Caries preventive practices and dental caries among boys aged 6–15 in Saudi Arabia

S.M. Yassin[1], S. Tikare[2], Z.M. AlKahtani[1], F.J. AlFaifi[3], W.S. AlFaifi[3], E. AlFaifi[3], A. Omair[3], K.S. Ravi[1]

1 Department of Paediatric Dentistry and Orthodontic Sciences, College of Dentistry, King Khalid University, Abha, Saudi Arabia
2 Department of Periodontics and Community Dental Sciences, College of Dentistry, King Khalid University, Abha, Saudi Arabia
3 College of Dentistry, King Khalid University, Abha, Saudi Arabia

e-mail: syasen@kku.edu.sa

DOI 10.23804/ejpd.2020.21.02.02

Abstract

Aim The aim of the present study was to assess caries preventive practices and dental caries among boys aged 6–15 in Saudi Arabia.

Materials and Methods The present cross-sectional study included a sampling frame of all male school students aged 6–15 years in a subpopulation of Saudi Arabia. A questionnaire was developed to collect information from mothers on the use of recommended caries preventive practices (RCPP) by the child. Children were examined clinically for dental caries status using DMFT index.

Results A total of 722 children and respective mothers participated in the study. The mean DMFT scores were significantly greater in children with no RCPP than those who used at least a single RCPP and a combination of RCPP ($p<0.05$). Regression analysis revealed that all RCPP were significantly associated with dental caries ($p<0.05$). Children not using any RCPP tool had higher risk of developing dental caries (OR 8.69; 95% CI 6.38–11.83).

Conclusion Brushing teeth at least twice a day, use of fluoridated toothpaste and consumption of sugary snacks less than once a day have significant influence in occurrence of dental caries. Using all RCPP tools were more effective in caries prevention than used individually.

KEYWORDS Preventive dentistry, Oral habits, School children, Logistic regression analysis.

Introduction

Dental caries is defined as a chronic, infectious disease caused by bacterial by-products that dissolve the enamel surface of teeth. The aetiological triad for dental caries includes: a susceptible tooth surface, specific bacteria in dental plaque (e.g., Streptococcus mutans, Lactobacillus) and a diet rich in fermentable carbohydrates, particularly sugars [Frazao, 2004]. Specific bacteria in the dental plaque can penetrate the tooth layers to infect the inner pulp tissue, causing excruciating pain and possibly resulting in pulpal necrosis, tooth loss and may even lead to systemic infection. If favourable lifestyle, practices related to oral hygiene and diet are neglected even for a period as short as a few weeks, it may lead to dental caries [Harris, 2004]. Dental caries not only affects oral health but the quality of life too. Oral pain arising from dental caries may affect speech, eating, sleeping, swallowing, and breathing [Paglia, 2019]. Dental caries, especially in the front teeth, may compromise self-image, self-esteem, and social acceptance [Lawrence and Leake, 2001].

Dental caries is a significant public health problem worldwide. According to a global study report of 2016, dental caries in permanent teeth ranks first (2.3 billion people), and twelfth in deciduous teeth (560 million children) among 310 various diseases and injuries studied [GBD 2015 Disease and Injury Incidence and Prevalence Collaborators, 2016]. Dental caries not only occurs in children and adolescents but can affect at all ages [Featherstone, 2004]. Dental caries could be professionally managed by treatment procedures ranging from simple restorations to pulp therapies and tooth extraction followed by prosthetic replacement. While dental treatments are costly, a high prevalence of dental caries would mean a substantial economic burden to society. A budget of US$ 1,618 to 3,513 per 1000 children has been estimated to treat dental caries in high-income countries, which may exceed available resources for the provision of essential health care packages for children in most low-income countries [Masood et al., 2015]. Aepidemiological studies have shown decreasing caries prevalence, especially in developed countries. This declining trend could be due to oral health preventive and promotive measures, including water fluoridation programmes, oral health education, use of fluoride toothpaste, a healthier diet containing sucrose substitutes [Marthaler, 2004].

