

Prevalence of early childhood caries among 5-year-old children: a systematic review

1 **Title page**

2

3 Article title:

4 Prevalence of early childhood caries among 5-year-old children: a systematic review

5

6 Author information:

7 Kitty Jieyi Chen¹, Sherry Shiqian Gao², Duangporn Duangthip^{3*}, Edward Chin Man8 Lo⁴, Chun Hung Chu⁵

9

10 ¹ E-mail address: kjychen@hku.hk11 ² E-mail address: gao1204@hku.hk12 ³ E-mail address: dduang@hku.hk13 ⁴ E-mail address: hrdplcm@hku.hk14 ⁵ E-mail address: chchu@hku.hk

15

16 ¹⁻⁵ Faculty of Dentistry, The University of Hong Kong, No. 34 Hospital Road, Sai
17 Ying Pun, Hong Kong Special Administration Region, China, postal code:000000.18 * Correspondence: dduang@hku.hk; Tel.: +852 2859 0287

19

1 **Prevalence of early childhood caries among 5-year-old children: a systematic**
2 **review**

3

4

5 **Abstract:**

6 The aim of this review is to describe the updated prevalence of early childhood caries
7 (ECC) among 5-year-old children globally. Two independent reviewers performed a
8 systematic literature search to identify English publications from January 2013 to Dec
9 2017 using MEDLINE, ISI Web of Science and Scopus. Search MeSH key words were
10 ‘Dental Caries’ AND ‘Child, Preschool’. The inclusion criteria were epidemiological
11 surveys reporting the caries status of 5-year-old children with the dmft index. The
12 quality of the publications was evaluated with the modified Newcastle-Ottawa Scale.
13 Among 2,410 identified publications, 37 articles with moderate or good quality were
14 included. Twenty included studies were conducted in Asia (China, India, Indonesia,
15 Korea, Nepal and Thailand), seven in Europe (Greece, Germany, Great Britain, and
16 Italy), six in South America (Brazil), two in the Middle East (Saudi Arabia and Turkey),
17 one in Oceania (Australia) and one in Africa (Sudan). The prevalence of ECC ranged
18 from 23% to 90%, and most of them (26/37) were higher than 50%. The mean dmft
19 score varied from 0.9 to 7.5. Based on the included studies published in the recent five
20 years, there is a wide variation of ECC prevalence across countries and ECC remains
21 prevalent in most countries worldwide.

22 **Introduction**

23 According to the American Academy of Pediatric Dentistry (AAPD), early childhood
24 caries (ECC) is defined as the presence of one or more decayed (noncavitated or
25 cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth
26 in a child at 71 months of age or younger [1]. ECC is considered as one of the most
27 prevalent diseases in childhood, affecting many children globally. The American
28 Dental Association identifies that ECC is a significant public health problem in
29 deprived communities and is also found throughout the general child population [2].
30 When comparing with other common childhood diseases, ECC is five times as frequent
31 as asthma and seven times as common as hay fever [3]. Therefore, the American
32 Dental Association urges the public and health professionals to recognize that a child’s
33 teeth are susceptible to decay as soon as they begin to erupt.

34

35 ECC is an infectious disease. Baby bottle tooth decay is recognized as one of the more
36 severe clinical manifestations of ECC. The term ‘ECC’ was suggested at the workshop
37 sponsored by the Centers for Disease Control and Prevention in 1994. The aim of this
38 nomenclature was to focus attention on the multiple factors (i.e. socioeconomic,
39 behavioral and psychosocial) contributing to caries at such early ages, rather than
40 ascribing sole causation to inappropriate feeding methods. Four main etiological
41 factors are well documented: susceptible host, cariogenic bacteria, fermentable
42 carbohydrate substrate and time for interaction of these factors [4]. The characteristics
43 of primary teeth, dietary habits and the efficiency of plaque removal make young
44 children one of the susceptible groups [5]. Other environmental risk factors, such as the
45 use of fluoride, access to dental care service, demographic background and
46 socioeconomic status, are also found to be related to ECC. In this context,
47 underprivileged children have a higher prevalence and more severity of ECC [6, 7]. In
48 some developing countries, prevalence of ECC is considered to be at epidemic
49 proportions.

50

51 A narrative literature review on the prevalence of nursing caries in the 1990s concluded
52 that high caries prevalence was found in Africa and Southeast Asia [8]. At that time,
53 presence of ECC was uncommon in some developed countries, such as England,
54 Sweden and Finland [9, 10]. In contrast, the prevalence of ECC had increased by as
55 much as 56% in some Eastern European countries [11].

56

57 Although no symptoms can be found at the early stage of dental caries, discomfort or
58 pain may occur when the lesion progresses into dentin or involves the dental pulp [12].
59 Untreated ECC may cause difficulties in sleeping and eating, and possibly affect
60 children’s growth and development [13]. Studies reported that children who suffered
61 from cavitated dentin caries were found to have lower body weight and height,
62 compared with those without dental caries [14]. In addition, higher rates of
63 absenteeism were found in children with untreated ECC, leading to a negative impact
64 on their school performance [15]. Moreover, hospitalization or emergency dental visits
65 were reported in some severe cases [16]. Such problems could become serious and
66 even life threatening.

67

68 Oral health is an important part of general health and has influences on children's lives
69 and future development. Different preventive strategies have been implemented to
70 reduce the burden of ECC in most countries. It is necessary for health authorities to
71 understand their dental caries situation of primary dentition before setting goals or
72 implementing effective dental services. Since the 5-year-old children are in the latest
73 stage of having a complete primary dentition, the World Health Organization (WHO)
74 has chosen them to be the index age group in basic oral health surveys on the situation
75 of the primary dentition [17]. The rapid changes in dietary and lifestyle patterns have
76 been noted throughout the world, possibly linking to the change of ECC pattern and
77 severity. The aim of this systematic review is to describe the updated information about
78 the prevalence of ECC amongst 5-year-old children globally.

79

80 **Methods**

81 Search strategy

82 Three electronic databases (MEDLINE, ISI Web of Science and Scopus) were selected
83 for searching peer-reviewed articles published in English from January 2013 to
84 December 2017. The last search date was 14th January 2018. Using medical subject
85 headings (MeSH), the search key words were ('Dental Caries' [MeSH]) AND 'Child,
86 Preschool' [MeSH]). Duplicate records and papers written in languages other than
87 English were excluded. A manual search was performed to identify additional articles
88 from the bibliography of the retrieved articles.

