SEVERITY AND PATTERN OF DENTAL CARIES OF THE FIRST PERMANENT MOLARS AMONG 5-12 YEAR-OLD CHILDREN ATTENDING DUBAI DENTAL HOSPITAL IN THE UNITED ARAB EMIRATES.

Mariam Nabeel Al Mansour
BDS, Jordan University of Science and Technology, 2015

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ABSTRACT

Severity and Pattern of Dental Caries of the First Permanent Molars among 5–12-Year-Old Children attending Dubai Dental Hospital in the United Arab Emirates.

Mariam Nabeel Al Mansour

Mawlood Kowash, Manal Al Halabi, Anas Al Salami, Iyad Hussein

Aims: Dental caries is the most frequent chronic disease in children, with a number of predisposing factors that should be evaluated on an individual basis. We aimed to retrospectively determine the severity and pattern of dental caries of the first permanent molars (FPMs), in addition to the total decayed, missing, filled surfaces (DMFS) of the FPM, the relationship of children's demographics, medical health status with the pattern and severity of FPM and to identify the most susceptible FPM tooth surface(s) for dental caries in the study group.

Materials and Methods: Patients' electronic clinical notes and radiographic images (N=1366) at Dubai Dental Hospital were investigated by accessing the digital clinical notes in Dental4Windows™ (D4W), over a four-year period between June 1st, 2016- February 29th, 2020. A total of 774 children, aged 5-12 years, were included (healthy, special needs and/or medically compromised). The recorded data were demographic variables and carious status of each FPM. All data analyses were performed using IBM-SPSS for Windows version 28.0. The Chi-squared test or Fisher's exact test was used to investigate the association of categorical data. In addition, Kolmogorov-Smirnov test was used to test the normality of continuous variables (age, DMFS scores) and Mann Whitney test to compare the means between the two

groups. Quantitative data were analysed and expressed in mean ± SD, and significance level was set at (P-value < 0.05 level).

Results: In the study sample, the prevalence of dental caries and mean DMFS of FPMs were 42% and 0.3075 (±0.04), respectively. The most prevalent decayed surface was the occlusal (29.2%), with no statistically significant difference between gender and nationality. Children with medical health problems and/or special needs had significantly higher caries in the buccal surfaces (12.3%) (P=0.042) compared to healthy children. The majority of proximal caries (mesial, distal) in our study were incipient and spread through the outer third of the enamel (4.9%).

Conclusions: In 5 to 12-year-old children attending Dubai Dental Hospital in Dubai, UAE, the prevalence of dental caries in the first permanent molars was high with the occlusal being the most affected surface. In addition, children with medical health problems and/or special needs have a higher tendency to develop dental caries. Therefore, an individually tailored preventive measures based on risk assessment are required to prevent and minimize the dental caries risk.

DEDICATION

I am dedicating this thesis to my beloved people who have meant and continue to mean so much to me. Although they are no longer with us in this world, their memories continue to regulate my life. First and foremost, to my grandmother Moodhi AlAteeqi whose love for me knew no bounds and, who taught me the value of hard work. Thank you so much, I will never forget you.

I also dedicate this dissertation work to my family, my loving parents, Nabeel AlMansour and Dr Wedad AlAteeqi who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve.

A special feeling of gratitude to my husband, Abdullah AlHussainan who has been a constant source of support and encouragement during the challenges of graduate school and life. I am truly thankful for having you in my life.

DECLARATION

I declare that all the content of this thesis is my own work. There is no conflict of interest with any other entity or organization

Name: MARIAM NABEEL ALMANSOUR

Signature:

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1. INTRODUCTION

Dental caries is the most prevalent and common chronic infectious disease of childhood (Okoye and Ekwueme, 2011;Dawkins et al., 2013). It causes tooth pain, discomfort, eating impairment, loss of tooth and possible delay in language development (Moses et al., 2011). Furthermore, dental caries has been increasing among school children due to frequent consumption of sugary substances, poor oral care practices, and inadequate health service utilization (WHO, 1984). Although efforts are made for prevention, dental caries continues to be a frequent disorder. Therefore, it was necessary to apply methods for its prevention and to intervene from its early stages (Chirca et al., 2015). Furthermore, the frequency, and severity of caries vary considerably depending on the tooth, its morphology, eruption stage, and the position in the dental arch, which can significantly influence the control of bacterial plaque (Chirca et al., 2015).

First permanent molars (FPM) most commonly erupt at the age of 6 or 7 years (Warren et al., 1997). Due to this early eruption, FPM undergoes challenges from occlusion and external environment such as acids and microorganisms at an early stage (Sadeghi M, 2007). Moreover, their anatomy and location also leave the FPM most susceptible to dental caries (Hescot and Roland, 1994; McDonald and Sheiham, 1992).

During the early stages of the eruption, the occlusal surface of the first permanent molar (FPM) is most susceptible to caries, as only the occlusal surface is exposed to the oral cavity. Other susceptible surfaces include proximal, buccal, and lingual surfaces (Kutesa et al., 2005).

Knowledge about the most affected teeth and surfaces can contribute to the design of preventive clinical procedures and community-based programs, thus resources can be targeted at teeth and surfaces at high risk (Kutesa et al., 2005). In addition to other conditions such as molar hypomineralisation (MIH), caries lead to early breakdown of the FPM (Dastouri et al.,

2020). As such, management of the FPM becomes a challenge to dentists around the world (Taylor et al., 2019).

A change in the trend in the prevalence of dental caries has been observed in different parts of the world. Improvements in gingival health and reduced caries prevalence have been reported in many developing countries (Kalsbeek and Verrips, 1990). The majority of the observed increase in dental caries in children and adolescents is confined to the occlusal surfaces of the posterior permanent molars. An updated Cochrane review evaluated the relative effectiveness of dental sealants and fluoride varnishes as important preventive options for preventing dental caries. However, it was found some low-quality evidence suggesting the superiority of one over the other for preventing the occlusal decay in permanent molar (Ahovuo-Saloranta et al., 2016). While effective, fluoride varnish and sealant applications are costly procedures that are only efficient when children and teeth are carefully selected. (Ahovuo-Saloranta et al., 2016).

Using WHO criteria, the prevalence of dental caries in the United Arab Emirates (UAE) in the 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%, and the mean DMFT was 2.5 (El Nadeef et al., 2010).

In the Emirate of Dubai, and to our knowledge, no studies have been conducted to assess the severity and pattern of dental caries in the first permanent molars. Thus, this study will examine the pattern and severity of caries among patients who attended the Dubai Dental Hospital in relation to tooth surfaces, age, gender, and nationality.

2. REVIEW OF THE LITERATURE

2.1 Description and significance

2.1.1 Morphology of First Permanent Molars

FPMs have a complex morphology, with marked differences between maxillary and mandibular FPMs. In general, FPMs have five cusps that are well-developed to carry out the teeth functions, although the fifth cusp is thought to have little physiological significance (Mufadhal et al., 2019). The four well-characterized cusps include the distolingual, distobuccal, mesio-buccal, and mesio-lingual cusps (Mufadhal et al., 2019). These teeth typically have three roots: palatal, mesio-buccal, and distobuccal. However, the root morphology might be different for maxillary and mandibular FPMs and even among people of different origins. A study of mandibular FPMs morphology in a Korean population found that 73.51% of the evaluated molars had 2 roots, 0.67% had one root, and 25.82% had three roots (Kim SY , 2013). Some maxillary FPMs have one, two, and even four roots (Mufadhal et al., 2019). Typically, the roots of molars grow as one root at the crown base and eventually divide into two for mandibular molars and three for maxillary molars (Mufadhal et al., 2019). Root fusion in mandibular FPMs assumes a C-shaped root, whereas maxillary FPMs might show diverse fusion configurations like a complete or partial fusion of several roots. Root fusion is not common in maxillary FPMs. The internal morphology of FPMs is intricate consists of different features and systems. The pulp cavity comprises the root canal system in the anatomical root and the pulp chamber in the anatomical crown (Mufadhal et al., 2019). Other key anatomical elements within the pulp space are canal orifices, pulp horns, furcation, accessory and lateral canals, apical foramina, and inter-canal anastomosis (Mufadhal et al., 2019). In Koreans, bilateral mandibular molars commonly have four canals, but two canals in distobuccal roots have been reported in this population (Kim SY , 2013). One study with a sample of 187 maxillary FPMs found that most mesio-buccal (70.6%), palatal (98.9%), and nearly all distobuccal roots had one canal. Nevertheless, some mesio-buccal roots (29.4%) had two canals (Muriithi et al., 2011). The anatomy of molars

potentially increases their susceptibility to plaque and cariogenic food particles, making them vulnerable to caries (Kutesa et al., 2005).