The World Health Organization (WHO) has been emphasising more on oral health prevention since combating dental caries through curative and therapeutic approaches would be costly

in many countries [Hobdell et al., 2003]. Prevention of dental caries is aimed at modifying all aetiological factors for which oral health-related behaviour and practice play a significant role. Even specific caries preventive measure may fail if compliance with oral hygiene instruction and healthy habits are poor [Nyvad, 2003]. The link between the amount of sugar intake and caries severity is well established [Peres et al., 2016]. WHO suggests that a free sugar intake of less than 5% to 10% of total energy intake could minimise the risk of dental caries throughout the life course of an individual [Moynihan, 2016]. Various forms of fluoride have shown to reduce the risk of caries. Regular use of fluoridated toothpaste increases the demineralisation threshold as compared to use of fluoride-free toothpaste [Duggal et al., 2001]. Recommended Oral Self-Care (ROSC) are an aggregate of crucial oral health practices including brushing teeth at least twice a day, exclusive or almost exclusive use of fluoridated toothpaste, and consumption of sugary snacks between main meals less than once a day [Folayan, 2016]. Such oral health practices among the population are quintessential in areas of high caries prevalence.

A population-based review conducted in Saudi Arabia has shown a high prevalence of dental caries among school-children [Al Agili, 2013]. An increase in the prevalence of dental caries in the past few decades is a subject of concern [Lagerweij and Van Loveren, 2015]. This inclining trend of dental caries is attributed to changing lifestyles among the Saudi population [Alhabdan et al., 2018]. Studies in the past have focused on either individual or limited oral health behaviour or practices with caries prevalence in Saudi Arabia [Ashi et al., 2017; Quadri et al., 2018]. There is a lack of research concerning the use of recommended caries preventive practices (RCPP) and its association with dental caries among the Saudi population. The objective of the present study was to assess caries preventive practices and dental caries among boys aged 6–15 years in Saudi Arabia.

Materials and methods

Study design and population

The present cross-sectional study included a sampling frame of all male school students aged 6–15 years in a subpopulation of Saudi Arabia. Only male children were included in this study due to cultural and administrative issues in Saudi Arabia. Following ethical approval from the Institutional Review Board (SRC/ETH/2016-17/048), a cluster random sampling strategy was used to include children and, later, their respective parents/guardians for the study. The list of schools in Asir province was obtained from the Ministry of Education, Saudi Arabia. A total of 4 public schools (two urban and two rural) were randomly selected. Permissions were obtained from the heads of schools after explaining the purpose of the study. All children from selected schools were included, and arrangements were made for interaction with respective mothers. Informed consent was obtained from mothers for both personal interview and clinical oral examination of children.

Data collection and analysis

A questionnaire was developed to collect information on use of recommended caries preventive tools by the child which included: brushing more than once a day, use of fluoridated toothpaste, eating sugary snacks less than once per day in between meals and utilisation of professional preventive dental services like fissure sealants and topical fluorides. The responses for each practice was recorded dichotomous as either Yes or No. Categories were made based on whether children used all RCPP, individual, or a combination of two RCPP tools. The items in the questionnaire were checked for face validity by subject experts who were not participating in the research and also translated into Arabic by a language expert. The investigators enumerated the questionnaire items to the parents, and responses were recorded. Following the questionnaire interview with parents/guardians, respective children were screened for Decayed, Missing, and Filled Teeth (DMFT) using the Oral Health Assessment Form for Children, of the World Health Organization [World Health Organization, 2013]. The clinical examinations were conducted under natural lighting conditions with disposable diagnostic kits as per international standards for infection control. Three examiners were trained and calibrated for recording DMFT scores with 20 children (Cronbach's alpha = 0.949). The collected data were entered into the computer using Microsoft Excel and statistically analysed using STATA Version 9.2.

Results

A total of 722 children participated in the study. Table 1 shows the distribution of dental caries by age. The prevalence of dental caries was found to be 93.49%. Only 59 (8%) children used all RCPP tools, and 273 (32%) did not use any RCPP tools (Table 2). Chi-square analysis showed dental caries to be significantly associated with RCPP, namely frequency of toothbrushing (twice or more per day), use of fluoridated toothpaste and previous history of professional topical fluoride application and fissure sealants ($p<0.05$) (Table 3). The mean DMFT scores were significantly higher in children with no RCPP than compared to those who used at least a single RCPP and other combinations of RCPP ($p<0.05$) (Table 4).

