 (25) | Iran | Primary | 504 | 1-3 y (M, F) | Clinic | WHO | T-test, Chi-Square, ANOVA, Logistic regression | DCP=3.26% depending on age |
| Night feeding - bottle + | Ozer et al. 2011 (26) | Turkey | Primary | 226 | 3-6 y (M, F) | School | WHO AAPD (ECC) | Bivariate analysis | ECCP=46.9% dmft=2.87 |
| Night feeding + | Kabil & Eltawil, 2016 (27) | Egypt | Primary | 140 | 2-4y (M, F) | Clinic | WHO (DMFT) | Logistic regression | DMFT=9.96 |
| Night feeding + | Kabil & Eltawil, 2017 (28) | Egypt | Primary | 108 | 2-4y (M, F) | Clinic | WHO (ECC) | Logistic regression | ECCP=57% (2-3yrs), 73% (3-4yrs) |
| Bottle feeding - on demand + | Sayegh et al. 2002b (23) | Jordan | Primary | 1140 | 4-5 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% dmft >4 in 31% |
| Sleep with bottle + | Alhabdan et al. 2018 (2) | KSA | Primary | 578 | 6-8 y (M) | School | WHO (dmft) | Adjusted Odds Ratios, Multivariate model logistic regression | DCCP=83% dmft=4.20 (SD 2.96) |
| Sleep next to mother + | Sayegh et al. 2002b (23) | Jordan | Primary | 1140 | 4-5 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% dmft >4 in 31% |
| Dummy use + | Sayegh et al. 2002b (23) | Jordan | Primary | 1140 | 4-5 y (M, F) | School | WHO (dmft) | Multivariate analysis | DCP=67% dmft >4 in 31% |
| Dummy sweetened + | Al-Malik et al. | KSA | Primary | 987 | 2-5 y | School | BASCD (dmft, Logistic regression | DCP=73% |
| Year (Study) | Study Design | Study Population | Country | Age | Clinical Setting | WHO Classification | Type of Analysis | Final ECCP/DCP | Final dmft | Final dfs |
|-------------|--------------|------------------|---------|-----|------------------|-------------------|----------------|----------------|-----------|----------|
| 2002 (4)    | CS           | M, F             | dmfs    |     |                  |                   | Logistic regression | ECCP=43%       | dmft=4.8  | dfs=12.67 |
|             |              |                  |         |     |                  |                   |                |                |           |          |
| Shared spoons between mother and child* | +             | Cogulu et al. 2008 | Turkey | Primary | 92 | 15-35 m | Clinic | WHO | Logistic regression |
|             |              | (M, F)           |         |      | (dft, dfs)      |                   |                | Final | DCP=45%   | Final | dft=1.0 |
|             |              |                  |         |      |                 |                   |                | Final | dfs=1.8   |        |          |

AAPD American Association Paediatric Dentistry, BASCD British Association for the Study of Community Dentistry, CS Cross-sectional, CC Case control, DCP Dental caries prevalence, deft decayed, extracted due to caries and filled primary teeth, dfs decayed, filled surfaces in primary teeth, dft decayed, filled primary teeth, dmfs decayed, missing and filled surfaces in primary teeth; DMFS decayed, missing and filled surfaces in permanent teeth, dntf decayed, missing, filled primary teeth, DMFT decayed, missing, filled permanent teeth, ECC Early childhood caries, ECCP Early childhood caries prevalence, F Female, ICADS The international caries Detection and Assessment System, L Longitudinal, KSA Kingdom of Saudi Arabia, m months M Male, WHO World Health Organisation, SiC Significant caries index, SD Standard deviation, y years

*Hashim et al. 2006, Hashim et al. 2009, Hashim et al. 2011 and Hashim et al. 2013 seem to be based on the same study population but reporting different results.

**Sayegh et al. 2002 and Sayegh et al. 2005 seem to be based on the same study population and the results mentioned in this table, have been reported in both articles.

Sweetend beverages refer to the consumption of various sweet beverages like soft drinks, fruit squashes, tea with sugar, flavoured milk, etc.

Sugar rich food may include consumption of all/and mix of items like candy, chocolates, dates, ice-cream, cakes, muffins, etc.

Sweet snacks include various food items with high sugar content.

KSA was part of this multinational study which also included Italy and Mexico. Only the results for KSA are presented in this table.

The dietary score was based on a few questions related to the consumption of cariogenic food and eating patterns with yes/no answer options.

Assessed by the Healthy Eating Index (HEI) 2010 and the Mediterranean Diet Quality Index for children and adolescents (KIDMED).

Nutritious food refers to a frequent consumption of high nutrient food like fruits, vegetables, beans, milk, eggs etc.

The feeding type had an impact on the caries prevalence as follows: 75.39% of breastfeed children, 70.39% of the formula fed, 68.67% of those who were weaned and 55% of those who got a mix of breast milk and formula had dental caries respectively.

During the baseline sampling mothers reported that they put their child’s spoon into their own mouth while feeding their child.