ORIGINAL ARTICLE

The Prevalence, Severity and Pattern of First Permanent Molars' Dental Caries in Children Attending A Postgraduate Dental Hospital: A Retrospective Study

Mariam N. Al Mansour, Manal Al Halabi, Iyad Hussein, Anas Salami, Amar H. Khamis, Mawlood Kowash

Hamdan Bin Mohammed College of Dental Medicine, Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai, United Arab Emirates

ABSTRACT

Introduction: First permanent molars (FPMs) erupt early and their anatomy and location leave them susceptible to dental caries. This study aimed to retrospectively determine the prevalence, severity and pattern of dental caries of FPMs and investigate their relationship if any with demographics and medical health status of the partcipants. **Methods:** This was a retrospective cross-sectional study. A sample of the digital case notes and radiographs of children aged 5 to 12 years who attended the only postgraduate dental hospital in Dubai were accessed. The recorded data included the children's demographic variables and the carious status of each FPM as recorded in the notes on the initial assessment. Descriptive and statistical analyses were conducted (P<0.05). **Results:** A total of 2984 FPMs were obtained from the digital records of 774 children. Their mean age was 8.07 (±2.23) years and only those that met the inclusion criteria were included in the study. The prevalence of dental caries and mean Decayed Missing Filled Surfaces of FPMs, were 42% and 0.3 (±0.04), respectively. The most prevalent decayed surface was the occlusal (29.2%), followed by mesial, buccal, palatal/ lingual, distal surfaces (24.2 %; 6.6 %; 3.1 %; 2.3 %) respectively. Children with medical problems and/or special needs had a significantly higher level of caries in the buccal surfaces (12.3%) (P=0.042). **Conclusion:** Caries of FPMs in a sample of Dubai children studied was prevalent, especially in those with special healthcare needs, thus indicating a necessity for targeted prevention and treatment focused on these keystone teeth.
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Keywords: Dental caries, first permanent molar (FPM), DMFS index, pattern of dental caries, Dubai.

Corresponding Author:
Mawlood Kowash, PhD
Email: mawlood.kowash@mbru.ac.ae
Tel: +971 50 5939004

INTRODUCTION

Dental caries is childhood's most prevalent chronic infectious disease (1, 2). The condition is associated with tooth pain, discomfort, eating impairment, loss of the tooth, and possible delay in language development (3). Dental caries occurs in different teeth sites at different rates, with occlusal surfaces being more susceptible than the proximal and smooth surfaces (4). If caries spreads to the dental pulp, it can result in sepsis and infection, leading to critical systemic consequences and even tooth loss (5). Socio-demographic and behavioual factors tend to elevate the risk of dental caries within the population. These factors include age, sex, poor oral hygiene, inappropriate tooth brushing behaviour, consumption of sugar-containing drinks, and presence of plaque (6). Despite prevention efforts, dental caries continues to be a frequently-occurring disorder. Therefore, in addition to emphasizing its prevention, it is important to diagnose and intervene during the early stages of the disease (7).

First permanent molars (FPMs) are instrumental in establishing occlusion and are perceived as very critical teeth. Primarily, FPMs determine the vertical distance between the lower and upper jaws, aesthetic proportions and occlusal height, which would significantly impact the teeth erupting later (8). Early removal of these teeth may lead to tilting and rotation of adjacent permanent teeth to hollow spaces, a shift in dental occlusion and midline and unilateral chewing. Further, FPMs are extremely vital in children in terms of mastication (9) and erupting at the age of 6 or 7 years (10). Due to this early eruption, FPMs are faced with challenges from the external environment such as acids and microorganisms at an early stage (11). Most of the caries among children occurs in fissures and pits. Fissures and pits are highly susceptible to caries since their anatomy attracts the accumulation of plaque. When these irregularities are

sealed, they become less morphologically susceptible (12).

Knowledge about the most affected teeth and surfaces can contribute to the design of preventive clinical plans and community-based programs. In this way, resources can be targeted to teeth and surfaces that are at high risk (13). In addition to other conditions such as molar hypomineralisation (MH), caries leads to early breakdown of the FPM (14). As such, managing the FPM becomes a challenge to dentists worldwide (15).