Multiple logistic regression analysis revealed that all RCPP were significantly associated with dental caries ($p<0.05$) (Table 5). However, only the professional application of topical fluoride and fissure sealant was found to be significantly associated when adjusted for other variables. The practice of not at least brushing twice a day had the highest risk among all RCPP tools (OR 110.5; 95% CI 41.29-295.72).

As compared to children from rural places, children from urban cities had more chance of developing dental caries (OR 12.68; 95% CI 9.12-17.65). Children not using any RCPP tools had a higher risk of developing dental caries (OR 8.69; 95% CI 6.38-11.83). The ROC curve with RCPP as a predictor for dental caries showed an area under the curve of 87.65% (Fig. 1).

Discussion

The present study was conducted to assess the use of recommended caries preventive practices and dental caries among boys aged 6–15 years in Saudi Arabia. Studies in the past have found a high prevalence of dental caries in Saudi Arabian children. The present study highlights the impact of self-care preventive measures on caries prevalence.

In our study, almost all of the 37.81% of children who had not used any RCPP had dental caries (99.27%). Such an observation could be understood as an obvious consequence

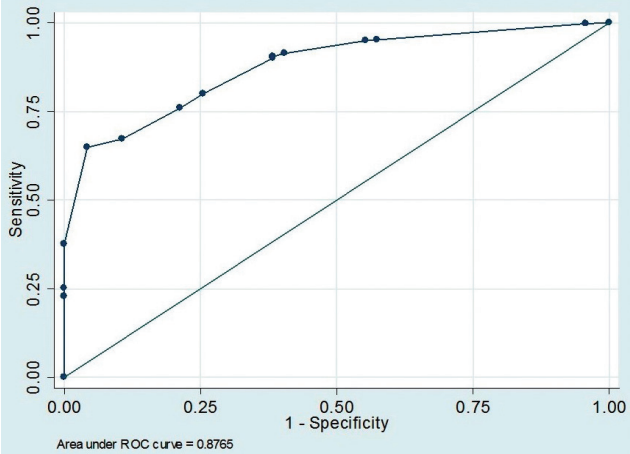

FIG 1 ROC curve with RCPP as a predictor for dental caries.

Age (years)	Caries		Caries-Free		Total	
	N	%	N	%	N	%
6	10	100.00	0	0.00	10	1.39
7	57	91.94	5	8.06	62	8.59
8	86	89.58	10	10.42	96	13.30
9	80	90.91	8	9.09	88	12.19
10	85	95.51	4	4.49	89	12.33
11	46	95.83	2	4.17	48	6.65
12	86	93.48	6	6.52	92	12.74
13	70	94.59	4	5.41	74	10.25
14	105	96.33	4	3.67	109	15.10
15	50	92.59	4	7.41	54	7.48
Total	675	93.49	47	6.51	722	100.00
Chi-square=7.0005 P = 0.6371						

**Statistically significant at 5% level of significance*

TABLE 1 Distribution of dental caries by age.

of negligence in preventive practices: 8.17% of children that used all RCPP tools had lower caries prevalence than those who did not (72.88%). Surprisingly, all children who used a single RCPP tool (fluoridated toothpaste/consumption of sugar less than once a day/toothbrushing twice or more a day) had dental caries (100%). Among children using a combination of RCPP tools had caries prevalence ranging from 78.57% to 91.96%. Very few children in our study had used professional therapies like topical fluorides (1.11%) and fissure sealants (3.05%) as RCPP tools. Even with professional caries preventive services, a high caries prevalence ranging from 62.5% to 95.4% was observed. It is interesting to note the overall high caries prevalence among our study children in spite of using RCPP tools. A careful insight into our results reveals that the DMFT index scores were inversely proportional to the number of RCPP tools used i.e., the dental caries count was highest in children using no RCPP tools and lowest in children using all RCPP tools. Prevalence values are not sensitive to such fluctuations in DMFT and within DMFT component scores and yields inflated results. It should be understood that RCPP tools have a profound impact in the reduction of dental caries. The mean filled teeth (F.T.) scores (0.5±1.3) were extremely lower as compared to decayed teeth (D.T.) scores (6.23±4.47) which clearly shows under-utilisation of dental services in spite of free medical and dental public health services in Saudi Arabia.