89

90 Study selection

91 Two reviewers (KJC and SSG) screened the titles and abstracts independently. Eligible
92 publications were identified according to the following three inclusion criteria.

93

- 94 1) Study design: Only epidemiological surveys investigating the prevalence of dental
95 caries were considered in the present review. Any cross-sectional study that was a
96 part of a longitudinal study or clinical trial was excluded. Other types of studies,
97 including laboratory studies, clinical trials, and case-control studies, were not
98 considered. Studies analyzing secondary data were also excluded.
- 99 2) Participants: Study participants were 5-year-old (aged 60 to 71 months) children.
100 The selected participants had to be representative of the general 5-year-old
101 population of the studied districts or countries. The sample size needed to be more

102 than 100 participants to maintain the representativeness.

103 3) Outcomes: Included studies had to report the caries prevalence and experience using
104 the dmft index.

105

106 The two reviewers retrieved and assessed independently the full texts of studies that
107 met the inclusion criteria or those that could not be determined by screening the titles
108 and abstracts. A third reviewer (DD) was consulted to make a decision if there was
109 disagreement between two reviewers.

110

111 *Data extraction and quality assessment*

112 The following information was extracted and summarized during the full-text
113 assessment: studied site, sampling method, sample size, diagnostic criteria, caries
114 prevalence and caries experience (dmft index). The Human Development Index (HDI)
115 of the survey site was extracted from the United Nations website [18]. The HDI reported
116 by the United Nations was used to study the relationship between the HDI and caries
117 prevalence. A linear regression was performed to analyze the relationship between HDI
118 and caries prevalence, and the statistical significance level was set at 0.05.

119

120 The quality of the included studies was assessed with the modified Newcastle-Ottawa
121 Scale adapted for cross-sectional studies (NOS) for risk of bias [19]. Two aspects which
122 were sample selection and the study outcome were scored between 0 and 8. Studies that
123 adopted random sampling method, had favorable sample size ($n > 100$), established
124 comparability between respondents and non-respondents and good response rate
125 ($> 80\%$), used well-established diagnosis criteria, had good reliability between
126 examiners (kappa value > 0.6) and adopted appropriate statistic methods were rated as a
127 full score or 8 (Appendices). The methodological quality of the studies was categorized
128 as poor (0-2), moderate (3-5) and good (6-8) according to the modified NOS for
129 descriptive purposes. Preferred Reporting Items for Systematic Reviews and
130 Meta-Analyses (PRISMA) was used as a basis for reporting in this systematic review
131 [20].

132

133 **Results**

134 A total of 2,410 articles (1,037 from MEDLINE, 552 from ISI Web of Science and 821
135 from Scopus) were identified and screened based on their titles and abstracts (Figure 1).

136 An initial screening of the title and abstract revealed that 551 articles were duplicates
137 and 1,707 articles did not meet the inclusion criteria. Full texts of the remaining 152
138 articles were assessed, and 37 studies [21-57] were included in this study. No
139 additional publication was identified from the bibliography of these 152 articles.

140

141 The included publications described the dental caries situations of the 5-year-old
142 children in 16 countries/districts from 6 continents. Most of the studies were conducted
143 in Asia (n=20, China, India, Indonesia, Korea, Nepal, Taiwan and Thailand) [21-40], in
144 Europe (n=7, Greece, Germany, Italy and United Kingdom) [41-47] and in Southern
145 America (n=6, Brazil) [48-53]. Two studies conducted in the Middle East (Saudi
146 Arabia and Turkey) [54, 55], one in Africa (Sudan) [56] and one in Oceania (Australia)
147 [57] were included. Out of 37 publications, 28 were from countries/districts with high
148 or very high HDI scores ($HDI > 0.70$), while only one publication was from a country
149 with a low HDI score ($HDI < 0.55$) (Table 1) [56].

150

151 Among the included articles, the prevalence of caries ranged from 22.5% in India to
152 90.0% in Indonesia, and the median of caries prevalence was 62.7%. Around
153 two-thirds of the studies (26/37) reported a caries prevalence of more than 50% (Table
154 1). Prevalence of ECC varied in different continents. In Asia, the majority of the
155 studies (17/20) reported that more than half of the study children had dental caries
156 experience. Similarly, two-thirds of the studies conducted in South America and all
157 studies in Africa and Middle East reported that their ECC prevalence was higher than
158 50%. In contrast, nearly all studies (8/9) conducted in Europe reported lower ECC
159 prevalence, comparing to that of other continents. Twenty-six studies (26/37) reported
160 caries experience in mean dmft scores. There was a wide range of dmft score from 0.9
161 in Germany, United Kingdom and Italy to 7.5 in Indonesia. The median of the mean
162 dmft score was 2.6. Eleven publications did not report caries experience. Only twelve
163 publications (12/37) reported untreated caries (dt), which constituted the main
164 component of the caries experience (Table 1).

165

166 The caries prevalence reported in the included studies varied among countries and
167 continents. In Australia, where the HDI was the highest among the included studies
168 (0.94), the caries prevalence was 44.4%. In Sudan where the lowest HDI (0.49) was,
169 their caries prevalence was 56%. No significant association was found between the

170 HDI and caries prevalence ($p=0.240$). Through using the modified NOS to assess the
171 quality of the articles, it was found in this review that all 37 publications had moderate
172 to good methodological quality (Table 2).

173

174 **Discussion**

175 Various preventive strategies have been implemented to reduce the burden of ECC in
176 different countries. The World Dental Federation (FDI), WHO and the International
177 Association of Dental Research (IADR) have embarked on the activities of preparing
178 the Global Oral Health Goals for the year 2020 [58]. One of the objectives was to
179 minimize the impact of dental caries on individuals and society, and to formulate
180 strategies for the early diagnosis, prevention and effective management of dental caries.
181 Unfortunately, the majority of the included epidemiological studies showed that ECC
182 remained prevalent among preschool children worldwide. In addition, untreated caries
183 in young children is still a significant health burden in many countries, which suggests
184 that greater attempts and different preventive measures are required if this goal is to be
185 reached by 2020.

