

Dental Caries in the First Permanent Molar during the Mixed Dentition Stage

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ABSTRACT

Background: The early eruption of the first permanent molar (FPM) favors its exposure to the risk factors for dental caries specific to the mixed dentition stage of dental development. The aim of this study was to assess the prevalence and distribution pattern of FPM dental caries and of the consequences of this pathology – caries with pulp involvement in the FPM and missing FPM (FPM extraction) in a sample of Romanian children during the mixed dentition stage.

Materials and methods: Eighty-seven children aged between five and 13 years, who attended a private dental clinic, were enrolled in the present study. The investigations were carried out as part of the comprehensive dental examinations. Written informed consent was obtained from one of the subjects' parents prior to his/her child's participation in this research. The collected data were statistically analyzed with STATA/MP13 software using the Chi square test. The level of significance was set at $p < 0.05$.

Results: The prevalence of FPM dental caries was 60.9%. There were statistically significant differences ($p = 0.004$) in the number of FPMs affected by dental caries per subject in relation to age. No statistically significant differences regarding the number of FPMs affected by dental caries per subject in relation to gender were found. With respect to the distribution pattern of FPM dental caries by location at tooth level, the mesial surface had the highest prevalence (in 36.8% of all investigated subjects), followed by the occlusal surface (33.3%). The prevalence of caries with pulp involvement in the FPM was 19.5% and children in the 10-11-year age group were the most affected (55.5%). There were statistically significant differences regarding the distribution pattern of caries with pulp involvement in the FPM by age ($p = 0.0001$). The prevalence of FPM extraction was 6.9% and, according to dental history and examination, loss of FPM was due to caries. Among children with missing FPM, five were older than the age recommended for achieving spontaneous space closure, which indicated the need for immediate intervention.

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Conclusions: *Considering the results of the present study, it can be stated that FPM dental caries represents a highly prevalent pathology during the mixed dentition stage. The findings are relevant and useful for the current clinical dental practice, emphasizing the importance of caries detection and diagnosis in developing a comprehensive dental treatment plan tailored to the specific needs of pediatric patients.*

Keywords: mixed dentition, first permanent molar, dental caries, pulp involvement, extraction, comprehensive management.

INTRODUCTION

Mixed dentition is the period of transition between primary and permanent dentition (1), extending between six and 13 years of age (2). The beginning of this stage is marked by the eruption of the first permanent molar (FPM), while the replacement of all deciduous teeth by their permanent successors and the eruption of the second permanent molar represent its end. The FPM is quoted as the most important tooth for the harmonious development of dental arches and occlusion (3, 4).

Dental caries is a chronic infectious disease representing the demineralization of the hard dental tissues as a consequence of microbial metabolism (5, 6). Four factors are involved in the etiology of dental caries, including oral microorganisms, oral environment, host and time (7, 8).

The FPM is the most vulnerable to caries among the teeth in the permanent dentition (9-12) and many factors contribute to this high prevalent pathology in the FPM. First of all, the development and mineralization of this tooth occur during the time of birth and immediately after it until the age of three (13). The duration of the FPM eruption is very long (between six months and one year), which represents a period without functionality, characterized by occlusal surface massive plaque accumulation (13). The fact that higher amounts of biofilm accumulate on the occlusal surface of partially erupted FPMs compared to fully erupted FPMs is illustrated by many researchers (14-17). Other factors that contribute to the FPM high caries susceptibility are explained by the FPM early eruption (3) and consequently, early exposure to the oral environment (9, 12), the posterior position in the dental arch (3, 18), the retentive mor-

phology of the occlusal surface (12), the immature enamel (12, 13), the lack of brushing skills by the child (3, 18) and parents' unawareness of the permanent nature of this molar (3). A particular feature in relation to the mixed dentition stage is the FPM coexistence with deciduous teeth which are mobile at the time of their shedding and often decayed (13). These conditions contribute to supplementing biofilm accumulation at FPM level and disadvantaging self-cleaning (13).

Researchers show that a strong correlation exists between preservation of FPM health in children and future dental health (3).

Lack of proper treatment of FPM dental caries can lead to irreversible damage to the dentin-pulp complex and even FPM loss.

The aim of this study was to evaluate the prevalence of FPM dental caries and its pattern of distribution in relation to age, gender and tooth surfaces, as well as the prevalence of the consequences of this pathology, including caries with pulp involvement in the FPM and missing FPM (FPM extraction), by age and gender, in a sample of Romanian children during the mixed dentition stage. □

MATERIALS AND METHODS

The present study was conducted in a private pediatric dental clinic on 87 children aged five to 13 years in the mixed dentition stage. Written informed consent was obtained from one of the subjects' parents prior to his/her child's participation to this research.