The role of sugars in dental caries had been extensively studied. Sucrose among other monosaccharaides was

Categories	Caries (N)	%	Caries Free (N)	%	Total	%
1=No RCPP	271	99.27	2	0.73	273	37.81
5=Used all 4 RCPP	43	72.88	16	27.12	59	8.17
2a=Fluoridated toothpaste	62	100.00	0	0.00	62	8.59
2b=Sugar <1	15	100.00	0	0.00	15	2.08
2c=Twice or more toothbrushing	74	100.00	0	0.00	74	10.25
3a=Fluoridated toothpaste+sugar<1	103	91.96	9	8.04	112	15.51
3b=Fluoridated toothpaste+twice toothbrushing	59	85.51	10	14.49	69	9.56
3c=Twice toothbrushing+ sugar<1	22	78.57	6	21.43	28	3.88
4a=Topical fluoride	5	62.50	3	37.50	8	1.11
4b=Sealants	21	95.45	1	4.55	22	3.05
Total	675	93.49	47	6.51	722	100.0
Chi-square=94.6782 P = 0.0001*						

**Statistically significant at 5% level of significance*

TABLE 2 Caries experience by Recommended Caries Preventive Practices (RCPP).

Factors	Caries	%	Caries Free	%	Total	%
Location						
Urban	482	92.69	38	7.31	520	72.02
Rural	193	95.54	9	4.46	202	27.98
Chi-square= 1.9452 P = 0.1631						
RCPP						
No	391	89.68	45	10.32	436	60.39
Yes	284	99.30	2	0.70	286	39.61
Chi-square= 26.2721 p=0.0001*						
Fluoridated toothpaste						
No	288	98.63	4	1.37	292	40.44
Yes	387	90.00	43	10.00	430	59.56
Chi-square=21.2821		p=0.0001*				
Sugar <1 per day						
No	487	94.02	31	5.98	518	71.75
Yes	188	92.16	16	7.84	204	28.25
Chi-square=0.8311		p=0.3620				
Toothbrushing 2 or >2						
No	442	99.10	4	0.90	446	61.77
Yes	233	84.42	43	15.58	276	38.23
Chi-square=60.3952 p=0.0001*						
Topical Fl and Sealants						
No	601	97.09	18	2.91	619	85.73
Yes	74	71.84	29	28.16	103	14.27
Chi-square= 92.4914 p=0.0001*						
Total	675	93.49	47	6.51	722	100.00

**Statistically significant at 5% level of significance*

TABLE 3 Association between dental caries with Recommended Caries Preventive Practices (RCPP) factors.

Categories	DT		MT		FT		DMFT	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1=No RCPP	10.29	3.76	0.61	1.34	0.56	1.61	11.24	4.63
5=Used all 4 RCPP	1.68	2.39	0.00	0.00	0.47	1.30	2.15	3.02
2a=Fluoridated toothpaste	5.06	1.86	0.32	0.72	0.08	0.27	5.10	2.30
2b=Sugar <1	9.00	2.73	0.07	0.26	0.73	1.62	9.80	2.76
2c=Twice or more toothbrushing	5.54	2.18	0.08	0.32	1.04	1.16	6.61	2.67
3a=Fluoridated toothpaste+ sugar<1	3.53	2.19	0.50	1.22	0.17	0.57	4.20	2.68
3b=Fluoridated toothpaste+twice toothbrushing	2.55	2.23	0.13	0.64	0.10	0.46	2.78	2.48
3c=Twice toothbrushing+ sugar<1	2.46	2.13	0.07	0.38	0.25	0.70	2.79	2.54
4a=Topical fluoride	2.63	2.45	0.00	0.00	0.50	1.41	3.13	3.09
4b=Sealants	3.09	2.04	0.18	0.85	2.18	1.94	5.45	3.83
Total	6.23	4.47	0.37	1.04	0.50	1.30	6.97	5.06
F-value	111.8038		4.5095		8.7170		82.1384	
P-value	0.0001*		0.0001*		0.0001*		0.0001*	

**Statistically significant at 5% level of significance*

TABLE 4 Comparison of Recommended Caries Preventive Practices (RCPP) with mean DMFT scores by one way ANOVA.