2.1.2 Importance of First Permanent Molars

The importance of FPMS can be evaluated from a developmental and functional point of view. The FPMs are instrumental in establishing the occlusion and are perceived as the most critical teeth (Abuaffan et al., 2018). Primarily, FPMs determine the vertical distance between lower and upper jaws, aesthetic proportions, and occlusal height and have great control over the teeth erupting later in front of and behind them (Abuaffan et al., 2018). Teeth that erupt later are forced to align to the previously erupted and, in occlusion, FPMs. Thus, FPMs has a role in delimiting the spaces where subsequent permanent teeth, such as second permanent molars (SPM) and premolars erupt. The significance of FPMs can further be determined by investigating what happens when they are lost. According to Ebrahimi et al., loss of FPMs due to caries has an adverse impact on occlusion and both arches (Ebrahimi et al., 2010). Early removal of these teeth may lead to tilting and rotation of adjacent permanent teeth to hollow spaces, a shift in dental malocclusion and midline, and unilateral chewing.

Furthermore, horizontal mandibular displacement and condyles displacement in the course of growth and development after mandibular FPMs loss causes the mandible to grow asymmetrically. Periodontal problems are likely to occur when children lose the first permanent molars (Ebrahimi et al., 2010). Based on these consequences, it is notable that FPMs are extremely vital in children. On the other hand, FPMs are vital in mastication. They are essential to the mechanical process of nutrient intake and processing, helping children's growth and development. Literature shows that the significance of FPMs in the development of a child's dentition cannot be underestimated, and their early extraction can interrupt the eruption and position of other permanent teeth (Ebrahimi et al., 2010).

2.2 Definition of caries, aetiology, risk factors, and treatment

2.2.1 Dental caries

It's known that caries results from complex interactions among the tooth structure, the dental biofilm, and dietary, salivary, and genetic influences (Zero et al., 2009). Dental caries is defined as "a biofilm-mediated, dynamic, multifactorial, sugar-driven disease that leads to phasic demineralisation and remineralisation of hard tissues of teeth" (Pitts et al., 2017). According to Abuaffan et al., dental caries can cause tooth discomfort, pain, eating impairment, delayed language development and loss of a tooth (Abuaffan et al., 2018). The clinical diagnosis of caries involves visual inspection of teeth by skilled examiners. Besides, sharp-pointed dental explorers or probes are still used because they increase caries diagnostic accuracy but might cause damages (Pitts et al., 2017). A tooth is deemed decayed if the clinical examination shows signs of wedging and colour change (Sadeghi M, 2007). Restored and dressed teeth might develop recurrent caries. Dental caries occurs in different teeth sites at different rates, with occlusal being more susceptible to infection than the proximal and smooth surfaces (McDonald and Sheiham, 1992). In accordance with Pitts and colleagues, the extent or severity of a caries lesion is not directly related to the discomfort and pain felt (Pitts et al., 2017). Nevertheless, severe toothache might be disabling if it occurs.

If caries spreads to the dental pulp, it can result in sepsis and infection, leading to critical systemic consequences and even tooth loss (Pitts et al., 2017). Caries activity is not restricted to a certain period of life because it persists throughout life, but the incidence of this disease declines as one age. Despite the age of onset, the rate of dental caries progression takes about 3-4 years before developing to pulpitis (Kutesa et al., 2005). Arguably, females are more prone to dental caries than males because of various reasons, such as early teeth eruption, diverse attitudes about dental attendance between males and females, financial independence to seek

dental care, and differences in dietary patterns between working men and housewives (Kutesa et al., 2005).

2.2.2 Aetiology of dental caries

Dental caries develops due to an intricate interaction among three fundamental factors: diet, bacteria, and host susceptibility (WHO, 1984). Tahir and Nazir expounded dental caries aetiology further by noting that caries occurs in the presence of bacteria, fermentable carbohydrates, and susceptible tooth surface (Tahir and Nazir, 2018). These authors introduce the aspect of time in dental caries aetiology because it does not simply happen overnight (Tahir and Nazir, 2018). It might take some time before the tooth starts decaying and initial symptoms become visible through clinical inspection. Plaque and bacteria should be present on teeth surface for caries to develop (WHO, 1984). The human oral cavity is an intricate ecosystem consisting of acid-tolerant and acid-producing bacteria. Nearly 700 diverse bacteria species reside in the oral cavity of humans, and almost 200-300 species are linked to dental plaque (Tahir and Nazir, 2018).

Bacteria in plaque produce acid through fermentation of ingested refined carbohydrates, particularly sugars (WHO, 1984). The production of acid on the tooth surface results in localized demineralization of the enamel surface, leading to progressive tooth destruction if not controlled and treated (WHO, 1984). S. mutants are the primary bacteria responsible for the development of caries in humans. These bacteria colonize tooth surfaces because of several virulence factors, including the capacity to form biofilms, metabolize carbohydrates, tolerate rapid and frequent environmental fluctuations, and extracellular polysaccharides synthesis (Tahir and Nazir, 2018). The extracellular polysaccharides synthesis facilitates the accumulation and adhesion of bacteria on the tooth surface and offers protection against defense mechanisms. In addition, S. mutants virulence properties enable the bacteria to alter the environment within the enamel to extremely cariogenic, ultimately resulting in caries formation (Tahir and Nazir, 2018).

2.2.3 Risk factors associated with dental caries

Nearly every country in the world has cases of dental caries because it affects both males and females of all races, age groups and socioeconomic statuses (Moses et al., 2011). However, socio-demographic and behavioral factors tend to elevate the risk of dental caries in a particular population. These factors are age, sex, poor oral hygiene, inappropriate tooth brushing behaviors, consumption of sugar-containing drinks, and plaque (Tahir and Nazir, 2018).

Caries incidence was linked with socioeconomic position and mother education in a study of 7- to 8-year-old children, but not with having two or more sugary snacks per day or oral hygiene status, according to the Caries Assessment Spectrum and Treatment (CAST) index (Mahboobi et al., 2021).

Now, this complex illness is produced by host agents and environmental variables. Despite the ongoing efforts to limit its prevalence, it remains frequent (Lee Y, 2013). A study involving school-aged children done in the expansive region of South-Central Kentucky found that residential location and insurance coverage were vital factors associated with untreated dental caries (Dawkins et al., 2013). The study showed that physical and social hindrances to oral health care, like lack of transportation, means to dental clinics, and unwillingness of dentists to treat Medicaid-insured children, are critical factors linked to poor dental health (Dawkins et al., 2013). Young children or school-aged children tend to consume sugary foods, such as sugary snacks and beverages, from vending machines inside or outside school. The consumption of these sugary foods together with poor dental hygiene, explains the high incidence of caries among older school children (Dawkins et al., 2013).

Another study in the UAE found that the most common causes of caries were eating a cariogenic diet, getting older with poor oral hygiene, and sociodemographic factors. The decreased prevalence of caries in the UAE over the last few years has been attributed to parent

education, improved food choices, and effective dental hygiene practices (Al Ayyan et al., 2017). UAE studies showed DMFT values for the permanent teeth ranging from 1.6 to 3.27 and prevalence rates ranging from 54 to 65 percent (Al Ayyan et al., 2017).

2.2.4 Treatment of dental caries

The management of dental caries has shifted from restoring tooth structure and surgical methods to creating and using materials to prevent caries, remineralization, minimally invasive therapy for hard-to-access sites, and materials for impregnating early lesions to prevent progression (Zero et al., 2009). Fluoride is among the most efficient materials for preventing caries and disease progression. Importantly, fluoride decreases sugar metabolism by bacteria, reduces plaque growth and acid production, facilitates repair of caries lesions, and crystallizes enamel, making it resistant to acid action (WHO, 1984). Consequently, the application of fluoride varnish and oral fluoride supplementation has been recommended among children at risk of dental caries and even those with caries to allow for early lesions repair (Abuaffan et al., 2018). Sealants are recommended as an effective treatment for caries. Research has found that sealants placement over lesions prevents disease progression and is affordable in comparison to routine restorative care (Zero et al., 2009). A majority of caries among children happen in fissures and pits. Fissures and pits are highly susceptible to caries since the anatomy attracts the accumulation of plaque (Lee Y, 2013).