186

187 In addition, the result showed a geographically disproportional distribution of ECC as
188 the situation in Africa and Asia were unsatisfactory compared to other continents. In
189 China which is the most populous country in the world, the present review showed no
190 improvement regarding the status of dental caries in Chinese preschool children,
191 compared to the results of the third national oral health survey in 2005 [59]. In contrast,
192 the situation of ECC among 5-year-old children in Wales and Scotland improved in
193 recent years when comparing to the previous survey in 2002-2003 [60]. As the fourth-
194 most expensive disease to treat, dental caries is one of the major burdens affecting
195 many children and families [61]. Study findings indicate that children at low
196 socioeconomic levels have higher risks of developing dental caries, but their access to
197 dental services is difficult. Therefore, underprivileged children suffering from dental
198 caries is common [62].

199

200 The HDI is a composite index of life expectancy, education and per-capita income
201 indicators. Country with a high HDI score has long lifespans, high education levels and
202 high gross domestic products (GDPs) per capita [18]. Studies in European and
203 Oceanian countries that had high HDI scores generally reported a low prevalence of

204 ECC. In Asia, three studies in India which had a moderate HDI score showed low
205 caries prevalence (<50%) [34, 36, 37]. Contradictorily, Korea and Hong Kong had very
206 high HDI scores, but their caries prevalence was high (>50%), compared with their
207 counterparts in Europe. Furthermore, eleven studies in Asia reported mean dmft scores
208 equivalent to or higher than 3 [22, 23, 24, 27, 29, 31-34, 39, 40]. It is noteworthy that
209 the HDI can indicate only the development level of the entire country and that the
210 socioeconomic status of an individual city or district cannot be reflected in this index,
211 which is a limitation of the present review.

212

213 The present systematic review has several strengths including using three main
214 databases including MEDLINE, ISI Web of Science and Scopus for searching
215 publications. MEDLINE is a well-established database of the U.S. National Library of
216 Medicine, which is the world's largest biomedical library [63]. MeSH and subheadings
217 make PubMed searches more sensitive and minimize false-negative (missed) hits by
218 compensating for the diversity of medical terminology [64, 65]. By searching 'Dental
219 caries' in MeSH term, 'Dental Decay', 'Cariou Dentine' and 'White Spots,' etc., were
220 included; hence, the keyword search was automatically 'expanded' to include more
221 specific terms. ISI Web of Science was another database for the literature search in this
222 review. It encompasses more than 12,000 journals and 160,000 conference proceedings
223 [66]. Scopus is also a big database of peer-reviewed literatures with over 4000 health
224 science titles indexed [67]. By using these three databases in this study, the literature
225 search could cover a large number of citation indexing journals. These journals are
226 generally considered the ones that publish good-quality studies. However, surveys
227 published in local journals and the governmental archives could not be found.

228

229 No significant disagreement was found between the independent reviewers in selecting
230 relevant studies in the literature search. The WHO recommends that epidemiological
231 studies should be conducted every 5 years to obtain the most updated ECC situation
232 [17]. Therefore, the present review focused on retrieving articles published from
233 January 2013 to December 2017. Only epidemiological surveys were selected. Cohort
234 and randomized clinical studies were not selected because these studies mostly
235 recruited children from specific community groups. Based on the WHO
236 recommendation, at least 50 subjects in a single survey site should be recruited. [17].
237 In the current review, only surveys with a sample size of more than 100 were included,

238 as multiple survey sites would be better representatives of the situation. The dmft index,
239 which was commonly used in dental surveys, was selected as an outcome of the
240 included studies [17]. Four studies adopted deft (decayed, extracted due to caries and
241 filled primary teeth) scores [26, 34, 36, 48] were also included. Following the adopted
242 inclusion criteria, only studies with good quality were included, resulting in limiting
243 number of included studies for this review.

244

245 It should be noted that the definition of ECC by AAPD includes both non-cavitated and
246 cavitated carious lesions. In the present review, few studies included both
247 non-cavitated and cavitated lesions as their decay component [46, 49, 52, 55, 57],
248 while most of the included studies adopted the WHO diagnostic criteria by defining
249 caries as the cavitation. To assess the methodological quality, a quality assessment tool
250 was needed. However, no agreed-upon or well-established quality assessment tool for
251 epidemiological surveys existed. In this study, the NOS was modified and adopted. All
252 studies included in this review had moderate to good methodological quality according
253 to the assessment using the modified NOS. They had adequate sample sizes for
254 statistical analysis. Almost all articles stated their statistical analysis methods clearly.
255 Therefore, these observations suggest that the three databases selected in this study
256 contained mostly acceptable studies, and the methodological quality of the included
257 articles was satisfactory.

258

259 The present findings urge dental educators and policy makers that prevalence of dental
260 caries is still high among preschool children in many countries, particularly in Asia,
261 South America and Africa. National and international oral health policy should
262 emphasize oral health promotion and prevention for children. It is important to prevent
263 and control ECC as the consequence of untreated ECC negatively affects the chewing
264 ability, speech development and the formation of a positive self-image [5] ECC is a
265 preventable disease, and plenty of preventive methods exist. Two important practical
266 approaches are sugar control and use of fluorides. A systematic review described an
267 association between the amount of sugar intake and dental caries, and suggested that
268 ECC can be reduced by restricting sugar intake [69]. In addition, topical use of
269 fluorides, including mouth rinse and toothpaste, helps to reduce dental caries [70, 71].
270 Governments and dental authorities should take these two approaches into
271 consideration when proposing oral health promotion programs. Strategies should be

272 formulated to reduce morbidity from ECC, thereby increase the quality of life of the
273 children. Evidence-based dental public health programs should be prioritized and
274 established to promote oral health in a sustainable way. Furthermore, the common risk
275 factor approach can be used to develop accessible cost-effective oral health systems for
276 the prevention and control of ECC. Oral health promotion and services on the
277 prevention and treatment of ECC can be integrated with other health sectors to improve
278 both oral and general health.