An updated Cochrane review evaluated the relative effectiveness of dental sealants and fluoride varnishes as important preventative options against dental caries. However, low-quality evidence suggested that there was low superiority of one over the other for preventing the occlusal decay in permanent molars (16). They also reported that whilst effective, fluoride varnish and sealant applications are costly procedures that are only efficient when carefully selected for individual children and teeth.

The same review (16) highlighted the importance of maintain optimal oral hygiene as brushing can remove dental plaque and brushing teeth twice a day with the appropriate method and fluoride toothpaste is considered the most acceptable and effective caries prevention method. Fermentable carbohydrate provides the energy and nutrition for the proliferation of bacteria, which is the most fundamental factor leading to dental caries. Limiting sugars to 5% of energy intake and reducing the number of sugary snacks can minimize the risk of dental caries (17). Systemic fluoride is traditionally found to be effective against dental decay. Higher-levels of fluoride in drinking water (≥ 0.7 ppm vs < 0.7 ppm) were associated with lower dental caries experience in all surface of permanent teeth (18).

Data about the prevalence of caries in FPMs is fragmented and global prevalence data is unavailable (19). Statistics from the World Health Organization (WHO) for decayed, missing, and filled teeth (DMFT) indicated a mean DMFT of 3.0 per child in the year 2000 and no more than 1.0 per child in 2010 for those aged 12 years (11). Using the WHO criteria, the prevalence of dental caries in the United Arab Emirates (UAE) in permanent teeth of 12-year-olds was found to be 54%; the mean DMFT (number of decayed, missing, or filled permanent teeth) per child was 1.6. The prevalence of dental caries in 15 year-olds was 65%, with a mean DMFT of 2.5 (20). In the Emirate of Dubai, to our knowledge, no studies have been conducted to assess the severity and pattern of dental caries in FPMs. Thus, this study aimed to examine the pattern and severity of caries in FPMs among patients who attended the only postgraduate dental hospital in Dubai and additionally explore the relationship with factors such as age, gender, nationality and medical health.

MATERIALS AND METHODS

Study Design and Population
The target population for this study was 5 to 12-year-old school children who attended the Paediatric Dentistry Department at the postgraduate dental hospital in the UAE during a four-year period from June 1st, 2016 until February 29th, 2020. The design of this retrospective cross-sectional study followed the guidelines published in the 'Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement' (21).

Data collection and quality assurance
Data were collected by accessing patient digital clinical records and radiographic images as stored in the hospital's records system, Dental4Windows® (D4W®). Only data from the initial visit for included children were collected for use. Processing was performed by the principal investigator (MA) and an assessor (AA). To assess the reproducibility and consistency of the readings and scoring, each investigator was calibrated by evaluating 13 intraoral bitewing and periapical radiographs, with the Kappa coefficient of 0.806 which was considered outstanding.

Inclusion criteria and exclusion criteria
Inclusion criteria were healthy, special needs and/or medically compromised children aged 5 to 12 years with complete electronic dental records and diagnostically acceptable radiographic image(s) of one or more FPMs. The subjects attended the Dental Hospital due to their need for dental treatment or for routine dental check-ups.

Exclusion criteria included children whose dental records indicated the presence of orthodontic bands, space maintainers, pits/fissure sealants, stainless steel crowns on the FPMs and those with dentofacial deformities and/or dental anomalies (e.g. molar hypomineralisation, amelogenesis imperfecta and dentinogenesis imperfecta). Children whose dental records did not include radiographic images or had poor quality radiographs and those patients who had unerupted FPMs were also excluded from the study. Additionally, all patient records registered with the previously used and outdated system (Dentimax®) were excluded because of difficulty accessing the files and retrieving the radiographs.

Sample Size
A total coverage convenient sample of all 5-12-year-old children's electronic case records were initially accessed (n= 1366) between June 1st 2016 - February 29th 2020. The number of cases notes that met the inclusion criteria was 774.