In addition, these regions, fissures and pits, are always narrow, making oral hygiene measures ineffective in eliminating plaque. When these irregularities are sealed, they become less morphologically susceptible. Nonetheless, the sealing of irregularities in teeth is particularly advocated among adults with a high dental caries index and young patients with erupting teeth (Lee Y, 2013). Another common dental caries treatment is remineralization. Zero et al. notes that partially demineralized enamel can be remineralized to nearly its initial size but cautions

that remineralization is impossible if the mineral phase is lost entirely (Zero et al., 2009). Therefore, early detection of dental caries through clinical procedures and appropriate early treatments are necessary to prevent systemic consequences linked to caries progression, such as tooth loss.

2.3 Severity and Prevalence of Dental Caries

2.3.1 Prevalence of dental caries in First Permanent Molars

Data about the prevalence of caries in FPMs is fragmented, and global prevalence data is unavailable. The World Health Organization (WHO) indicates that caries is increasing in urban populations, mainly in developing nations and relatively declining in industrialized countries (WHO, 1984). WHO's goals for decayed, missing, and filled teeth (DMFT) is an average of about 3 in 2000 and not more than 1.0 in 2010 at the age of 12 years (Sadeghi M, 2007). An evaluation study of the prevalence and severity of dental caries school children in the Gulf Cooperation Council (GCC) area was conducted in 2017, found that the overall DMFT was 2.57, and the prevalence was 64.7% (Al Ayyan et al., 2017).

Perhaps the largest caries prevalence in FPMs was done in Zhejiang Province in China. This study recruited 1,423,720 participants aged 6-8 years and found that dental caries on FPMs rose from 20.4% in 2013 to 29.0% in 2017 despite the existence of an Oral Health Promotion Project (OHPP) (Zhu et al., 2021). Out of 432 children in Jeddah, Kingdom of Saudi Arabia, 75.5% or 326 children had carious the first permanent molars. About 112 (26%), 120 (28%), 67 (15.5%), 27 (6%), had one, two, three and four molars carious lesion(s), respectively (Al-Samadani et al., 2012). Based on the current data, caries in the first permanent molars are a critical public health problem in most world.

2.4 Molar-Hypomineralisation and Enforced Extraction of FPMs

2.4.1 MH anomaly affecting FPMs

MIH is defined as a hypomineralisation of systemic origin that affects one to all of the first permanent molars and is often associated with affected permanent incisors (Weerheijm et al., 2001). MIH anomalies can be soft, porous and their clinical presentation can vary from yellow to white or brownish opacities (Zameer et al., 2020). Nevertheless, there is always a clear boundary between sound and affected enamel. Under the masticatory forces, tooth structure can be lost because of the porous, brittle enamel. Therefore, the discoloured opacities and enamel porosities can lead to aesthetic and functional complications among MIH-affected children (Zameer et al., 2020). Furthermore, some enamel abnormalities, such as amelogenesis imperfect, hypoplasia, and opacities, are clinically analogous to MIH defects, which can happen during amelogenesis (Zameer et al., 2020).

Walshaw and colleagues obtained radiographs from 101 patients aged 6-15 years in their study of MIH anomalies and found that the prevalence of these defects differs substantially. Co-existing hypodontia occurred in 12%, infra-occlusion of primary molars was present in 9%, and concurrent ectopic FPMs developed in 8% of the participants (Walshaw et al., 2020). Abnormal morphology, including microdont and macrodont teeth, was identified in 9% of the patients. Generally, about 29% of the patients were found to have a dental anomaly (Walshaw et al., 2020). MIH diagnosis criteria might include at least one anomaly affecting FPMs, such as post-eruptive enamel breakdown (PEEB), demarcated enamel opacity, and atypical extraction or atypical restoration because of MIH (Garot et al., 2017). PEEB is a defect that is associated with a substantial decline in the enamel depth after tooth eruption (Garot et al., 2017). A study conducted by Hussain et al. reported that the prevalence of MIH in Dubai, UAE was 27.2 % (Hussain et al., 2018). Molar hypomineralisation (MH) was more prevalent; 65.6% of children identified had only MH, whereas 34.4% had MIH. Despite the high prevalence of MIH, the severity was mild. The prevalence of MIH and MH was significantly related to gender

and location of the tooth in the oral cavity, in which girls and maxillary molars exhibit the higher significant prevalence of MIH (32.6%, P=0.002), (20.8%, P≤0.005), respectively (Hussain et al., 2018).

2.4.2 Enforced Extraction of FPMs affected with MH

The UK published guidelines for enforced extractions of first permanent molars (EExFPMs) in 2014 (RCSEng Guidelines, 2014). Since the guidelines of EExFPMs were first published, the procedure has gained support as well as opposition from dentists, patients, and other stakeholders. Presently, the Royal College of Surgeons in the UK advocates and supports EExFPMs. In contrast, the American Academy of Pediatric Dentistry suggests that EExFPMs is not a recognized clinical practice (AAPD guidelines website, 2019). This contrasting opinion is also prevalent in the public and dentistry practice. In Taylor et al.'s study, 71.6% of specialists in pediatric dentistry (SPD) indicated that patients with compromised first FPMs (cFPMs) required treatment, and 86.8% of general dental practitioners (GDP) noted they feel obliged to treat cFPMs (Taylor et al., 2019). A study conducted in the United Arab Emirates (UAE) found that over 85% of pediatric dentists favored saving broken down FPMs (BDFPMs) instead of extracting them. In comparison, 89% referred children with BDFPMs to other specialists (Dastouri et al., 2020).

In general, FPMs extraction is a rare option because of orthodontic reasons. However, some pediatric dentists advocate saving FPMs regardless of whether they are pulpally compromised since their extraction always makes treatment more complex (Dastouri et al., 2020). Additionally, once the removal is done, clinicians experience challenges determining whether a balancing extraction or compensating extraction is essential even though the UK's guidelines on EExFPMs recommend these extractions in specific circumstances (RCSEng Guidelines, 2014). Compensation extraction involves extracting the opposing FPM to inhibit it over erupting, while balancing extraction involves extracting contralateral FPM to create symmetry

(RCSEng Guidelines, 2014). Hence, a majority of studies recommend considering whether extraction is suitable for a child to prevent unnecessary and inappropriate dental extractions (Dastouri et al., 2020).

2.4.3 Complications related to early extraction of first permanent molar

The complications of extraction of FPMs depend on the age of removal, and better outcomes have been reported in patients aged 8-10 years (Al khadra, 2017). Early removal of FPMs results in a reduced post extraction space but not complete extraction space closure (Saber et al., 2018). Second permanent molars (SPMs) and not second premolars seem to reduce FPMs extraction space. Upon extraction, SPM distances and angles increased both in mandible and maxilla, while second premolar distances and angles decreased in both in mandible and maxilla (Saber et al., 2018). In this regard, extraction of FPMs may create large residual spaces that cannot be closed by SPMs (Rahhal, 2014). When these large residual spaces are closed without significant crowding, it can adversely impact soft tissue profile's aesthetics due to unattractive anterior segment retraction (Rahhal, 2014).

Early FPM extraction has also studied the retrieval of incisors and lingual tipping. Bilateral extraction of lower FPM led to marked lingual tipping and retrusion of mandibular incisors (Saber et al., 2018). Removal of FPMs before a child is eight years old can potentially lead to distal tilting, rotation, and drifting of the adjacent unerupted second premolar tooth (Rahhal, 2014). This complication occurs if a second premolar is inclined and diverts from the SPM roots' bifurcation. In this case, the second premolar lacks the direction normally offered by FPM and might erupt distally into the socket of FPM (Rahhal, 2014). On the other hand, dentistry specialists are cognizant that appropriate extraction of FPMs in children can lead to good space reduction and favourable permanent dentition development (Al khadra, 2017).

In the Emirate of Dubai, and to our knowledge, no studies have been conducted to assess the severity and pattern of dental caries in the first permanent molars. Thus, this study will examine

the pattern and severity of caries among patients who attended the Dubai Dental Hospital in relation to tooth surfaces, age, gender, and nationality.

3. AIM

The main aim of this study was to determine the severity and pattern of dental caries of the FPMs in 5-12 year-old children attending Dubai Dental Hospital at Hamdan Bin Mohammed College of Dental Medicine/Mohammed Bin Rashid University of Medicine and Health Sciences in the United Arab Emirates (UAE).

3.1 Specific objectives

- To identify the most susceptible surface(s) for dental caries of the first permanent molars among 5-12 years old children.
- To calculate the total percentage of dental caries in FPMs.
- To determine the mean of DMFS in FPMs and per tooth.
- To clarify the relationship of children's demographics (gender, nationality), and medical health with the severity and pattern of caries of FPMs.