Factors	With caries	%	Unadjusted OR	95% CI OR		p-value	Adjusted OR	95% CI OR		p-value
				Lower	Upper			Lower	Upper	
Location										
Rural	482	92.69			Ref.				Ref.	
Urban	193	95.54	12.68	9.12	17.65	0.0001*	1.55	0.72	3.36	0.2670
RCPP										
No	391	89.68	8.69	6.38	11.83	0.0001*	1.51	0.64	3.55	0.3430
Yes	284	99.30			Ref.				Ref.	
Fluoridated toothpaste										
No	288	98.63	72.00	26.84	193.14	0.0001*	-	-	-	-
Yes	387	90.00			Ref.				Ref.	
Sugar <1 per day										
No	487	94.02	15.71	10.93	22.59	0.0001*	0.80	0.40	1.58	0.5130
Yes	188	92.16			Ref.					
Tooth brushing 2 or >2										
No	442	99.10	110.5	41.29	295.72	0.0001*	-	-	-	-
Yes	233	84.42			Ref.				Ref.	
Topical fl and sealants										
No	601	97.09	33.39	20.89	53.36	0.0001*	6.71	3.36	13.40	0.0001*
Yes	74	71.84			Ref.				Ref.	
Total	675	93.49								

Statistically significant at 5% level of significance

TABLE 5 Multiple Logistic Regression Analysis with dental caries as dependent variable.

considered as "arch criminal" of dental caries [Newbrun, 1967]. Later research findings have suggested that cariogenic potential of other monosaccharides is comparable with sucrose [Cury JA, et al., 2000]. Sugars are involved in biofilm synthesis and could be quickly metabolized by the bacteria to form acids as by-products leading to demineralization of tooth structures [Nishimura, 2012]. Sugar intake in children has been proved a strong factor in dental caries [Goldenfum GM et. al., 2019]. World Health Organization emphasises on reduction in the total amount of sugar consumption to less than 5% to 10% of total energy intake per day. Recent research suggests that personal dietary goals to minimise caries risk should be more focused on reducing frequency than the amount [van Loveren, 2019]. Similar to other research findings, our study did not highlight any significant association between frequency of sugar consumption alone and the occurrence of dental caries [Folayan et al., 2016]. It is interesting to note that sugar consumption less than once per day combined with use of fluoridated toothpaste had significantly lower DMFT scores than when both preventive tools were used independently. However, it is imperative to include diet counselling emphasizing a reduction in consumption of sugars in oral health education programmes.

Toothbrushing is one of the primary measures for the maintenance of oral health. A critical factor to be considered though is toothbrushing frequency. Several studies have established the association of periodontal diseases with infrequent toothbrushing habits [Zimmermann, 2015]. Brushing twice or more a day could be standard practice in the recent times. A combination of regular tooth-brushing with fluoride and reduced sugar intake have shown to be effective in preventing dental caries among young children [Tickle et al., 2016]. A recent systematic review and meta-analysis revealed higher incidence of caries among self-reported infrequent brushers than frequent brushers (OR, 1.50; 95% CI, 1.34 to 1.69) and those brushing less than 2 times a day than more than 2 times a day (OR: 1.45; 95% CI: 1.21 to 1.74). Similarly, our study results showed that not brushing at least twice daily had a higher caries risk with an unadjusted OR of 110.5. DMFT scores in the present study were significantly lower in children with brushing habit twice or more daily (6.61±2.67) alone as RCPP or in combination with the use of fluoridated toothpaste (2.78±2.48) and restricted sugar intake of less than once per day (2.79±2.54) than those who did not use any RCPP tools (11.24±4.63). It can be observed that though toothbrushing frequency itself is an effective caries preventive tool, using more than one RCPP had a larger impact in caries prevention. A sizable number (37.8%) of children in our study did not practice any of the RCPP tools, which calls for immediate public health attention.