Patient demographics
Demographic characteristics collected included Age (number of years), Gender (Male or Female), Nationality

(from the UAE or other countries) and General Health (healthy, special needs and/or medically compromised).

DMFS Index of FPMs
DMFS of FPMs were recorded from the included patient clinical records and charted using the WHO criteria (22) as outlined below:
- No tooth surface should be recorded more than once, either decayed or filled teeth.
- Only cavitated surfaces due to caries were considered carious but not the demineralised surfaces.
- Filled teeth surfaces with secondary caries should be counted as decayed.
- Teeth missing only due to caries should be counted as missing, as well as those indicated for extraction.
- A tooth surface that is decayed and filled is considered decayed.
- Temporary restorations are considered as decayed.

First permanent molar radiographic caries data
The two calibrated assessors (MM and AA) verified the recorded clinical caries data from the radiographic images [Bitewings (BW), Periapicals (PA), and Orthopantographs (OPG)] in the D4W® (Fig 1). In addition, grading the extent of proximal caries into enamel and dentin was conducted using the available radiographs into the following categories: Grade 1; Radiolucency in the outer half of the enamel, Grade 2; Radiolucency in the inner half of the enamel, Grade 3; Radiolucency in the outer third of the dentine, Grade 4; Radiolucency in the middle third of the dentine, Grade 5; Radiolucency in the inner third of the dentine (23).

Statistical Analysis
Data were analysed using IBM-SPSS for Windows version 28.0 (SPSS Inc., Chicago, IL). The Chi-squared test or Fisher's exact test was used to investigate the associations between categorical data. In addition, the
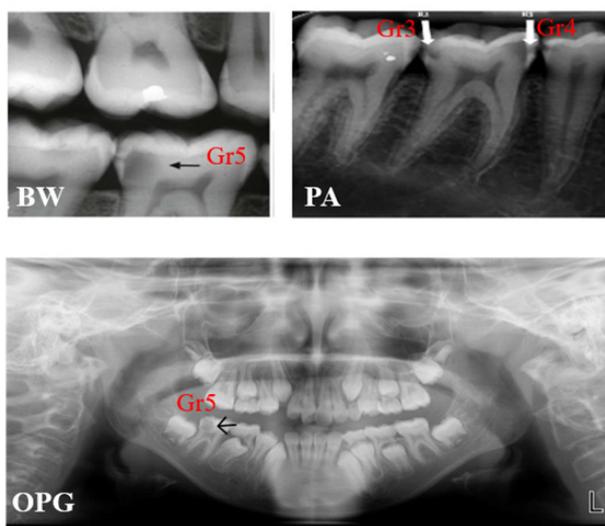

Figure 1: Dental radiographic images showing different stages and extent (grading) of dental caries [Bitewing (BW), Periapical (PA), Orthopantograph (OPG) and Grade (Gr)].

Kolmogorov-Smirnov test was used to test the normality of continuous variables (age, DMFS scores) and the Mann-Whitney test to compare the means between the two groups. Quantitative data were analysed and expressed as mean ± SD. The level of statistical significance was fixed at $P < 0.05$.

Ethical considerations
This retrospective descriptive cross-sectional study was approved by the institutional Research Ethics Review Committee at Mohammed Bin Rashid University of Medicine and Health Sciences (Reference: MBRU-IRB-2020-023, approved on August 25th, 2020). The patients' names were kept anonymous to protect their privacy and confidentiality. This study was conducted in full conformance with principles of the "Declaration of Helsinki" and Good Clinical Practice (GCP).

RESULTS

Demographical characteristics
The total initial sample of children's electronic case records was 1366 of which 592 did not met the inclusion criteria and were excluded. A total of 774 (56.7%) records of children (5 to 12-year-old) were included in the study. The mean age of the study sample was 8.07 (±2.23) years old with 397 (51%) of the children being males. The majority (n=522) were non-UAE nationals (67%). Around 701 (91%) of the children in this sample were healthy and 73 (9%) were special needs and/or medically compromised children.