4. MATERIALS AND METHODS

4.1 Study Design and Population

This was a retrospective descriptive cross-sectional study using patients' electronic notes and radiographic images. The data were collected by accessing the digital clinical notes in Dubai Dental Hospital (DDH), Dental4Windows™ (D4W). The study was performed during the period between March 1st and May 31st, 2021, to investigate the severity and pattern of FPMs caries among 5 to 12 year-old school children who attended the Pediatric Dentistry Department at DDH in the United Arab Emirates during a four-year period from June 1st, 2016-February 29th, 2020.

4.2 Eligibility criteria

4.2.1 Inclusion criteria

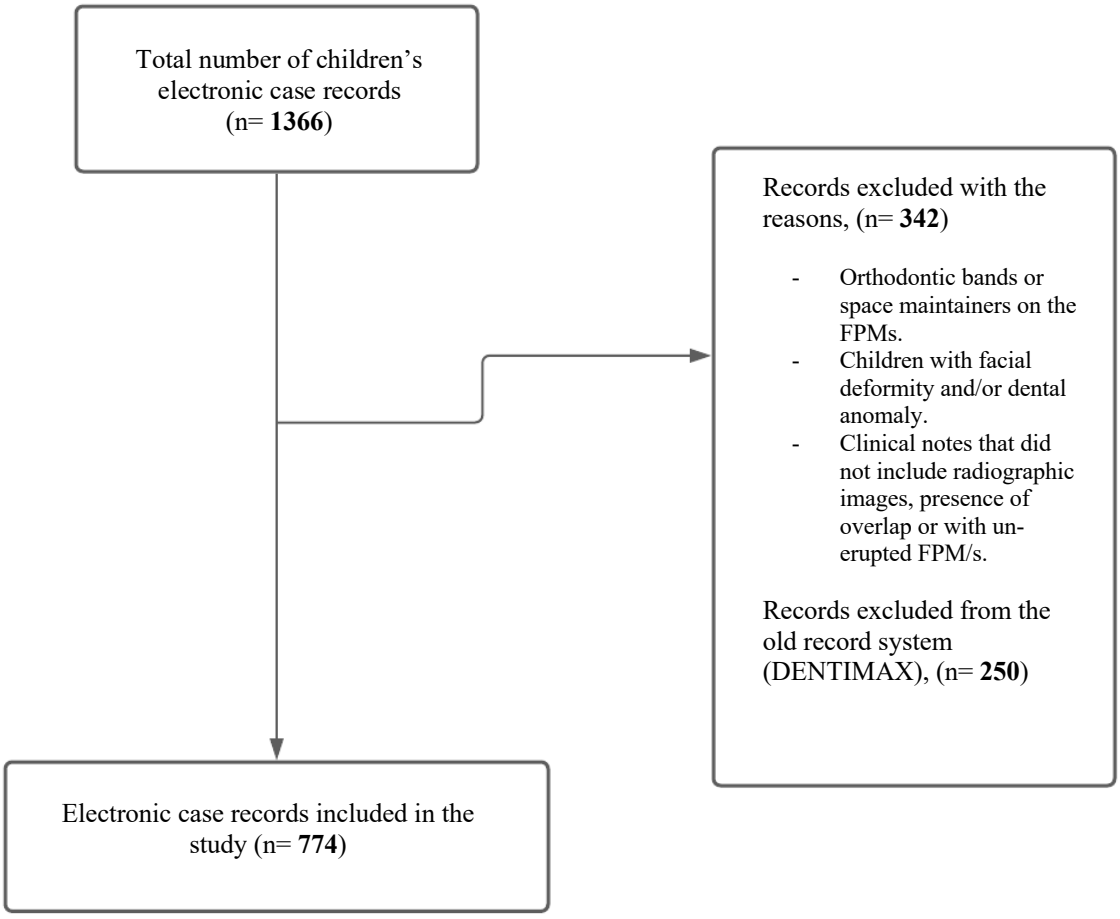
Healthy, special needs and/or medically compromised children aged 5-12 years with complete electronic dental charting and diagnostically acceptable quality radiographic image(s) of one or more FPMs who attended the pediatric dentistry department at Dubai Dental Hospital due to their need of dental treatment or regular dental check-ups.

4.2.2 Exclusion criteria

The study excluded children whose notes indicated the presence of orthodontic bands, space maintainers, pits/fissure sealants, stainless steel crowns on the FPMs, those with dentofacial deformities and/or dental anomalies such as (MIH, AI and DI). Also, children whose notes did not have radiographic images, with overlapped radiographs and those patients who had unerupted FPMs were excluded from the study. In addition, all patient records registered the previously used and out dated system of DDH (Dentimax®) were excluded because of difficulty in accessing the files and retrieving the radiographs. This system was in operation

prior to June 2016. A flowchart showing the data extraction process is presented in (Figure 1).

FIGURE 1: Flowchart showing the process of data extraction



4.3 Sample Size

Total coverage of all children's electronic case records that met the inclusion criteria (n= 774) between June 1st 2016 - February 29th 2020, were included in the study. This was a convenience sample, and no power calculation was conducted for this retrospective study.

4.4 Data Collection

The data were collected through accessing the digital patient record system (D4W) of the Pediatric Dentistry Clinic at DDH. Only the data of the initial visit for included children was recorded. The process was done by the principal investigator (MA) and an assessor (AA) using a Microsoft Excel standard proforma (Appendices 1 and 2).

4.5 Pilot Study

A pilot study of randomly selected 10 intraoral bitewing and periapical radiographs was conducted before commencing the data collection process and the needed alterations in the data collection sheet (proforma) were made.

4.6 Inter- and Intra-examiner calibration

To assess the reproducibility and consistency of the readings and scoring, the principal investigator (MA) and an assessor (AA) were calibrated by Dr.Mawlood Kowash (Professor-Pediatric Dentistry).

A randomly selected 13 intraoral bitewing and periapical radiographs were separately assessed twice at a 2-week period. The Kappa coefficients were 0.806 (for intra-examiner calibration of principal investigator MA), 0.755 (for intra-examiner calibration of assessor AA), and 0.806 for the inter examiner-calibration analysis, which was considered outstanding.

4.7 The patients' demographics

The sample's demographic characteristics collected were: Age in year, Gender (Male or Female), Nationality (from the United Arab Emirates or Other Countries), and General Health (healthy, special needs and/or medically compromised).

4.8 DMFS Index of FPMs

Overall DMFS of FPMs was recorded from the included children's clinical notes and charting using the WHO criteria (1997):

- 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 and also those which are indicated for extraction.
- Teeth missing due to accident or congenitally missing are not counted as missing.
- A tooth surface that is decayed and filled is considered decayed.
- Temporary restorations are considered as decayed.

4.9 First permanent molar radiographic caries data

The recorded clinical caries data were verified from the radiographic images [Bitewings (BW), Periapicals (PA), and Orthopantographs (OPG)] in the D4W. And the quality of radiographic assessment was standardized by evaluating all the included radiographs in the same room, with the same darkness, on the same monitor resolution and with the same brightness and contrast. This was carried out by the two calibrated assessors (MM, and AA). In addition, grading the extent of proximal caries into enamel and dentin was conducted using the available radiographs (Pocket Dentistry website, 12: Diagnosis and Management of Dental Caries, 2017) (Appendix 3) into the following:

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.

4.10 Statistical Analysis

Data were entered in computer using IBM-SPSS for Windows version 28.0 (SPSS Inc., Chicago, IL). The Chi-squared test or Fisher's exact test were used to investigate the association of categorical data. In addition, Kolmogorov-Smirnov test was used to test the

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

4.11 Ethical considerations

The ethical approval was obtained from the Research Ethics Review Committee at Mohammed Bin Rashid University of Medicine and Health Sciences (Appendix 4, RE: 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", Good Clinical Practice (GCP), and within the laws and regulations of the UAE/Ministry of Health and Prevention.

5. RESULTS

5.1 Demographical characteristics of the sample study

Out of 1366 records, a total of 774 children aged 5 to 12 years met the inclusion criteria and were included in the study. The mean age of the study sample was 8.07 (±2.23) years old, 397 (51%) of the children were males and 377 (49%) were females. The majority were non-UAE nationalities (67%). Around 701(91%) of children who attended Dubai Dental Hospital were healthy and 73(9%) were special needs and/or medically compromised children. The latter were recorded as having conditions such as asthma, autism, attention deficiency hyperactivity disorder (ADHD), liver disease, kidney disease, congenital heart disease, iron deficiency anemia, sickle cell anemia, cerebral palsy, coeliac disease, G6PD anemia, thalassemia, and Kawasaki disease. The demographic characteristics of participants are summarised in Table 1.