279

280 Children are often too young to take care of their teeth and cannot brush their teeth
281 effectively. Therefore, parents and caregivers play an important role in promoting oral
282 health for their children. Evidence suggests that parental engagement is required during
283 the perinatal period for the effective prevention of ECC [71]. The government and
284 health professional organizations should reduce disparities in ECC between different
285 socioeconomic groups within countries, as well as reduce inequalities in ECC across
286 countries. In addition, the government should take responsibility for training health
287 care providers to perform periodically epidemiological surveillance of ECC among
288 young children. In addition to community health workers, social workers and dietitians,
289 can play an effective role in prevention of ECC.

290

291 **Conclusions**

292 Based on the included studies published in the past five years (2013-2017), prevalence
293 of ECC varies significantly across countries. In addition, ECC remains prevalent in
294 most countries worldwide.

295

296 **Abbreviations:**

297 ECC: Early Childhood Caries

298 HDI: Human Development Index

299 WHO: World Health Organization

300 MeSH: medical subject headings

301 NOS: Newcastle-Ottawa Scale

302

303 **Conflict of Interest and Sources of Funding**

304 The authors declare no conflict of interest and no funding has been available.

305

306 **References**

- 307 1. American Academy of Pediatric Dentistry. Policy on early childhood caries (ECC):
308 classifications, consequences, and preventive strategies. *Pediatr Dent* 2016,
309 **38**:52-4.
- 310 2. American Dental Association. Statement on early childhood caries.
311 [http://www.ada.org/en/about-the-ada/ada-positions-policies-and-statements/statem](http://www.ada.org/en/about-the-ada/ada-positions-policies-and-statements/statement-on-early-childhood-carries)
312 [ent-on-early-childhood-carries](http://www.ada.org/en/about-the-ada/ada-positions-policies-and-statements/statement-on-early-childhood-carries) Assessed Feb 10th, 2018.
- 313 3. Bagramian RA, Garcia-Godoy F, Volpe AR. The global increase in dental caries:
314 A pending public health crisis. *Am J Dent* 2009; **22**: 3-8.
- 315 4. Gupta P, Gupta N, Pawar AP, Birajdar SS, Natt AS, Singh HP. Role of sugar and
316 sugar substitutes in dental caries: A review. *ISRN Dent* 2013; **2013**: 519421.
- 317 5. Alazmah A. Early childhood caries: A review. *J Contemp Dent Pract* 2017; **18**:
318 732-7.
- 319 6. Kawashita Y, Kitamura M, Saito T. Early childhood caries. *Int J Dent Oral Health*
320 2011; **2011**: 725320.
- 321 7. Mantonanaki M, Koletsi-Kounari H, Mamai-Homata E, Paaioannou W.
322 Prevalence of dental caries in 5-year-old Greek children and the use of dental
323 services: evaluation of socioeconomic, behavioural factors and living conditions.
324 *Int Dent J* 2013; **63**: 72-9.
- 325 8. Milnes AR. Description and epidemiology of nursing caries. *J Public Health Dent*
326 1996; **56**: 38-50.
- 327 9. Douglass JM, Tinanoff N, Tang JMW, Altman DS. Dental caries patterns and oral
328 health behaviors in Arizona infants and toddlers. *Community Dent Oral Epidemiol*
329 2001; **29**: 14-22.
- 330 10. Davies GM, Blinkhorn FA, Duxbury JT. Caries among 3-year-olds in Greater
331 Manchester. *Br Dent J* 2001; **190**: 381-4.
- 332 11. Szatko F, Wierzbicka M, Dybizbanska E, Struzycka I, Iwanicka-Frankowska E.
333 Oral health of Polish three-year-olds and mothers' oral health-related
334 knowledge. *Community Dent Health* 2004; **21**: 175-80.
- 335 12. Ferraz NKL, Nogueira LC, Pinheiro MLP, Marques LS, Ramos-Jorge ML,
336 Ramos-Jorge J. Clinical consequences of untreated dental caries and toothache in
337 preschool children. *Pediatr Dent* 2014; **36**: 389-92.
- 338 13. Ortiz FR, Tomazoni F, Oliveira MDM, Piovesan C, Mendes F, Ardenghi TM.
339 Toothache, associated factors, and its impact on Oral Health-Related Quality of
340 Life (OHRQoL) in preschool children. *Braz Dent J* 2014; **25**: 546-53.
- 341 14. Li LW, Wong HM, Peng SM, McGrath CP. Anthropometric measurements and
342 dental caries in children: a systematic review of longitudinal studies. *Adv Nutr*
343 2015; **6**: 52-63.
- 344 15. Neves ÉTB, Firmino RT, de França Perazzo M, Gomes MC, Martins CC, Paiva
345 SM, Granville-Garcia AF. Absenteeism among preschool children due to oral
346 problems. *J Public Health* 2016; **24**: 65-72.
- 347 16. Allareddy V, Nalliah RP, Haque M, Johnson H, Rampa SB, Lee MK.