Subjects were assigned to one of the following age groups: 5-6 years, 6-7 years, 7-8 years, 8-9 years, 9-10 years, 10-11 years, 11-12 years and older than 12 years.

The investigations were carried out as part of the comprehensive dental examinations.

Subjects' assessment comprised the following information: the presence of FPM dental caries and its distribution in relation to age group and subject's gender; the FPM surfaces affected by dental caries according to age group and subject's gender; the presence of caries with pulp involvement (inflamed or infected pulp) and its distribution with regard to age group and subject's gender; and the missing FPM (FPM extraction) and its distribution by age and gender.

The examinations were carried out with a blunt-ended dental explorer and a mouth mirror under the operating light. Dental caries was diagnosed based on the World Health Organization criteria (19-21).

For occlusal surfaces and smooth surfaces, dental caries was recorded as present when the lesion was obvious by visual examination, showed undermined enamel, and had a softened floor or wall when tactile exploring it (19-21).

For approximal surfaces, dental caries was recorded as present when there were signs of undermined enamel (discoloration) (20) or the dental explorer had entered a lesion (21).

Caries with pulp involvement were diagnosed as symptomatic irreversible pulpitis (vital inflamed pulp) and necrotic pulp based on the diagnostic criteria published by the American Academy of Pediatric Dentistry (AAPD) (22).

Caries with pulp involvement were recorded when (22): a) FPM showed a deep caries lesion penetrating the pulp and a history of spontaneous unprovoked pain of long duration, not relieved with over-the-counter analgesics was reported; the diagnosis was symptomatic irreversible pulpitis (vital inflamed pulp); and b) FPM showed a deep caries lesion penetrating the pulp chamber with no pulp vitality signs present, sometimes in association with periradicular changes which were clinically and radiographically identified; the diagnosis was necrotic pulp.

FPM loss (FPM extraction) was diagnosed by clinical and radiographic examination accompanied by a review of dental history, when a missing FPM was recorded. Delayed eruption and impaction were considered in the differential diagnosis of FPM loss.

The collected data were statistically analyzed with STATA/MP13 software using the Chi square test. The level of significance was set at $p < 0.05$. □

RESULTS

The study sample comprised 44 females and 43 males. The gender distribution pattern according to the eight age groups is presented in Table 1.

Age group	Females		Males		Total	
	N	%	N	%	N	%
5-6 years	1	2.3	3	7.0	4	4.6
6-7 years	10	22.7	6	13.9	16	18.4
7-8 years	4	9.1	11	25.6	15	17.2
8-9 years	10	22.7	6	13.9	16	18.4
9-10 years	5	11.4	5	11.6	10	11.5
10-11 years	9	20.4	9	20.9	18	20.7
11-12 years	4	9.1	1	2.3	5	5.8
>12 years	1	2.3	2	4.7	3	3.4
Total	44	50.6	43	49.4	87	100
Chi square test; $p = 0.299$						

N=number of subjects

TABLE 1. Distribution of study sample by age and gender

Dental caries

The prevalence of FPM dental caries was 60.9% in the study group. Among the investigated children, 39.1% of them had no decayed FPMs, 9.2% had one affected FPM, 17.2% showed two FPMs with caries lesions, 6.9% presented three decayed FPMs and 27.6% had all four FPMs affected (Table 2).

As shown in Table 2, lack of caries lesions in the FPM was high in the first age groups. Thus, the number of children with no dental caries of the FPM in the sample of 6-7-year-olds represented 26.5%, while those in the age group 7-8 years and 8-9 years represented 14.7% each among subjects with no affected FPMs. On the contrary, children with no dental caries of the FPM in the age group older than 12 years represented only 2.9% of the subjects in this category. As shown in Table 2, there were statistically significant differences ($p = 0.004$) in the number of FPMs affected by dental caries per subject in relation to age.

Regarding the distribution of FPM dental caries in relation to subjects' gender (Table 3), a similar prevalence was found for girls and boys. The situations with one affected FPM and two affected FPMs per subject were more frequently encountered among boys than girls (62.5% vs

Age group	All FPMs without dental caries		One FPM with dental caries		Two FPMs with dental caries		Three FPMs with dental caries		All FPMs with dental caries		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
5-6 years	4	11.8	0	0	0	0	0	0	0	0	4	4.6
6-7 years	9	26.5	1	12.5	4	26.7	0	0	2	8.33	16	18.4
7-8 years	5	14.7	0	0	1	6.7	0	0	9	37.5	15	17.2
8-9 years	5	14.7	3	37.5	2	13.3	0	0	6	25	16	18.4
9-10 years	3	8.8	3	37.5	2	13.3	0	0	2	8.3	10	11.5
10-11 years	4	11.8	0	0	5	33.3	5	83.3	4	16.7	18	20.7
11-12 years	3	8.8	1	12.5	0	0	0	0	1	4.2	5	5.8
>12 years	1	2.9	0	0	1	6.7	1	16.7	0	0	3	3.4
Total	34	39.1	8	9.2	15	17.2	6	6.9	24	27.6	87	100
Chi square test; $p = 0.004$												