Table 1: Demographical characteristics of the participants

Variables	N (%)
Gender	
Male	397 (51)
Female	377 (49)
Nationality	
UAE	252 (33)
Non-UAE	522 (67)
Age: mean (SD)	8.07 (2.23)
Health Status	
Healthy	701 (91)
Special health needs/medically compromised	73 (9)

5.2 Radiographical characteristics of the study sample

The majority of radiographic images that were used to verify the recorded caries in FPMs were BWs (88%). The others were OPG and PA radiographs with the least percentages.

As for grading the extent of proximal caries (mesial, distal), 146 (4.9%) FPMs teeth had caries extended into the outer half of enamel (Grade 1) in the maxillary right, maxillary left, mandibular left, and mandibular right molars respectively. Followed in order as presented in Table 2 by caries extending into the inner half of enamel (Grade 2), into the outer third of dentine (Grade 3), into the inner third of dentine (Grade 5), and caries extending into the middle third of dentine (Grade 4).

Table 2: Radiographic characteristics of the study sample

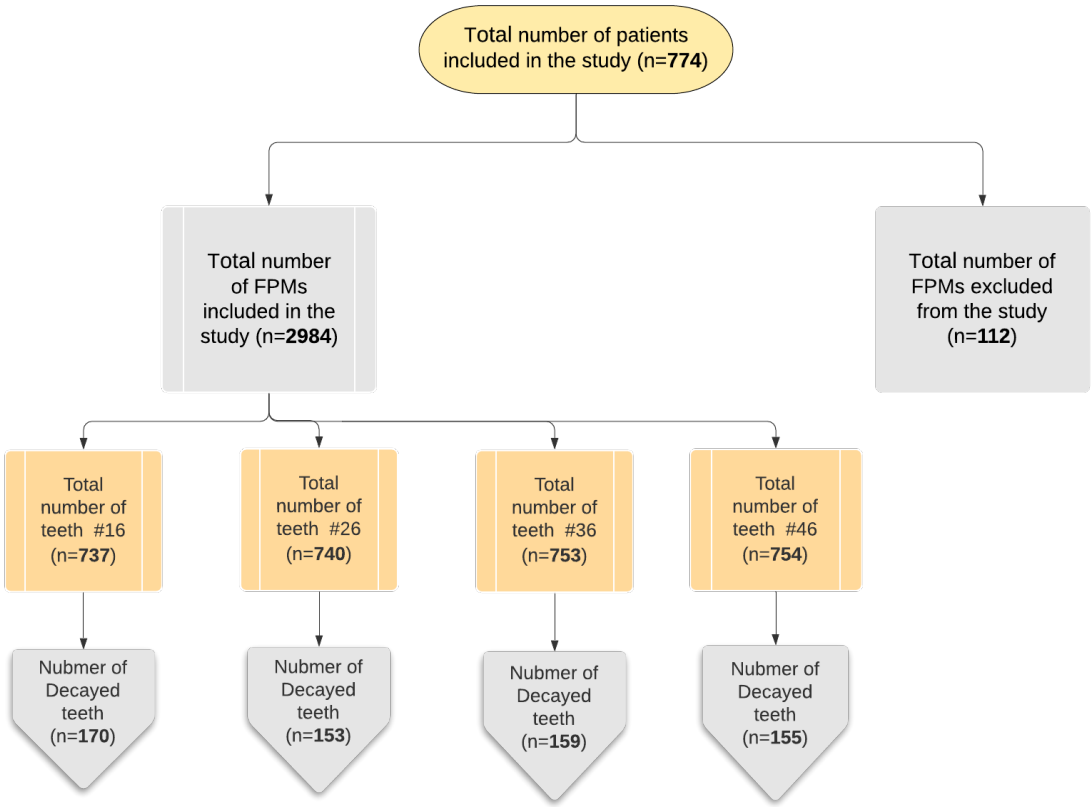
Variables	Tooth 16	Tooth 26	Tooth 36	Tooth 46	Total FPMs
Type of radiographs (N (%)*)					
BWs	638 (86.6)	641 (88.8)	657 (87.4)	658 (89.4)	2,594 (88.0)
OPGs	92 (12.5)	72 (10)	87 (11.6)	69 (9.4)	320 (10.8)
PAs	7 (0.9)	9 (1.2)	8 (1)	9 (1.2)	33 (1.12)
Grading of proximal caries (N (%)*)					
None	649 (88.1)	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

5.3 Descriptive statistics of assessed FPMs

Out of 774 enrolled patients, 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 (Figure 2).

FIGURE 2: Flowchart showing the total number of included FPMs



5.4 Prevalence of dental caries of first permanent molars

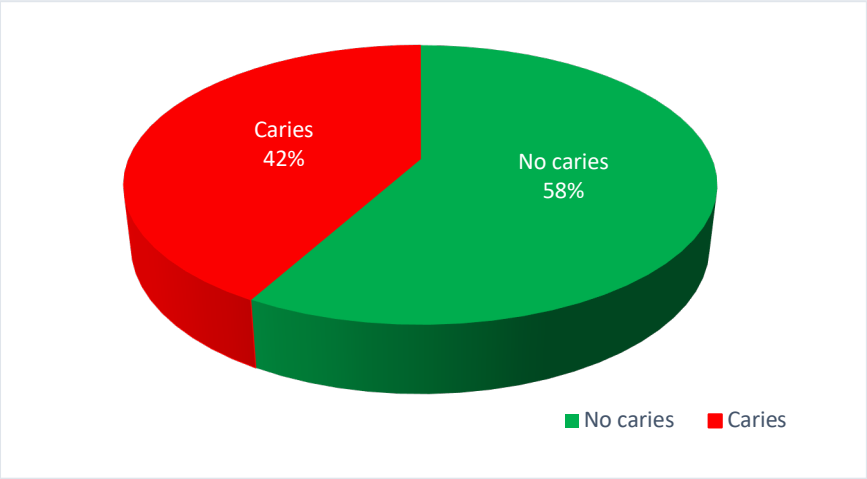
The prevalence of dental caries of all FPMs (Figure 3) was 324 (42%). The most commonly affected surface was occlusal. There was no statistically significant association between caries on different surfaces and gender (Table 3). The rate of caries per surface in FPMs was higher in non-UAE nationals, but the differences were 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 3).

Table 3: Association between caries per surface and demographical data

Surface	**O**	**M**	**D**	**B**	**P/L**
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

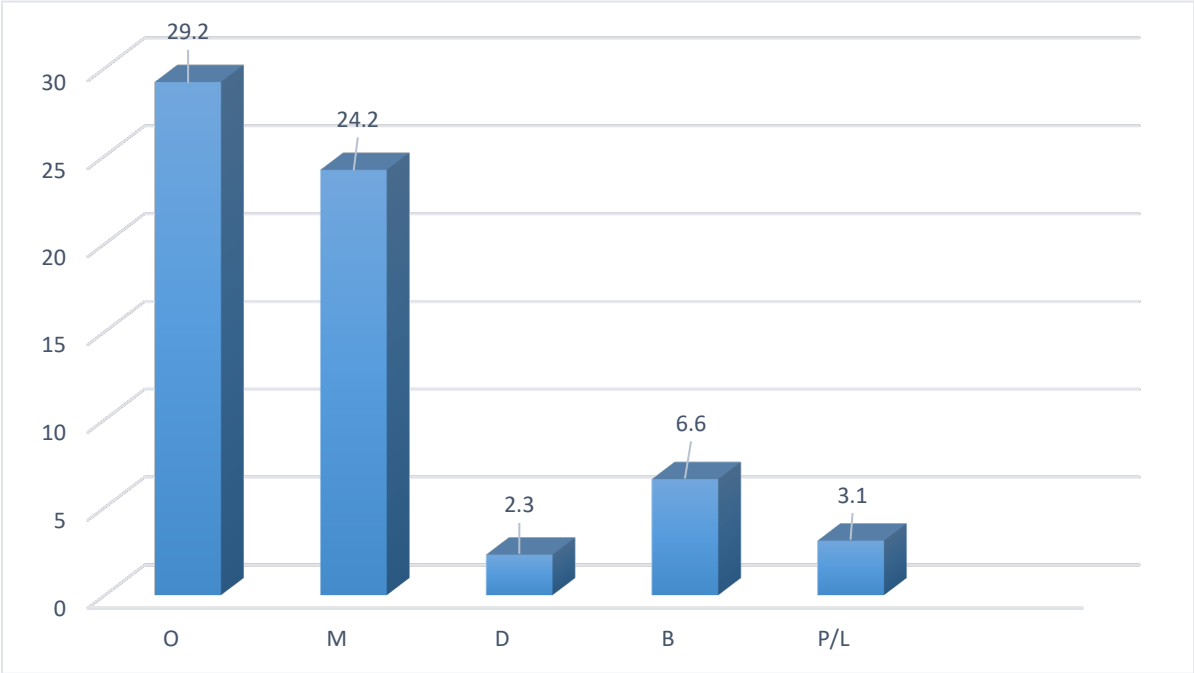
FIGURE 3: Prevalence of dental caries in FPMs



5.5 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, buccal, palatal/ lingual, distal surfaces (24.2 %); (6.6 %); (3.1 %); (2.3 %); respectively (Figure 4).