- 348 Hospital-based emergency department visits with dental conditions among
349 children in the United States: nationwide epidemiological data. *Pediatr Dent* 2014;
350 **36**: 393-9.
- 351 17. World Health Organization. Oral health surveys: basic methods. Geneva: World
352 Health Organization; 2013.
- 353 18. Human Development Report Office. Human Development Report 2016.
354 <http://hdr.undp.org/en/composite/HDI> Accessed Feb 14th, 2018.
- 355 19. Stang A. Critical evaluation of the Newcastle-Ottawa scale for the assessment of
356 the quality of nonrandomized studies in meta-analyses. *Eur J Epidemiol* 2010;
357 **25**: 603-5.
- 358 20. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P,
359 Stewart LA, Group PRISMA-P. Preferred reporting items for systematic review
360 and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015; **4**:1.
- 361 21. Chen KJ, Gao SS, Duangthip D, Li SKY, Lo ECM, Chu CH. Dental caries status
362 and its associated factors among 5-year-old Hong Kong children: a cross-sectional
363 study. *BMC Oral Health* 2017; **17**: 121.
- 364 22. Peng SM, Wong HM, King NM, McGrath C. Is dental caries experience
365 associated with adiposity status in preschool children? *Int J Paediatr Dent* 2014;
366 **24**: 122-30.
- 367 23. Bridges SM, Parthasarathy DS, Wong HM, Yiu CKY, Au TK, McGrath CPJ. The
368 relationship between caregiver functional oral health literacy and child oral health
369 status. *Patient Educ Coun* 2014; **94**: 411-6.
- 370 24. Han DH, Kim DH, Kim MJ, Kim JB, Jung-Choi K, Bae KH. Regular dental
371 checkup and snack-soda drink consumption of preschool children are associated
372 with early childhood caries in Korean caregiver/preschool children dyads.
373 *Community Dent Oral Epidemiol* 2014; **42**: 70-8.
- 374 25. Lin YC, Wang WC, Chen JH, Chen PH, Lee CH, Huang HL. Significant caries
375 and the interactive effects of maternal-related oral hygiene factors in urban
376 preschool children. *J Public Health Dent* 2017; **3**: 188-96.
- 377 26. Yen CE, Hu SW. Association between dental caries and obesity in preschool
378 children. *Eur J Paediatr Dent* 2013; **14**: 185-9.
- 379 27. Li Y, Wulaerhan J, Liu Y, Abudureyimu A, Zhao J. Prevalence of severe early
380 childhood caries and associated socioeconomic and behavioral factors in Xinjiang,
381 China: a cross-sectional study. *BMC Oral Health* 2017; **17**: 144.
- 382 28. Jiang YY. Prevalence of Early Childhood Caries Among 2- to 5-year-old
383 Preschoolers in kindergartens of Weifang city, China: A cross-sectional Study.
384 *Oral Health Prev Dent* 2017; **15**: 89-97.
- 385 29. Chen X, Zhan JY, Lu HX, Ye H, Ye W, Zhang W, Yang WJ, Feng XP. Factors
386 associated with black tooth stain in Chinese preschool children. *Clin Oral Investig*
387 2014; **18**: 2059-66.
- 388 30. Wulaerhan J, Abudureyimu A, Bao XL, Zhao J. Risk determinants associated with
389 early childhood caries in Uygur children: a preschool-based cross-sectional study.

- 390 *BMC Oral Health* 2014; **14**: 136.
- 391 31. Krisdapong S, Somkotra T, Kueakulpipat W. Disparities in early childhood caries
392 and its impact on oral health-related quality of life of preschool children. *Asia Pac*
393 *J Public Health* 2014; **26**: 285-94.
- 394 32. Pattanaporn K, Saraithong P, Khongkhunthian S, Aleksejuniene J, Laohapensang
395 P, Chhun N, Chen Z, Li Y. Mode of delivery, mutans streptococci colonization,
396 and early childhood caries in three- to five-year-old Thai children. *Community*
397 *Dent Oral Epidemiol* 2013; **41**: 212–23.
- 398 33. Adiatman M, Yuvana AL, Nasia AA, Rahardjo A, Maharani DA, Zhang SN.
399 Dental and gingival status of 5 and 12-year-old children in Jakarta and its satellite
400 cities. *J Dent Indones* 2016; **23**: 5-9.
- 401 34. Kakanur M, Nayak M, Patil SS, Thakur R, Paul ST, Tewathia N. Exploring the
402 multitude of risk factors associated with early childhood caries. *Indian J Dent Res*
403 2017; **28**: 27-32.
- 404 35. Sujlana A, Pannu PK. Family related factors associated with caries prevalence in
405 the primary dentition of five-year-old children. *J Indian Soc Pedod Prev Dent*
406 2015; **33**: 83-7.
- 407 36. Gupta D, Momin RK, Mathur A, Srinivas KT, Jain A, Dommaraju N, Dalai DR,
408 Gupta RK. Dental caries and their treatment needs in 3-5 Year old preschool
409 children in a rural district of India. *North Am J Med Sci* 2015; **7**: 143-50.
- 410 37. Gopal S, Chandrappa V, Kadidal U, Rayala C, Vegesna M. Prevalence and
411 predictors of early childhood caries in 3- to 6-year-old South Indian children--A
412 cross-sectional descriptive study. *Oral Health Prev Dent* 2016; **14**: 267-73.
- 413 38. Mittal M, Chaudhary P, Chopra R, Khattar V. Oral health status of 5 years and 12
414 years old school going children in rural Gurgaon, India: an epidemiological study.
415 *J Indian Soc Pedod Prev Dent* 2014; **32**: 3-8.
- 416 39. Sankeshwari RM, Ankola AV, Tangade PS, Hebbal MI. Association of
417 socio-economic status and dietary habits with early childhood caries among 3- to
418 5-year-old children of Belgaum city. *Eur Arch Paediatr Dent* 2013; **14**: 147–53.
- 419 40. Thapa P, Aryal KK, Dhimal M, Mehata S, Pokhrel AU, Pandit A, Pandey AR,
420 Bista B, Dhakal P, Karki KB, Pradhan S. Oral health condition of school children
421 in Nawalparasi district, Nepal. *J Nepal Health Res Counc* 2015; **13**: 7-13.
- 422 41. Grund K, Goddon I, Schüler IM, Lehmann T, Heinrich-Weltzien R. Clinical
423 consequences of untreated dental caries in German 5-and 8-year-olds. *BMC Oral*
424 *Health* 2015; **15**: 140.
- 425 42. Bissar A, Schiller P, Wolff A, Niekusch U, Schulte AG. Factors contributing to
426 severe early childhood caries in south-west Germany. *Clin Oral Invest* 2014; **18**:
427 1411-8.
- 428 43. Monaghan, N, Davies GM, Jones CM, Neville JS, Pitts NB. The caries experience
429 of 5-year-old children in Scotland, Wales and England in 2011-2012: reports of
430 cross-sectional surveys using BASCD criteria. *Community Dent Health* 2014; **31**:
431 105-10.