Radiographical characteristics
Most radiographic images used to verify the recorded caries in FPMs were BWs (88%), after exclusion of any with proximal overlap. The remaining (12%) were OPG and PA radiographs. As for grading the extent of proximal caries (mesial, distal), 146 (4.9%) FPM teeth had caries extended into the outer half of the enamel (Grade 1) in the maxillary right, maxillary left, mandibular left, and mandibular right molars. The radiographical characteristics of participant teeth are summarised in Table I with the grading as previously outlined for Grade 1 and caries extending into the inner half of enamel designated Grade 2, into the outer third of dentine as Grade 3, into the inner third of dentine as Grade 5.

Descriptive statistics of assessed FPMs
From the 774 included children, 2984 FPMs met the inclusion criteria and 112 FPMs were excluded from the study. The below flow-chart shows the total number of FPMs included in the study (Fig 2).

Dental caries of FPMs
A total of 324 (42%) FPMs had dental caries. The most commonly affected surface was the occlusal one. There was no statistically significant association between caries on different surfaces and gender (Table II). The

Table 1: Radiographic characteristics of the study sample

Variables	Tooth 16	Tooth 26	Tooth 36	Tooth 46	Total FPMs
		Type of radiographs N (%)*			
BWs	638 (86.6)	641 (88.8)	657 (87.4)	658(89.4)	2,594 (88.0)
OPGs	92 (12.5)	72 (10)	87 (11.6)	69(9.4)	320 (10.8)
PAs	7 (0.9)	9(1.2)	8(1)	9(1.2)	33 (1.12)
		Grading of proximal caries N (%)*			
None	649 (88.1)	662 (89.6)	695 (92.7)	681 (90.4)	2,687 (90.2)
Grade 1	46 (6.2)	39 (5.3)	27 (3.6)	34 (4.6)	146 (4.9)
Grade 2	22 (3)	21 (2.8)	12 (1.6)	20 (2.7)	75 (2.5)
Grade 3	15 (2)	14 (1.9)	10 (1.3)	10 (1.3)	49 (1.6)
Grade 4	3 (0.4)	1(0.1)	2(0.3)	4(0.5)	10 (0.34)
Grade 5	2 (0.3)	2(0.3)	4(0.5)	4(0.5)	12 (0.4)

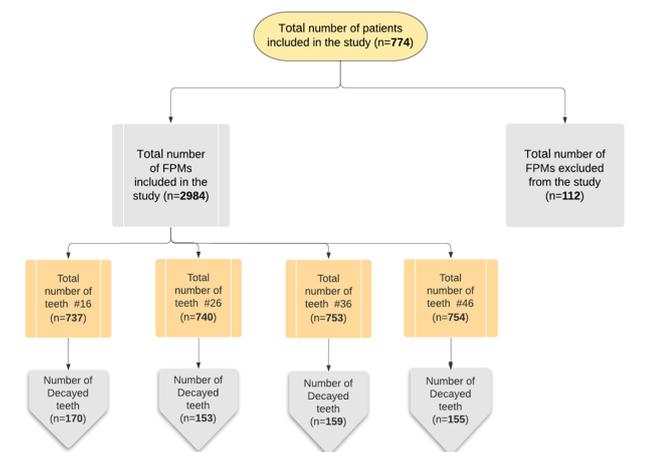* Percentages between parenthesis are rounded and included for comparison

Table II: Association between caries per surface and demographic data

Surface	Occlusal	Mesial	Distal	Buccal	Palatal/Lingual
		Gender N (%)			
M	115 (29)	89 (22.4)	10 (2.5)	22 (5.5)	9 (2.3)
F	114 (30.2)	98 (26)	8 (2.1)	29 (7.7)	15 (4)
p-value	0.397	0.141	0.450	0.144	0.122
		Nationality N (%)			
UAE	72 (28.6)	58 (23)	6 (2.4)	15 (6)	6 (2.4)
Non-UAE	157 (30.1)	129 (24.7)	12 (2.3)	36 (6.9)	18 (3.4)
p-value	0.366	0.366	0.561	0.362	0.287
		Medical Health N (%)			
Healthy	209 (28.9)	174 (24.8)	17 (2.4)	42 (6)	19 (2.7)
Medical issue	20 (27.3)	13 (17.8)	1 (1.4)	9 (12.3)	5 (6.8)
p-value	0.389	0.115	0.481	**0.042***	0.067