Fluorides remain the most effective measure against dental caries. Professional topical fluorides and pit and fissure sealants make caries preventive approach more holistic. Based on scientific evidence, the American Academy of Pediatric Dentistry states that use of topical fluorides is both safe and highly effective in reducing dental caries prevalence [American Academy of Pediatric Dentistry, 2008]. The use of pit and fissure resin sealants prevents occlusal caries by forming a mechanical

barrier and blocks entry of food and microorganisms into the narrow pits and crevices. A recent systematic review suggests that use of fissure sealants can reduce dental caries by 11%–51% as compared to no sealants [Ahovuo-Saloranta et al., 2017]. A very meager fraction (4.15%) out of the total subjects in our study sought professional therapies like pit and fissure sealants and topical fluorides. Using professional preventive services was the only preventive tool to have a significant association with dental caries when multiple regression model was adjusted with all other factors. Children not seeking professional preventive services were found to have a 6.71 times higher risk of developing dental caries than those who did not use such services. Education level of parents has been associated with dental caries [Giugliano et al., 2018]. Awareness regarding professional caries preventive services among parents needs to be promoted.

The present study is not an exception to limitations. The study population consisted of only male children from a suburban region in Saudi Arabia. The school system in the entire Saudi Arabia is such that female children have exclusive schools with female teachers and administrative staff. Male members of society are not allowed within female school campuses due to local regulations. The included sample children had a wide age range with variations in their snacking and dietary habits. Dietary factors other than sugar intake and several other preventive factors like use of oral hygiene aids (mouth rinse, dental floss) were not considered in this study. The outcomes of the review cannot be generalised to the entire Saudi Arabia. However, despite limitations, our study was successful in emphasising the potential effect that the use of RCPP tool may have on the development of dental caries. Yet, results draw attention during public health education for children in this community for promoting the use of all RCPP tools. Future research covering female counterparts of the population with additional dietary and behavioural factors is required.

Conclusions

Single or combined use of caries preventive practice tools was significantly associated with dental caries. Children with no caries preventive practices were found to have a high risk of dental caries. Caries-preventive practices could be used as an effective caries preventive tool. A comprehensive oral health education programme focusing on prevention of dental caries targeting both children and parents is need-of-the-hour in Saudi Arabian sub-population.