N=number of subjects

TABLE 2.
Number of FPMs affected by dental caries *per subject* in relation to age

Gender	All FPMs without dental caries		One FPM with dental caries		Two FPMs with dental caries		Three FPMs with dental caries		All FPMs with dental caries		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Girls	18	52.9	3	37.5	7	46.7	3	50	13	54.2	44	50.57
Boys	16	47.1	5	62.5	8	53.3	3	50	11	45.8	43	49.43
Total	34	39.1	8	9.2	15	17.2	6	6.9	24	27.6	87	100
Chi square test; $p = 0.933$												

N=number of subjects

TABLE 3.
Number of FPMs affected by dental caries *per subject* in relation to gender

37.5% and 53.3% vs 46.7%), while those with four affected FPMs *per subject* were more commonly seen among girls (54.2%). Cases with three affected FPMs were equally distributed between boys and girls (50%). There were no statistically significant differences in the number of FPMs affected by dental caries *per subject* in relation to gender ($p = 0.933$) (Table 3).

With respect to the distribution pattern of FPM dental caries by tooth site (Tables 4 and 5), the mesial surface had the highest prevalence (in 36.8% of all investigated subjects), followed by the occlusal surface (33.3%), distal-occlusal location (11.5%), buccal-occlusal location (8%), mesial-occlusal location (6.9%) and the lingual-occlusal, lingual and buccal locations, each in 1.1%

of participants. According to data summarised in Table 4, the incidence of caries lesions affecting several dental surfaces increased with subjects' age.

In what concerns the distribution of dental caries on the FPM surfaces by gender (Table 5), similar occurrence rates were found in girls and boys for the occlusal and distal-occlusal locations. The mesial-occlusal location was more frequently found in male subjects than female ones (83.3% vs 16.7 %), while the buccal-occlusal and mesial locations were more prevalent in girls than boys (57.1% vs 42.9% and 53.1% vs 46.9%).

Figure 1 shows the clinical picture of an occlusal caries in tooth 46, in a boy aged 10 years and two months.

Age group	O		M-O		D-O		B-O		L-O		L		B		M		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
5-6 years	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12.5	4	4.6
6-7 years	7	24.1	0	0	1	10	0	0	0	0	0	0	0	0	8	25	16	18.4
7-8 years	6	20.7	1	16.7	3	30	0	0	0	0	0	0	0	0	5	15.6	15	17.2
8-9 years	3	10.3	2	33.3	3	30	2	28.6	0	0	1	100	0	0	5	15.6	16	18.4
9-10 years	4	13.8	1	16.7	0	0	1	14.3	0	0	0	0	1	100	3	9.4	10	11.5
10-11 years	6	20.7	2	33.3	2	20	3	42.9	1	100	0	0	0	0	4	12.5	18	20.7
11-12 years	2	6.9	0	0	0	0	1	14.3	0	0	0	0	0	0	2	6.3	5	5.8
>12 years	1	3.5	0	0	1	10	0	0	0	0	0	0	0	0	1	3.1	3	3.4
Total	29	33.3	6	6.9	10	11.5	7	8.0	1	1.1	1	1.1	1	1.1	32	36.8	87	100
Chi square test; p = 0.800																		

TABLE 4. Distribution pattern of dental caries on the FPM surfaces by age

O=occlusal location; M-O=mesial-occlusal location; D-O=distal-occlusal location;

B-O=buccal-occlusal location; L-O=lingual-occlusal location;

L=lingual location; B=buccal location; M=mesial location; N=number of subjects.

Gender	O		M-O		D-O		B-O		L-O		L		B		M		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Girls	15	51.7	1	16.7	5	50	4	57.1	0	0	1	100	1	100	17	53.1	44	50.6
Boys	14	48.2	5	83.3	5	50	3	42.9	1	100	0	0	0	0	15	46.9	43	49.4
Total	29	33.3	6	6.9	10	11.5	7	8.0	1	1.1	1	1.1	1	1.1	32	36.8	87	100
Chi square test; p = 0.545																		

TABLE 5. Distribution pattern of dental caries on the FPM surfaces by gender

O=occlusal location; M-O=mesial-occlusal location; D-O=distal-occlusal location;

B-O=buccal-occlusal location; L-O=lingual-occlusal location;

L=lingual location; B=buccal location; M=mesial location;

N=number of subjects.