*Statistically significant

Figure 2: Flowchart showing the total number of included FPMs
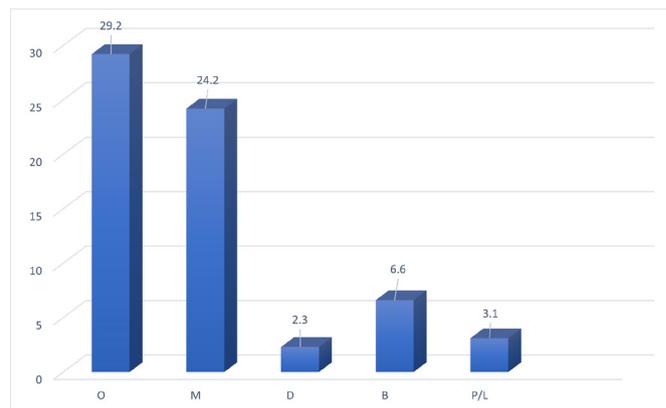
Figure 3: Percentage of caries by surface

Figure 4: The mean of DMFS and per tooth

rate of caries per surface in FPMs was higher in non-UAE nationals, but the difference was not statistically significant. Children with medical health problems and/or special needs had significantly higher buccal carious surfaces 9 (12.3%) compared to healthy individuals 42 (6%) with a p-value of 0.042 (Table II).

The distribution of dental caries in different surfaces among FPMs

In this study, caries was found to be most prevalent on occlusal surfaces (29.2%), followed by mesial (24.2 %), buccal (6.6 %), palatal/ lingual (3.1 %), distal (2.3 %) surfaces (Fig 3).

The mean DMFS of FPMs

The mean DMFS was 0.31 (± 0.04) in the included sample set (Fig 4). All FPMs across different locations had almost the same DMFS; (0.34), (0.31), (0.33), and (0.25) in the maxillary right, maxillary left, mandibular
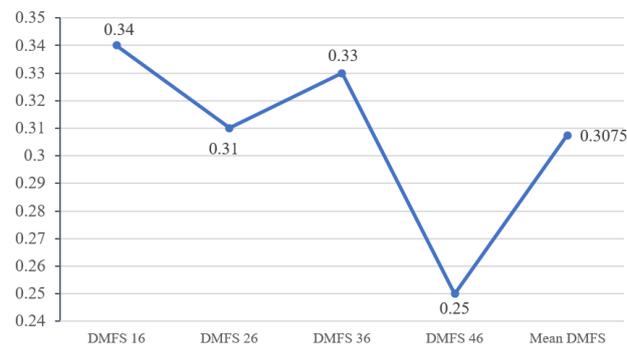
left, and mandibular right molars respectively. There was no statistically significant (p<0.05) association between DMFS per tooth and the gender, nationality, and medical health status of the patient. Table III summarizes the comparison of mean DMFS according to demographic characteristics.

Table III: Relationship of DMFS per tooth with demographic data.

DMFS	DMFS 16	DMFS 26	DMFS 36	DMFS 46
Gender Mean (SD)				
M	0.31 (0.65)	0.30 (0.60)	0.33 (0.62)	0.24 (0.53)
F	0.34 (0.65)	0.32 (0.61)	0.33 (0.60)	0.27 (0.60)
p-value	0.10	0.56	0.81	0.44
Nationality Mean (SD)				
UAE	0.30 (0.60)	0.30 (0.60)	0.33 (0.60)	0.25 (0.60)
Non-UAE	0.35 (0.70)	0.31 (0.61)	0.33 (0.63)	0.25 (0.54)
p-value	0.44	0.60	0.67	0.71
Medical Health Status Mean (SD)				
Healthy	0.34 (0.65)	0.30 (0.60)	0.33 (0.61)	0.25 (0.54)
Medical issue	0.34 (0.66)	0.35 (0.64)	0.33 (0.63)	0.25 (0.59)
p-value	0.76	0.60	0.99	0.61