References

- Ahovuo-Saloranta A, Forss H, Walsh T, Nordblad A, Mäkelä M, Worthington HV. Pit and fissure sealants for preventing dental decay in permanent teeth. Cochrane Database Syst Rev 2017; 7(7): CD001830.
- Al Agili DE. A systematic review of population-based dental caries studies among children in Saudi Arabia. Saudi Dent J 2013; 25(1): 3-11.
- Alhabdan YA, Albeshr AG, Yenugadhati N, Jradi H. Prevalence of dental caries and associated factors among primary school children: a population-based cross-sectional study in Riyadh, Saudi Arabia. Environ Health Prev Med 2018; 23(1): 60.
- American Academy on Pediatric Dentistry Council on Clinical Affairs. Guideline on fluoride therapy. Pediatr Dent 2008; 30 (7): 121-124.
- Ashi H, Campus G, Bertéus Forslund H, Hafiz W, Ahmed N, Lingström P. The Influence of Sweet Taste Perception on Dietary Intake in Relation to Dental Caries and BMI in Saudi Arabian Schoolchildren. Int J Dent 2017; (4262053): 1-8.
- Cury JA, Rebello MAB, Del Bel Cury AA, Derbyshire MTVC, Tabchoury CPM. Biochemical composition and cariogenicity of dental plaque formed in the presence of sucrose or glucose and fructose. Caries Res. 2000; 34: 491-497.
- Duggal MS, Toumba KJ, Amaechi BT, Kowash MB, Higham SM. Enamel demineralization in situ with various frequencies of carbohydrate consumption with and without fluoride toothpaste. J Dent Res 2001; 80(8): 1721-1724.
- Featherstone JD. The continuum of dental caries--evidence for a dynamic disease process. J Dent Res 2004; 83 (Spec No C): C39-42.
- Folayan MO, Kolawole KA, Chukwumah NM, Oyedele T, Agbaje HO, Onyejaka N,Oziegbe EO, Oshomoji OV. Use of caries prevention tools and associated caries risk in a suburban population of children in Nigeria. Eur Arch Paediatr Dent 2016; 17(3): 187-193.
- Frazao P. Epidemiology of dental caries: when structure and context matter. Braz Oral Res 2012; 26(1): 108-114.
- GBD 2015 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016; 388: 1545-1602.
- Giugliano D, d'Apuzzo F, Majorana A, Campus G, Nucci F, Flores-Mir C, Perillo L. Influence of occlusal characteristics, food intake and oral hygiene habits on dental caries in adolescents: a cross-sectional study. Eur J Paediatr Dent 2018 Jun;19(2):95-100.
- Goldenfum GM, Silva NC, Almeida IA, Moura MS, Silva BB, Jardim JJ, Rodrigues JA. Risk indicators of caries lesion activity in children. Eur J Paediatr Dent 2019 Sep;20(3):179-182.
- Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. Community Dent Health 2004; 21(1): 71-85.
- Hobdell M, Petersen PE, Clarkson J, Johnson N. Global goals for oral health 2020. Int Dent J 2003; 53(5): 285-288.
- Lagerweij MD, van Loveren C. Declining caries trends: are we satisfied? Curr Oral Health Rep 2015; 2(4): 212-217.
- Lawrence HP, Leake JL. The U.S. Surgeon General's report on oral health in America: A Canadian perspective. J Can Dent Assoc 2001; 67(10): 587.
- Marthaler TM. Changes in dental caries 1953-2003. Caries Res 2004; 38 (3): 173-181.
- Masood M, Sheiham A, Bernabé E. Household expenditure for dental care in low and middle income countries. PLoS One 2015; 10(4): e0123075.
- Moynihan P. Sugars and Dental Caries: Evidence for setting a recommended threshold for intake. Adv Nutr 2016; 7(1): 149-156.
- Newbrun E. Sucrose, the arch criminal of dental caries. Odontol Revy 1967; 18(4): 373-386.
- Nishimura J, Saito T, Yoneyama H, Bai LL, Okumura K, Isogai E. Biofilm Formation by Streptococcus mutans and Related Bacteria. Advances in Microbiology 2012; 29(3): 208-215.
- Nyvad B, Fejerskov O, Kidd EAM: The role of oral hygiene; in Fejerskov O, Kidd EAM (eds): Dental caries, the disease and clinical management. Oxford, Blackwell: Munksgaard; 2003. p 171–176.
- Paglia L, Friuli S, Colombo S, Paglia M. The effect of added sugars on children's health outcomes: Obesity, Obstructive Sleep Apnea Syndrome (OSAS), Attention-Deficit/Hyperactivity Disorder (ADHD) and Chronic Diseases. Eur J Paediatr Dent 2019 Jun;20(2):127-132.
- Peres MA, Sheiham A, Liu P, Demarco FF, Silva AE, Assunçao MC, Menezes AM, Barros FC, Peres KG. Sugar consumption and changes in dental caries from childhood to adolescence. J Dent Res 2016; 95(4): 388-394.
- Quadri MFA, Shubayr MA, Hattan AH, Wafi SA, Jafer AH. Oral Hygiene Practices among Saudi Arabian Children and Its Relation to Their Dental Caries Status. Int J Dent 2018; 3234970: 1-6.
- Tickle M, O'Neill C, Donaldson M, Birch S, Noble S, Killough S, et al. A randomised controlled trial to measure the effects and costs of a dental caries prevention regime for young children attending primary care dental services: the Northern Ireland Caries Prevention in Practice (NIC-PIP) trial. Health Technol Assess 2016; 20(71): 1–96.
- Van Loveren C. Sugar restriction for caries prevention: amount and frequency. Which Is More Important?. Caries Res 2019; 53(2): 168-175.
- World Health Organization. Oral health surveys: basic methods. 5th ed. France: WHO Library Cataloguing 2013; 36-37.
- Zimmermann, H, Zimmermann, N, Hagenfeld, D, Veile, A, Kim, T-S, Becher, H. Is frequency of toothbrushing a risk factor for periodontitis? A systematic review and meta-analysis. Community Dent Oral Epidemiol 2015; 43: 116–127.