- 432 44. Ferro R, Besostri A, Olivieri A. Survey of Caries Experience in 3- to 5-year-old
433 Children in Northeast Italy in 2011 and Its Trend 1984-2011. *Oral Health Prev*
434 *Dent* 2017; **15**: 475-81.
- 435 45. Nobile CGA, Fortunato L, Bianco A, Pileggi C, Pavia M. Pattern and severity of
436 early childhood caries in Southern Italy: a preschool-based cross-sectional study.
437 *BMC Public Health* 2014; **14**: 206.
- 438 46. Ferrazzano GF, Sangianantoni G, Cantile T, Ingenito A. Relationship between
439 social and behavioural factors and caries experience in schoolchildren in Italy.
440 *Oral Health Prev Dent* 2016; **14**: 55-61.
- 441 47. Tsanidou E, Nena E, Rossos A, Lendengolts Z, Nikolaidis C, Tselebonis A,
442 Constantinidis TC. Caries prevalence and manganese and iron levels of drinking
443 water in school children living in a rural/semi-urban region of North-Eastern
444 Greece. *Environ Health Prev Med* 2015; **20**: 482.
- 445 48. Abanto J, Tsakos G, Martins Paiva S, Carvalho TS, Raggio DP, Bönecker M.
446 Impact of dental caries and trauma on quality of life among 5- to 6-year-old
447 children: perceptions of parents and children. *Community Dent Oral Epidemiol*
448 2014; **42**: 385-94.
- 449 49. Carvalho JC, Silva EF, Vieira EO, Pollaris A, Guillet A, Mestrinho HD. Oral
450 health determinants and caries outcome among non-privileged children. *Caries*
451 *Res* 2014; **48**: 515-23.
- 452 50. Do Amaral RC, Batista MJ, Meirelles MPMR, Cypriano S, de Sousa MLR.
453 Dental caries trends among preschool children in Indaiatuba, SP, Brazil. *Brazilian*
454 *Journal of Oral Sciences* 2014; **13**: 1-5.
- 455 51. Scarpelli AC, Paiva SM, Viegas CM, Carvalho AC, Ferreira FM, Pordeus IA. Oral
456 health-related quality of life among Brazilian preschool children. *Community*
457 *Dent Oral Epidemiol* 2013; **41**: 336-44.
- 458 52. Lourenço CB, de Lima Saintrain MV, Vieira APGF. Child, neglect and oral health.
459 *BMC Pediatrics* 2013; **13**: 188.
- 460 53. Corrêa-Faria P, Martins-Júnior PA, Vieira-Andrade RG, Marques LS,
461 Ramos-Jorge ML. Factors associated with the development of early childhood
462 caries among Brazilian preschoolers. *Braz Oral Res* 2013; **27**, 356-62.
- 463 54. Al-Meedani LA, Al-Dlaigan YH. Prevalence of dental caries and associated social
464 risk factors among preschool children in Riyadh, Saudi Arabia. *Pak J Med Sci*
465 2016; **32**: 452-6.
- 466 55. Abbasoglu Z, Tanboga I, Kuchler EC, Deeley K, Weber M, Kaspar C, Korachi M,
467 Vieira AR. Early childhood caries is associated with genetic variants in enamel
468 formation and immune response genes. *Caries Res* 2015; **49**: 70-7.
- 469 56. Elidrissi SM, Naidoo S. Prevalence of dental caries and toothbrushing habits
470 among preschool children in Khartoum State, Sudan. *Int Dent J* 2016; **66**: 215-20.
- 471 57. Blinkhorn AS, Byun R, Johnson G, Metha P, Kay M, Lewis P. The dental health
472 of primary school children living in fluoridated, pre-fluoridated and
473 non-fluoridated communities in New South Wales, Australia. *BMC Oral Health*

- 474 2015; **15**: 9.
- 475 58. Hobdell M, Petersen PE, Clarkson J, Johnson N. Global goals for oral health 2020.
476 *Int Dent J* 2003; **53**: 285-8.
- 477 59. Liu J, Zhang SS, Zheng SG, Xu T, Si Y. Oral Health Status and Oral Health Care
478 Model in China. *Chin J Dent Res* 2016; **19**: 207-15.
- 479 60. Pitts NB, Boyles J, Nugent ZJ, Thomas N, Pine CM, British Association for the
480 Study of Community Dentistry. The dental caries experience of 5-year-old
481 children in England and Wales (2003/4) and in Scotland (2002/3). Surveys
482 co-ordinated by the British Association for the Study of Community Dentistry.
483 *Community Dent Health* 2005; **22**: 46-56.
- 484 61. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari M, Bhandari B, Murray CJL,
485 Marcenes W. Global burden of untreated caries: a systematic review and
486 metaregression. *J Dent Res* 2015; **94**: 650-8.
- 487 62. Pinilla J, Negrín-Hernández MA, Abásolo I. Time trends in socio-economic
488 inequalities in the lack of access to dental services among children in Spain
489 1987-2011. *Int J Equity Health* 2015; **14**: 9.
- 490 63. U.S. National Library of Medicine. MEDLINE Journal Selection.
491 <https://www.nlm.nih.gov/pubs/factsheets/jsel.html> Accessed on Feb 14, 2018.
- 492 64. Georgia State University Library. WHAT IS MESH.
493 <http://research.library.gsu.edu/c.php?g=115556&p=753156> Accessed on Feb 14th,
494 2018.
- 495 65. Fatehi F, Gray LC, Wootton R. How to improve your PubMed/MEDLINE
496 searches: 3. advanced searching, MeSH and My NCBI. *J Telemed Telecare* 2014;
497 **20**: 102-12.
- 498 66. Clarivate Analytics. Web of Science. <http://wokinfo.com> Accessed on Feb 14th,
499 2018.
- 500 67. Burnham JF. Scopus database: a review. *Biomedical digital libraries* 2006; **3**: 1.
- 501 68. Bhoopathi PH, Patil, ATIL PU, Kamath BV, Gopal D, Kumar S, Kulkarni G.
502 Caries Detection with ICDAS and the WHO Criteria: A Comparative Study. *J Clin*
503 *Diagn Res* 2017; **11**:12.
- 504 69. Marinho VCC, Higgins JPT, Logan S, Sheiham A. Fluoride mouthrinses for
505 preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*
506 2003; 3.
- 507 70. Marinho VCC, Higgins JPT, Logan S, Sheiham A. Fluoride toothpastes for

508 preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*
509 2003; 1.

510 71. Edelstein BL. Pediatric Dental-Focused Interprofessional Interventions. *Dental*
511 *Clinics* 2017; **61**: 589-606.