DISCUSSION

Dental caries in FPMs is a problem faced by dentists worldwide, occasionally necessitating their extraction when it is too late to instigate repair (24). Therefore, assessing FPMs in various populations is important to help target preventative resources. This study attempted to assess the pattern and severity of dental caries in FPMs in patients attending a postgraduate dental hospital in Dubai. Although we cannot extrapolate the results to the whole Dubai population (around 3.5 million). Dubai is a metropolitan city with 85% expatriate population and this is reflected by the results of the study where 67% of sample were records of non-Emirati children. However, since the Dubai Dental Hospital is the only postgraduate dental hospital in the city, it acts as a primary and secondary dental health care centre and as a result treats a significant number of children of different nationalities and different socioeconomic backgrounds. Therefore, this study is of great significance to help quantify the prevalence and severity of these very important teeth, inform the need for specific prevention and treatment strategies for FPM dental caries and promote overall dental health. Furthermore, it is important to develop a better understanding of the size of this problem in our population as this has not been previously investigated.

This is of important relevance to UAE dentists, who in general tend to restore FPMs rather than extract them (14).

The data revealed a high overall prevalence of dental caries of FPMs among 5–12-year-old year old children (42%). When comparing this prevalence to reported prevalence in other countries in the region, it was noted to be relatively lower. A study in Sudan (8) reported a prevalence of 61%, while another study (25) in Abha city, Kingdom of Saudi Arabia (KSA) reported a prevalence of 66.4%. Higher prevalence was also reported by Andegiorgish et al. (26) in Eritrea (78.0%) and Akaji et al. (27) in Nigeria (54.4 %) . Another recent Nigerian study in 2022 reported 71.8% and 28.8% in mandibular and maxillary first molars, respectively in 12-year-olds (28). However, the prevalence in Romania (7) was reported as 25.82%, and in the Zhejiang Province in China the prevalence in urban areas was 24.3%, whilst in rural areas 26.9% (29). All of the reported differences in prevalence could be attributed to sociodemographic factors, different sample sizes, ages, diagnostic criteria, or statistical methods used.

The occlusal surface of FPMs was found to be the most affected surface in this study (29.2 %). This is consistent with the results of a recent study published in 2021 by Que et al. in which the occlusal surface was the site of the greatest number of dental caries incidents in FPMs, followed by the buccal and lingual surfaces (30). These findings are also concurrent with the study conducted by Abuaffan et al. in 2018 (8), who reported that the most frequently decayed site in FPMs was the occlusal surface (43.2%).

These results can possibly be explained by the specific anatomy of occlusal surfaces of molar teeth (pits and fissures), which usually act as stagnation areas for plaque accumulation and are difficult to be washed away by saliva or even with toothbrushing. A study conducted in China by Wang et al. found that the prevalence of medium and deep pits and fissures and medium and severe plaque accumulation in FPMs was 84.6%, and 67.4%, respectively (31). Furthermore, these findings were related to 7 to 8 year old children whom have a high prevalence of dental caries in both deciduous and permanent dentitions. This supports the need for instigating appropriate preventive measures, particularly the use of sealants in children at high risk of tooth decay. Although more independent, these children still require prompting, parental supervision and motivation. Therefore, parents should be educated about their role in providing help, when appropriate, with toothbrushing for some children, depending on risk and capability (32). Brushing the teeth twice per day using toothpaste containing fluoride is regarded the most acceptable and efficient method of avoiding caries as it is vital to remove dental plaque and maintain good oral hygiene. The use of fluoride varnish as a caries prevention measure will

produce prevention results similar to those achieved by using fissures sealants in first permanent molars (33). A recent study by Chizoba et al. recommended interventions such as the sealing of the pits and fissures of molar teeth from the age of 6 years, as well as other evidence-based strategies (28).