FIGURE 4: Percentage of caries by surface



5.6 The mean DMFS of first permanent molars

The mean of DMFS was 0.3075 (±0.04) among the included sample (Figure 5). All FPMs in different locations had almost the same DMFS (0.34), (0.31), (0.33), (0.25) in the maxillary right, maxillary left, mandibular left, and mandibular right molars respectively (Figure 5).

There was no statically significant (P-value<0.05) association between DMFS per tooth and the gender, nationality and medical health status. Table 4 summarizes the comparison of mean DMFS according to demographic characteristics.

FIGURE 5: The mean of DMFS and per tooth

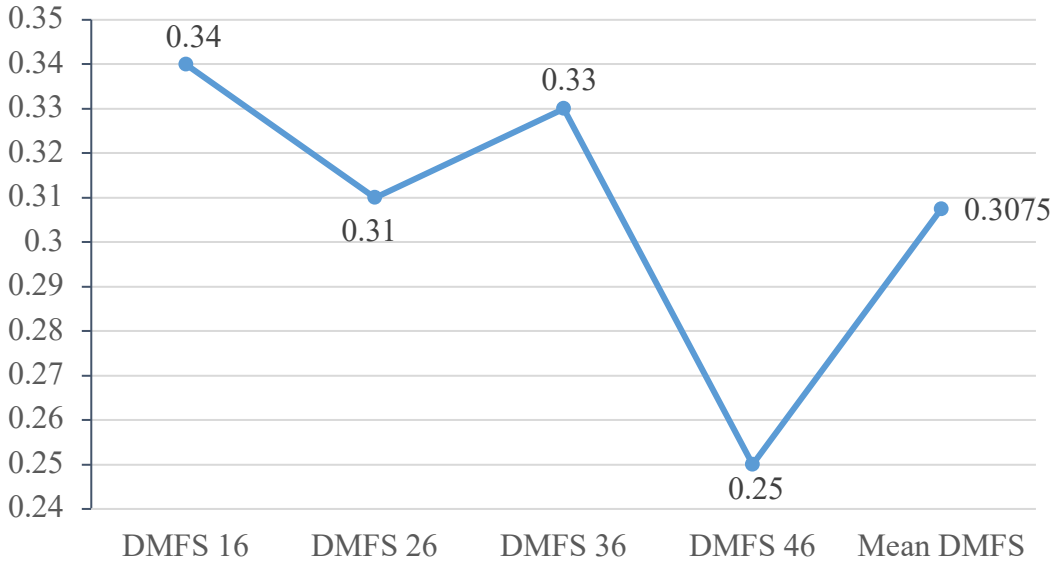


Table 4: Relationship of DMFS per tooth with demographical data

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

*Statistically significant

6. DISCUSSION

First permanent molars (FPMs) are keystone teeth for humans (Almugla, 2021). This study attempted to assess the prevalence of dental caries in FPMs among patients attending Dubai Dental Hospital. 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. Also, it is important to develop a better understanding of the size of this problem in our population as this has not been previously investigated.

In our study, we included only children in which their ages range from 5-12 year old. This was based on most of other previous studies that used the same age range so that it will be easy to compare the results.

The data revealed a high overall prevalence of dental caries of FPMs among 5–12-year-old children (42%). When comparing this prevalence to reported prevalences in other countries, it was noted to be relatively higher. A study in Sudan reported a prevalence of (61%), while another study in Abha City, Kingdom of Saudi Arabia (KSA) reported a prevalence of (66.4%) (Abuaffan et al., 2018) (Rafi et al., 2012). Whereas in Taiwan the reported prevalence was 52% and 68.79% in Central Africa (Warren et al., 1997) (Que and Jia et al., 2021). Moreover, the prevalence in Romania was reported as 25.82%, and 24.3%, 26.9% in urban and rural areas of Zhejiang Province, China respectively (Chirca et al., 2015) (Zhu et al., 2021). All of the reported differences in prevalence could be attributed to sociodemographic factors, different sample sizes, different ages, diagnostic criteria, or statistical methods.

The occlusal surface of FPMs was found to be the most affected surface in the study (29.2 %). The prevalence of caries in mesial, buccal, palatal/ lingual and distal surfaces was 24.2 %; 6.6

%; 3.1 %; 2.3 %; respectively. This is consistent with the results of a recent study in 2021 by Que et al. in which occlusal surface was the site of the greatest number of dental caries incidents in FPMs molars, followed by the buccal and lingual surfaces (Que et al., 2021). These findings are also concurrent with the study conducted by Abuaffan et al., who reported that the most frequently decayed site in FPMs was the occlusal surface (43.2%) (Abuaffan et al., 2018). Dental radiographs are highly accurate at detecting proximal and dentine carious lesions (Keenan J et al., 2016). Therefor an accurate result could not be confirmed due to the difficulty in verifying initial stages of occlusal caries from radiographs. However, 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 were 84.6%, 67.4%, respectively. Furthermore, these findings were related to 7- to 8-year-old children whom they have a high prevalence of dental caries in both the deciduous and permanent dentitions, which support the idea of instituting appropriate preventive measures and call for preventive measures, particularly the use of sealants in children at high risk of tooth decay (Wang et al., 2012). At independently but they still require prompting, parental supervision, and motivation. Parents should be educated about their role in providing help when appropriate with toothbrushing for some children, depending on risk and capability (DoH Prevention toolkit, 2021). Fluoride reduces the solubility of enamel and promotes enamel remineralization, which helps to prevent dental caries. Furthermore, it also interferes with the metabolism of cariogenic bacteria (Walsh et al., 2019). Brushing the teeth twice per day using the proper method and toothpaste containing fluoride is regarded the most acceptable and efficient method of avoiding caries, is vital to remove dental plaque and keep good oral hygiene (Ahovuo-Saloranta et al., 2016). The use of fluoride varnish as a caries-

prevention measure will produce caries prevention that is similar to that achieved by using fissures sealants in first permanent molars (Chestnutt et al., 2017).

Our study excluded FPMs in those children who have dentofacial deformities and/or dental anomalies. However, Wuollet et al.'s study has concluded that children's FPMs with Molar-Incisor Hypomineralisation were more prone to caries than their peers' FPMs (Wuollet et al., 2018). This fact can be attributed to the raised sensitivity of hypomineralized teeth, in which maintaining a proper oral hygiene cannot be achieved, resulting in an increased caries rates (Grossi et al., 2017). Furthermore, because hypomineralized enamel has higher porosity and lower mechanical resistance, the tooth may be susceptible not only to dental caries, but also to post-eruptive breakdown (PEB) when the affected tooth is subjected to occlusal load. (Weerheijm et al., 2003). The extent to which the enamel structure is complete is the primary cause of increased caries activity. Many oral difficulties plagued people with Amelogenesis Imperfecta, including sensitivity and aesthetics, which were mostly caused by active tooth decay (Markovic et al., 2010).

The oral health status among children with Down syndrome (DS) in Dubai, United Arab Emirates, was assessed by Ghaith et al. It was concluded that when compared to healthy children, DS children in Dubai had a higher caries rate (Ghaith et al., 2019). The authors recommended focusing on parental education programs emphasizing the significance of special needs children's oral health and establishing proper prevention and community oral health care programs aimed at special needs children (Ghaith et al., 2019). Moreover, children with Cleft Lip/Palate were categorized as high caries risk individuals compared to controls (Wells, 2014). Some of the contributing factors seem to be higher prevalence of enamel defects and impaired oral hygiene (Sundell, 2016). This can be as a result of a reluctance to brush around the cleft

site, poorly aligned maxillary dentition and limited access following surgical repair of the upper lip and possible scarring (Ahluwalia et al., 2004).

Children with medical health problems and/or special needs had significantly higher (P-value = 0.042) buccal carious surfaces 9 (12.3%) than healthy children 42 (6%). Although the former was few in number (9%) when compared to healthy children (91%), this significant finding was found after conducting Kolmogorov-Smirnov test to assess the normal distribution of continuous variables.