512

513 **Figure Legends**

514 Figure 1. Flowchart of literature search

515

516 **Appendices**

517 Appendices: Newcastle-Ottawa Scale adapted for cross-sectional study.

518

519 **Authorship:**

520 KJC: performing data search, data entry and analysis and writing the manuscript; SSG:
521 performing data search, data entry and analysis; DD: performing data checking and
522 performing critical revision of the manuscript for important intellectual content; ECML:
523 performing critical revision of the manuscript for important intellectual content; CHC:
524 performing critical revision of the manuscript for important intellectual content; All
525 authors read and approved the final manuscript.

526

527 **Data Sharing and Data Accessibility**

528 The dataset used and/or analyzed during the current study available from the
529 corresponding author on reasonable request.

1 **Table 1.** Summary of the selected studies

Authors Year [Ref]	Study site (Human Development Index)	Sampling method (sample size)	Diagnosis criteria	Caries prevalence	Caries experience (dmft±SD)	Decayed teeth (dt±SD)
Africa						
Elidrissi et al. 2016 [56]	Khartoum State, Sudan (0.49)	Systematic (196)	dmft (WHO)	56.1%	2.8±4.0	N/A
Asia						
Chen et al. 2017 [21]	Hong Kong SAR, China (0.92)	Multistage (501)	dmft (WHO)	55%	2.7±3.7	2.6±3.7
Peng et al. 2013 [22]	Hong Kong Island, China (0.92)	Multistage (390)	dmft (WHO)	75.3%	4.2±4.6	N/A
Bridges et al. 2014 [23]	Hong Kong Island, China (0.92)	Multistage (301)	dmft (WHO)	75.4%	4.2±4.5	3.3±3.9
Han et al. 2014 [24]	Ulsan, Korea (0.90)	Stratified random (530)	dmft (WHO)	60.9%	N/A	N/A
Lin et al. 2017[25]	Kaohsiung, Taiwan (0.88)	Stratified cluster (232)	dmft (WHO)	81.0%	N/A	N/A
Yen et al. 2013 [26]	Taichung, Taiwan (0.88)	Random selection (146)	deft (WHO)	71.0%	4.8±4.2	N/A
Li et al. 2017 [27]	Xinjiang, China (0.74)	Multistage (640)	dmft (WHO)	84.5%	5.2±4.0	N/A
Jiang et al. 2017 [28]	Shandong, China (0.74)	Stratified random (1,080)	dmft (WHO)	63.1%	2.6±2.5	N/A
Chen et al. 2014 [29]	Shanghai, China (0.74)	Multistage (610)	dmft (WHO)	64.8%	3.5±4.1	N/A
Wulaerhan et al. 2014 [30]	Kashgar, China (0.74)	Three-stage stratified (266)	dmft (WHO)	82.0%	N/A	N/A
Krisdapong et al. 2014 [31]	Bangkok, Thailand (0.74)	Stratified random (503)	dmft (WHO)	77.7%	6.2±5.2	5.2
Pattanaporn et al. 2013 [32]	Chiang Mai, Thailand (0.74)	Not report (167)	dmft (WHO)	78.0%	5.3±5.0	N/A
Adiatman et al. 2016 [33]	Jakarta, Indonesia (0.69)	Cluster random (390)	dmft (WHO)	90.0%	7.5±5.5	6.8±4.9
Kakanur, et al. 2016 [34]	Bengaluru city, India (0.62)	Multiphase (298)	deft (WHO)	27.5%	5.1±3.6	N/A
Sujlana et al. 2015 [35]	Haryana, India (0.62)	Multistage (400)	dmft (WHO)	59.0%	2.8±3.2	2.7±3.1
Gupta et al. 2015 [36]	Moradabad, India (0.62)	Simple random (568)	deft (WHO)	47.5%	2.4±1.7	2.2±0.7
Gopal et al. 2016 [37]	Andhra Pradesh, India (0.62)	Simple random (170)	dmft (WHO)	22.9%	N/A	N/A
Mittal et al. 2014 [38]	Gurgaon, India (0.62)	Multistage (619)	dmft (WHO)	68.5%	1.9±0.4	N/A
Sankeshwari et al. 2014 [39]	Belgaum, India (0.62)	Simple random (302)	dmft (WHO)	70.2%	3.0±3.6	3.0±3.6
Thapa et al. 2015 [40]	Nawalparasi, Nepal (0.56)	Systematic random (357)	dmft (Unspecified)	64.4%	4.4±3.1	N/A

2

3

Table 1 (continued). Summary of the selected studies

Authors Year [Ref]	Study site (Human Development Index)	Sampling method (sample size)	Diagnosis criteria	Caries prevalence	Caries experience (dmft±SD)	Decayed teeth (dt±SD)
Europe						
Grund et al. 2015 [41]	Ennepe-Ruhr, Germany (0.93)	Multistage (406)	dmft (WHO)	26.2%	0.9±2.0	0.5±1.4
Bissar et al. 2014 [42]	Heidelberg, Germany (0.93)	Multistage (385)	dmft (WHO)	28.6%	N/A	N/A
Monaghan et al. 2014 [43]	Wales, United Kingdom (0.91)	Multistage (7,734)	dmft (BASCD)	41.0%	1.6	N/A
Monaghan et al. 2014 [43]	England, United Kingdom (0.91)	Multistage (133,516)	dmft (BASCD)	27.9%	0.9	N/A
Monaghan et al. 2014 [43]	Scotland, United Kingdom (0.91)	Census (13,232)	dmft (BASCD)	33.0%	1.4	N/A
Ferro et al. 2017[44]	Veneto region, Italy (0.89)	Random selection (728)	dmft (BASCD)	35.2%	1.3±2.6	1.2±2.5
Nobile et al. 2014 [45]	Southern, Italy (0.89)	Two-stage cluster (158)	dmft (WHO)	29.8%	0.9±1.8	0.9±1.7
Ferrazzano et al. 2016 [46]	Campania, Italy (0.89)	Multistage (387)	dmft (Definition)	43.4%	1.4±2.1	1.1±1.7
Tsanidou et al. 2015 [47]	North Eastern, Greece (0.87)	Not reported (317)	dmft (WHO)	64.2%	2.3±2.6	N/A
Middle East						
Al-Meedani et al. 2016 [54]	Riyadh, Saudi Arabia (0.85)	Stratified random (252)	dmft (WHO)	75.0%	N/A	N/A
Abbasoglu et al. 2015 [55]	Turkey (0.77)	Convenient (145)	dmft (Definition)	66.9%	N/A	N/A
Oceania						
Blinkhorn et al. 2015 [57]	New South Wales, Australia (0.94)	Multistage (820)	dmft (Definition)	44.4%	1.7	1.2±0.1
South America						
Abanto et al. 2014 [48]	Brazil (0.75)	Convenient (335)	deft (WHO)	64.8%	N/A	N/A
Carvalho et al. 2014 [49]	Federal District, Brazil (0.75)	Cluster (602)	dmft (Definition)	53.6%	2.1±0.1	N/A
Do Amaral et al. 2014 [50]	Indaiatuba, Brazil (0.75)	Systematic probabilistic (303)	dmft (WHO)	41.6%	1.5	N/A
Scarpelli et al. 2014 [51]	Belo Horizonte, Brazil (0.75)	Multistage (1635)	dmft (WHO)	46.2%	N/A	N/A
Lourenço et al. 2013 [52]	Pacoti, Brazil (0.75)	Census (149)	dmft (Definition)	67.8%	N/A	2.2±2.4
Corrêa-Faria et al. 2013 [53]	Minas Gerais, Brazil (0.75)	Systematic random (134)	dmft (WHO)	62.7%	N/A	N/A