The present study excluded FPMs in those children who had dentofacial deformities and/or dental anomalies. However, Wuollet et al. (34) concluded that children's FPMs with Molar-Incisor Hypomineralisation (MIH) were more prone to caries than their peers' FPMs. This fact can be attributed to the raised sensitivity of hypomineralized teeth, in which maintaining proper oral hygiene cannot be achieved, resulting in an increase in caries rates (35). A study conducted by Hussain et al in 2018 reported that the prevalence of MIH in Dubai, UAE was 27.2% (36). The extent to which the enamel structure is complete is the primary cause of increased caries activity. Many oral difficulties are found in people with Amelogenesis Imperfecta and other enamel defects, including sensitivity and aesthetic-related issues, mainly caused by active tooth decay (37). A further example includes children with Cleft Lip/Palate that have been categorized as high caries risk individuals compared to controls (38, 39). Children with medical health problems and/or special needs had significantly higher buccal carious surfaces than healthy children in this study. Although this group was fewer in number (9%) compared to healthy children (91%), this significant finding was not surprising. Individuals with medical health issues and /or special needs are more susceptible to develop dental problems and have a reduced quality of oral health. This is applicable to Dubai; for example, the oral health status among children with Down syndrome (DS) in Dubai was assessed by Ghaith et al. in 2019 where authors concluded that when compared to healthy children, DS children in Dubai had a higher caries rate (40). Also, Al-Raeesi et al. found that children in Dubai, UAE with β-thalassemia major had significantly higher DMFT than healthy controls (41). Among Dubai Cerebral Palsy (CP) children, the prevalence of dental caries in general is 53% (42). Findings indicated that this vulnerable group of patients has a greater need for dental services, with a focus on identifying high caries risk children and implementing the pillars of prevention for them.

The mean DMFS (0.31) in the present study was lower compared to studies conducted in Taiwan (1.46) by Warren et al. (10) and in Sгo Tomй Island, Central Africa (3.54) by Que et al. (30). The majority of our study's proximal caries (mesial, distal) spread throughout the outer third of the enamel (4.9%), followed by caries extending into the inner half of enamel, the outer third of dentine, the inner third of dentine and caries extending into the middle third of dentine in all FPMs teeth. The variations in caries levels between published studies can be attributed to the method of assessment. The CAST index provided more detailed reporting of stages of dental caries, which will be useful for oral health planners compared to the DMF index (43).

The fact that verification of the proximal caries was based on the available radiographs may have affected our study's accuracy of caries detection. The majority of radiographic images that were used to verify the recorded caries in FPMs were BWs (88%) after excluding the ones with overlap. The others were OPG and PA radiographs (10.8%, 1.12%, respectively). Bitewing radiography is the most widely used method for caries detection and has the highest diagnostic accuracy. Detecting dental caries using dental panoramic images is a very challenging task due to the low quality of the image and the ambiguity of decay regions (44).

To the best of the authors' knowledge, the present study was the first study conducted in the UAE and used sound methodology and an appropriate sample size. However, it has some inherent limitations because of its retrospective nature and the data collected being dependent on the accuracy of patient dental records and the quality and type of radiographs. Further research is required to assess a wide range of factors that might affect the prevalence, severity and pattern of dental caries in FPMs, such as oral health habits, diet and family socioeconomic status, which will help improve the standards of prevention of dental caries.

Taking into consideration study limitations, the following recommendations are suggested. Fissure sealants and fluoride varnish application should be implemented in children as early as the eruption of FPMs. This would reduce the caries prevalence of the FPMs. Recognize that children with medical health problems and/ or special needs are more likely to develop dental problems, emphasizing the importance of focusing on these high-caries-risk groups and providing them with intensive preventative care.

CONCLUSION

This retrospective study revealed a prevalence of dental caries among 5 to 12-year-old children attending postgraduate hospital in Dubai. Within its limitations, the most carious tooth surface was the occlusal, followed by mesial, buccal, palatal/lingual and distal surfaces for each FPM. Children with medical health problems and/or special needs had significantly higher buccal carious surfaces. In addition, most proximal caries were incipient and spread throughout the outer third of the enamel.

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