Individuals with medical health issues and /or with special needs are more susceptible to developing dental problems and have a reduced quality of oral health life. Therefore, understanding the oral health issues that this group faces is extremely beneficial in order to develop a proper comprehensive treatment plan with the multidisciplinary management.

Several examples of high dental caries in medically compromised patients in Dubai have been reported. For example, Al-Raeesi et al. found that children in Dubai, UAE with β-thalassemia major had significantly higher DMFT than the healthy controls (p-value = 0.017). It can be explained by the fact that affected individuals and their families are preoccupied with their life-threatening problems (Al-Raeesi et al., 2018). Therefore, education regarding the prevention of dental caries and the importance of maintaining good oral hygiene should be a priority when caring for these children (Al-Raeesi et al., 2018).

Each medical condition has its risks and consequences. Alnuaimi et al. study has briefly reviewed the oral health problems in leukemic children (Alnuaimi et al., 2014). Leukemic children may be at higher risk due to the diet rich in carbohydrates, medications containing sucrose, salivary gland hypofunction, and xerostomia (Padmini and Bai, 2014). In addition, the oral sequelae of cancer therapy cannot be avoided. Therefore, prevention and management of

oral and dental problems before the initiation of cancer therapy is essential (Alnuaimi et al., 2014).

Among Dubai Cerebral Palsy children (CP) the prevalence of dental caries in general was 53% (Al Hashmi et al., 2017). It indicated that this vulnerable group of patients has a greater need for dental services due to their limited skills, physical and mental disabilities in maintaining good oral hygiene. Oral health awareness programs for parents/caregivers are critical for the prevention of oral disease in this patient population (Al Hashmi et al., 2017).

Another Dubai study by Mansoor et al. investigated the oral health challenges in Dubai children with autism spectrum disorder (ASD) and their families in accessing oral health care (Mansoor et al., 2018). The majority of ASD children's parents (83.3%) reported that their children need assistance in brushing their teeth, this is related to difficulty in social interactions and a lack of manual dexterity, both of which make it difficult for parents or caregivers to provide oral care to autistic children (Mansoor et al., 2018).

High caries risk children must be identified and involved early in the prevention of poor oral health and caries, which is the cornerstone of the success of dental management to minimise operative intervention. The emphasis of preventive dental care lies in patient and family education, dietary advice, plaque control, fissure sealants, topical fluorides, and sugar-free medicines wherever possible.

The mean DMFS (0.3075) in the present study was lower compared to studies conducted in Taiwan (1.46) and in São Tomé Island, Central Africa (3.542) (Warren et al., 1997) (Que and Jia et al., 2021).

Non-UAE nationalities had a greater rate of caries per surface in the FPMs compared to the UAE national participants. However, there was no statistically significant difference. The

reasons for the reported possible difference were not investigated, however, it can be attributed to multiple predisposing factors.

The majority of proximal caries (mesial, distal) in our study spread through the outer third of the enamel (4.9%). Followed respectively 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. Early signs of caries consist of noncavitated carious lesions and the progression of the disease process with further loss of tooth minerals leads to a cavitated lesion, those becoming more difficult in treating as loss of tooth structure creates niches for the biofilm that are not easily accessible (Schwendicke et al. 2016). Therefore, early detection, diagnosis, and the use of effective nonrestorative treatments are crucial for the management of non-cavitated carious lesions. It is recommended to apply topical fluoride to incipient enamel caries in permanent teeth since it is beneficial in inhibiting cavitation, as well as the reduction and smoothing of a white spot lesion (Hayashi et al., 2020).

The fact that we have verified the proximal caries based on the available radiograph might has affect the accuracy of caries detection in our study. 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 OPGs and PA radiographs with the least percentages 10.8%, 1.12%, respectively. Bitewing radiography is the most widely used method for caries detection and has the highest diagnostic accuracy, while 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 (Akarslan et al., 2008). Also, panoramic image covers the entire patient dentition along with surrounding bones and jaw structure, that detailed view of each tooth cannot be given. Hence, structures in Panoramic images lack specific boundaries, and visual quality is extremely low in comparison with other types of dental radiographs (Naam et al., 2016).

To the best of the authors' knowledge, the present study was the first study conducted in the UAE and used an appropriate sample and sound methodology. However, it does have some inherent limitations because of it is retrospective nature and the data collected dependent on the accuracy of patient dental records and the quality and type of the radiographs. The sample size of the study was adequate and comparable with other previous studies. However, the number of patients with decayed FPMs may be underestimated because we included only the D4W dental records and excluded the records from the old Dentimax system. The results of decayed surfaces in our study might be underestimated due to the lack of accuracy in the caries detection when used panoramic images. Although occlusal caries was found the most prevalent in the present study, lack of calibration of primary examiners who documented decayed surfaces (dental charts) and the challenging of radiographic verification might affect the accuracy of decayed surfaces numbers. Furthermore, because the ages of the participants were recorded in years rather than months, the exact age of the occurrence of dental caries could have been slightly altered.

Further research is required to assess a wide range of factors that might affect the prevalence of dental caries in FPM, such as oral health habits, diet, and family socioeconomic status, which will help improve the standards of prevention of dental caries.

7. CONCLUSIONS and RECOMMENDATIONS

7.1 Conclusions

In the sample of 5- to 12-year-old children attending DDH, this retrospective study revealed a high prevalence of dental caries. 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 compared to healthy individuals. In addition, the majority of proximal caries (mesial, distal) in our study were incipient and spread through the outer third of the enamel.

7.2 Recommendations

Based on conclusion and after considering the limitations, the following recommendations are suggested:

1) Fissure sealant should be implemented on children as early as the eruption of FPMs. This would reduce the caries prevalence of the FPMs.
1) 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.

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9. APPENDICES

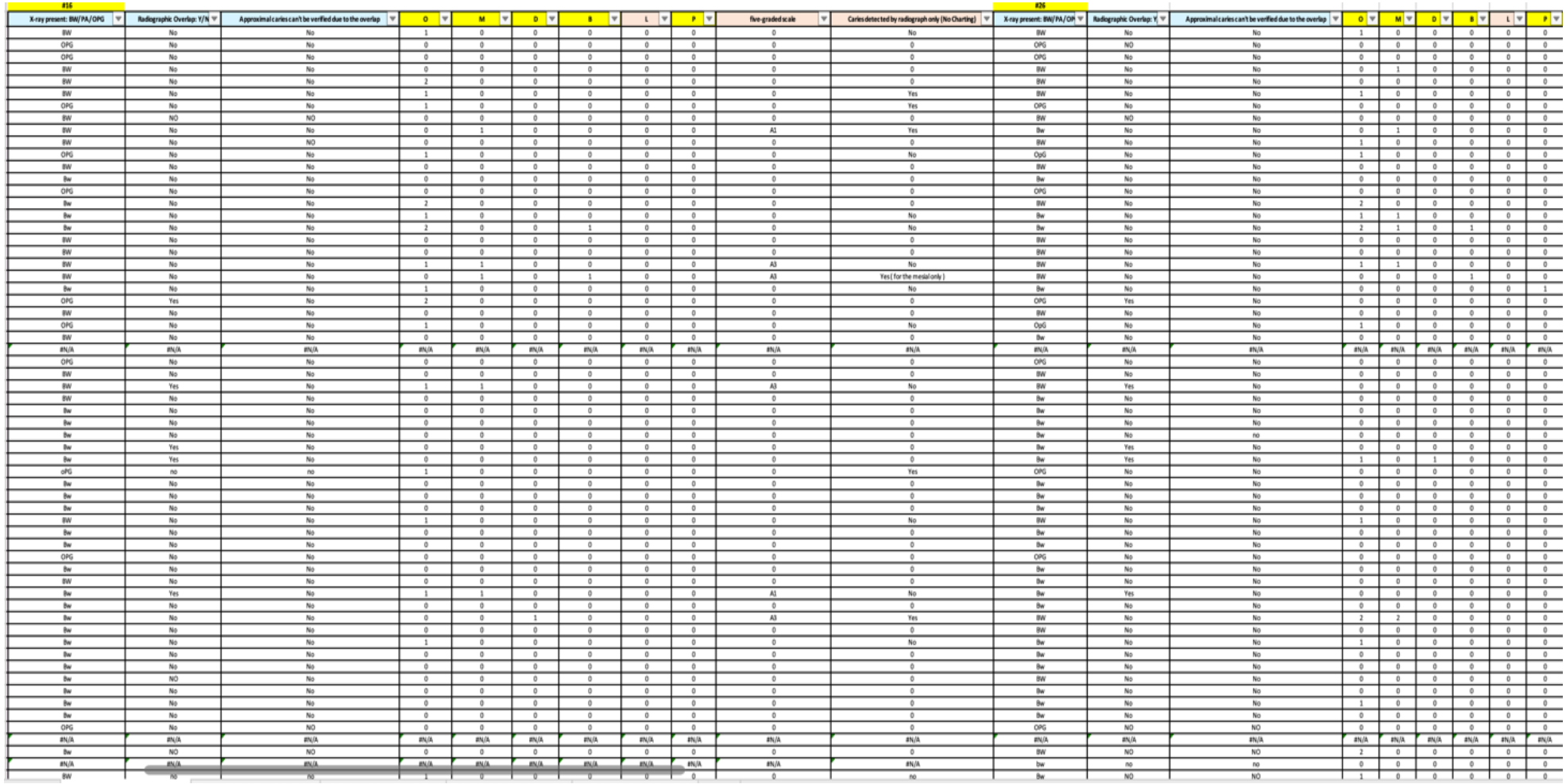
9.1 Appendix 1

Microsoft Excel standard proforma showing the recorded demographic variables of the participants.