4 dmft= decayed missing and filled primary teeth, deft=decayed, extracted due to caries, filled primary teeth,
5 WHO=World Health Organization, Definition= Diagnosis criteria set by researchers, BASCD= British Association
6 for the Study of Community Dentistry, N/A= not applicable.
7

8 **Table 2** Quality assessment of the selected publications with the modified Newcastle-Ottawa Scale

Authors [Ref]	Study site	Item						Total	Quality
		1	2	3	4	5	6		
Africa									
Elidrissi et al. 2016 [56]	Khartoum State, Sudan	1	1	1	2	2	1	8	Good
Asia									
Chen et al. 2017 [21]	Hong Kong SAR, China	1	1	1	2	2	1	8	Good
Peng et al. 2017 [22]	Hong Kong Island, China	1	1	0	2	2	1	7	Good
Bridges et al. 2014 [23]	Hong Kong Island, China	1	1	0	2	0	1	5	Moderate
Han, et al. 2014 [24]	Ulsan, Korea	1	1	0	2	2	1	7	Good
Lin et al. 2017 [25]	Kaohsiung, Taiwan	1	1	0	2	2	1	8	Good
Yen et al. 2013 [26]	Taichung, Taiwan	1	1	0	2	0	1	5	Moderate
Li et al. 2017 [27]	Xinjiang, China	1	1	1	2	2	1	8	Good
Jiang et al. 2017 [28]	Shandong, China	1	1	0	2	2	1	7	Good
Chen et al. 2014 [29]	Shanghai, China	1	1	1	2	2	1	8	Good
Wulaerhan et al. 2014 [30]	Kashgar, China	1	1	0	2	2	1	7	Good
Krisdapong et al. 2014[31]	Bangkok, Thailand	1	1	1	2	2	1	8	Good
Pattanapom et al. 2013 [32]	Chiang Mai, Thailand	0	1	0	2	0	1	4	Moderate
Adiatman et al. 2016 [33]	Jakarta, Indonesia	1	1	0	2	2	1	7	Good
Kakanur, et al. 2016 [34]	Bengaluru city, India	1	1	0	2	0	1	5	Moderate
Sujlana et al.2015 [35]	Haryana, India	1	1	0	2	0	1	5	Moderate
Gupta et al.2015 [36]	Moradabad, India	1	1	0	2	2	1	7	Good
Gopal et al.2016 [37]	Andhra Pradesh, India	1	1	0	2	2	1	7	Good
Mittal et al.2014 [38]	Gurgaon, India	0	1	0	2	0	1	4	Moderate
Sankeshwari et al. 2014 [39]	Belgaum, India	1	1	0	2	2	1	7	Good
Thapa et al.2015 [40]	Nawalparasi, Nepal	1	1	0	2	0	1	6	Good
Europe									
Grund et al. 2015 [41]	Ennepe-Ruhr, Germany	1	1	0	2	2	1	7	Good
Bissar et al. 2014 [42]	Heidelberg, Germany	1	1	0	2	2	1	7	Good
Monaghan et al.2014 [43]	Great Britain, UK	1	1	0	2	2	0	6	Good
Ferro et al. 2017 [44]	Veneto region, Italy	1	1	1	2	2	1	8	Good
Nobile et al. 2014 [45]	Southern, Italy	1	1	0	2	2	1	7	Good
Ferrazzano et al. 2016 [46]	Campania, Italy	1	1	0	1	2	1	6	Good
Tsanidou et al. 2015 [47]	North Eastern, Greece	0	1	0	2	2	1	6	Good
Middle East									
Al-Meedani et al.2016 [54]	Riyadh, Saudi Arabia	1	1	0	2	2	1	7	Good
Abbasoglu et al. 2015 [55]	Turkey	0	1	0	1	0	1	3	Moderate
Oceania									
Blinkhom et al. 2015 [57]	NSW, Australia	1	1	0	1	2	1	6	Good
South America									
Abanto et al. 2014 [48]	Brazil	0	1	0	2	2	1	6	Good
Carvalho et al. 2014 [49]	Federal District, Brazil	1	1	0	1	2	1	6	Good
Do Amaral et al. 2014 [50]	Indaiatuba, Brazil	1	1	0	1	2	1	6	Good
Scarpelli et al. 2014 [51]	Belo Horizonte, Brazil	1	1	1	2	2	1	8	Good
Lourenço et al. 2013 [52]	Pacoti, Brazil	1	1	0	1	2	0	5	Moderate
Corrêa-Faria et al. 2013 [53]	Minas Gerais, Brazil	1	1	0	2	2	1	7	Good

9 Item 1 – Representativeness, Item 2 - Sample size, Item 3 - Non-respondents, Item 4 - Ascertainment of risk factor (diagnosis),

10 Item 5 - Outcome assess, Item 6 –Statistics.

11

Figure 1. Flowchart of literature search