Demographic Informations				General Health
Patient's ID	Gender: M/F	Patient's Age	Nationality (UAE/Others)	medically compromised / special needs pt.
10751	M	11	India	F&W
11133	M	10	Pakistan	F&W
11146	F	12	UAE	F&W
11161	F	10	Yemen	F&W
11180	F	10	others	F&W
11246	M	11	Indian	F&W
11249	F	6	palestine	f&W
11263	F	6	Iran	F&W
11266	M	12	Iran	F&W
11285	M	8	Afghanistan	F&W
11302	F	5	Russia	F&W
11348	M	11	Ethiopia	F&W
11367	F	7	Jordan	F&W
11372	M	9	Indian	F&W
11375	F	11	Egypt	F&W
11385	M	8	australia	F&W
11455	F	7	Iraq	F&W
11456	M	9	India	F&W
11474	M	11	UAE	f&W
11481	M	11	UAE	f&W
11502	M	12	UAE	f&W
11507	F	11	Jordan	f&W
11530	F	11	UAE	f&W
11547	M	9	CHINA	f&W
11594	F	11	Philippine	f&W
11620	M	7	Yemen	f&W
11621	F	9	yemen	f&W

9.2 **Appendix 2**

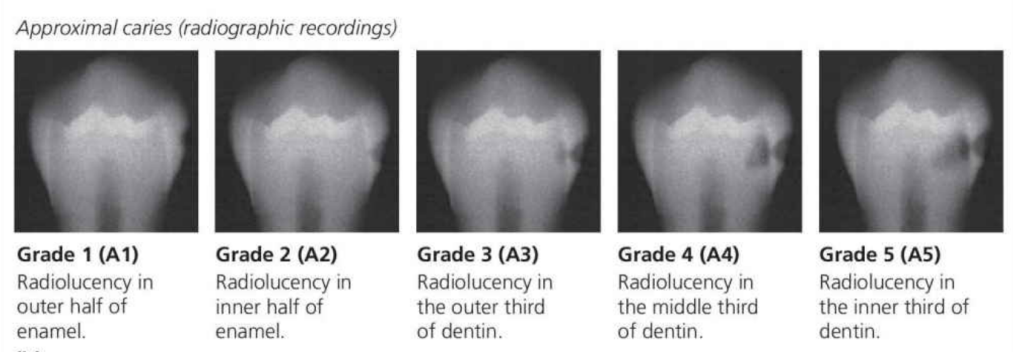
Microsoft Excel standard proforma showing the recorded carious and radiographical characteristics of each FPM.



#16												#26							
X-ray present: BW/PA/OPG	Radiographic Overlap: Y/N	Approximal caries can't be verified due to the overlap	O	M	D	B	L	P	five-graded scale	Caries detected by radiograph only (No Charting)	X-ray present: BW/PA/OP	Radiographic Overlap: Y	Approximal caries can't be verified due to the overlap	O	M	D	B	L	P
BW	No	No	1	0	0	0	0	0	0	No	BW	No	No	1	0	0	0	0	0
OPG	No	No	0	0	0	0	0	0	0	0	OPG	NO	No	0	0	0	0	0	0
OPG	No	No	0	0	0	0	0	0	0	0	OPG	No	No	0	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	1	0	0	0	0
BW	No	No	2	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
BW	No	No	1	0	0	0	0	0	0	Yes	BW	No	No	1	0	0	0	0	0
OPG	No	No	1	0	0	0	0	0	0	Yes	OPG	No	No	0	0	0	0	0	0
BW	NO	NO	0	0	0	0	0	0	0	0	BW	NO	No	0	0	0	0	0	0
BW	No	No	0	1	0	0	0	0	A1	Yes	Bw	No	No	0	1	0	0	0	0
BW	No	NO	0	0	0	0	0	0	0	0	BW	No	No	1	0	0	0	0	0
OPG	No	No	1	0	0	0	0	0	0	No	OpG	No	No	1	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
OPG	No	No	0	0	0	0	0	0	0	0	OPG	No	No	0	0	0	0	0	0
Bw	No	No	2	0	0	0	0	0	0	0	BW	No	No	2	0	0	0	0	0
Bw	No	No	1	0	0	0	0	0	0	No	Bw	No	No	1	1	0	0	0	0
Bw	No	No	2	0	0	1	0	0	0	No	Bw	No	No	2	1	0	1	0	0
BW	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
BW	No	No	1	1	0	0	0	0	A3	No	BW	No	No	1	1	0	0	0	0
BW	No	No	0	1	0	1	0	0	A3	Yes (for the mesial only)	BW	No	No	0	0	0	1	0	0
Bw	No	No	1	0	0	0	0	0	0	No	Bw	No	No	0	0	0	0	0	1
OPG	Yes	No	2	0	0	0	0	0	0	0	OPG	Yes	No	0	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
OPG	No	No	1	0	0	0	0	0	0	No	OpG	No	No	1	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
OPG	No	No	0	0	0	0	0	0	0	0	OPG	No	No	0	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
BW	Yes	No	1	1	0	0	0	0	A3	No	BW	Yes	No	0	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	no	0	0	0	0	0	0
Bw	Yes	No	0	0	0	0	0	0	0	0	Bw	Yes	No	0	0	0	0	0	0
Bw	Yes	No	0	0	0	0	0	0	0	0	Bw	Yes	No	1	0	1	0	0	0
oPG	no	no	1	0	0	0	0	0	0	Yes	OPG	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
BW	No	No	1	0	0	0	0	0	0	No	BW	No	No	1	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
OPG	No	No	0	0	0	0	0	0	0	0	OPG	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
BW	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	Yes	No	1	1	0	0	0	0	A1	No	Bw	Yes	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	1	0	0	0	A3	Yes	BW	No	No	2	2	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
Bw	No	No	1	0	0	0	0	0	0	No	Bw	No	No	1	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	NO	No	0	0	0	0	0	0	0	0	BW	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	1	0	0	0	0	0
Bw	No	No	0	0	0	0	0	0	0	0	Bw	No	No	0	0	0	0	0	0
OPG	No	NO	0	0	0	0	0	0	0	0	OPG	NO	NO	0	0	0	0	0	0
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Bw	NO	NO	0	0	0	0	0	0	0	0	BW	NO	NO	2	0	0	0	0	0
#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	bw	no	no	0	0	0	0	0	0
BW	No	no	1	0	0	0	0	0	0	no	Bw	NO	NO	1	0	0	0	0	0

9.3 **Appendix 3**

Alternative index using a five-graded scale for severity grading of caries on free approximal tooth surfaces. (Reference: Pocket Dentistry website, 12: Diagnosis and Management of Dental Caries)



9.4 **Appendix 4**

The ethical approval from the Research Ethics Review Committee at Mohammed Bin Rashid University of Medicine and Health Sciences.

25 August 2020

Dr Mariam Al Mansour
Resident
HBMCDM

RE: MBRU-IRB-2020-023

Dear Dr Mariam,
Thank you for submitting the study titled "Severity and Pattern of Dental Caries of the First Permanent Molars among 5-12-Years-Old Dubai Children attending Dubai Dental Hospital in the United Arab Emirates" to the IRB for exempt review. The Board has reviewed the same in its meeting of 25.08.2020 and has agreed to approve it.

The project can now commence. Any change in protocol should be notified to the Board.

For any questions, please contact the Institutional Review Board irb@mbru.ac.ae.

Thank you for your interest in MBRU-IRB.

Sincerely,

Essa Kazim, FRCS
Chairman, MBRU-IRB

MBRU/IRB/2020/023 Page **1** of **1**