FIGURE 1. Dental caries on tooth 46, in a boy aged 10 years and two months

Caries with pulp involvement

The caries with pulp involvement in the FPM showed a prevalence of 19.5% in the study group (Tables 6 and 7). One FPM affected by

caries with pulp involvement was present in 9.2% of participants, two FPMs showing caries with pulp involvement in 8% and three FPMs showing caries with pulp involvement in only 2.3% of subjects. We did not encounter any subject who presented caries with pulp involvement in all FPMs. Lack of caries with pulp involvement was highly prevalent in 6–10-year-old children, who accounted for 75.6% of subjects without this pathology (Table 6). The highest prevalence of caries with pulp involvement was seen in children aged 10–11 years, of which 55.5% had this oral health problem (Table 6). A caries with pulp involvement in the tooth 36 after treatment, in a girl aged 10 years and 11 months, is shown in Figure 2. It is worth noting the high prevalence of cases without dental caries with pulp involvement in the FPM (80.5% of all sub-

Age group	All FPMs without caries with pulp involvement		One FPM affected by caries with pulp involvement		Two FPMs affected by caries with pulp involvement		Three FPMs affected by caries with pulp involvement		Total	
	N	%	N	%	N	%	N	%	N	%
5-6 years	4	5.7	0	0	0	0	0	0	4	4.6
6-7 years	16	22.9	0	0	0	0	0	0	16	18.4
7-8 years	15	21.4	0	0	0	0	0	0	15	17.2
8-9 years	13	18.6	0	0	2	28.6	1	50	16	18.4
9-10 years	9	12.7	0	0	1	14.3	0	0	10	11.5
10-11 years	8	11.4	6	75	4	57.1	0	0	18	20.7
11-12 years	4	5.7	0	0	0	0	1	50	5	5.8
>12 years	1	1.4	2	25	0	0	0	0	3	3.4
Total	70	80.5	8	9.2	7	8.0	2	2.3	87	100

Chi square test; $p = 0.0001$

N=number of subjects.

TABLE 6. Distribution pattern of caries with pulp involvement in the FPM by age

Gender	All FPMs without caries with pulp involvement		One FPM affected by caries with pulp involvement		Two FPMs affected by caries with pulp involvement		Three FPMs affected by caries with pulp involvement		Total	
	N	%	N	%	N	%	N	%	N	%
Girls	36	51.4	4	50	3	42.9	1	50	44	50.6
Boys	34	48.6	4	50	4	57.1	1	50	43	49.4
Total	70	80.5	8	9.2	7	8.0	2	2.3	87	100

Chi square test; $p = 0.979$

N=number of subjects.

TABLE 7. Distribution pattern of caries with pulp involvement in the FPM by gender

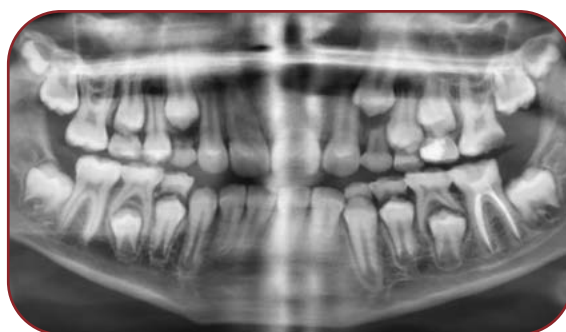


FIGURE 2. Caries with pulp involvement after treatment in tooth 36, on the orthopantomography (OPG) image, in a girl aged 10 years and 11 months

pulp involvement *per* subject was more prevalent in boys than girls (57.1% vs 42.9%). The remaining situations analyzed by us were equally distributed between genders (50%).

FPM extraction

The prevalence of FPM extraction was 6.9% (Tables 8 and 9). Among the 87 pediatric patients, 81 (93.1%) showed no FPM extractions. The extraction of one FPM was found in 5.7% and that of two FPMs in 1.1% of subjects. According to data summarized in Table 8, FPM extraction was encountered in children aged 8-13 years.

Regarding the gender-related distribution of FPM extraction (Table 9), two girls and three boys had one FPM extracted and one girl had two FPMs extracted. □

DISCUSSIONS

The present study evaluated the distribution pattern of FPM dental caries as well as the

jects). As shown by Table 6, there were statistically significant differences in the age-related distribution pattern of caries with pulp involvement in the FPM ($p = 0.0001$).

The distribution pattern of caries with pulp involvement in the FPM by gender (Table 7) shows a similar prevalence for girls and boys. The situation of two FPMs affected by caries with

Age group	No FPM extraction		One FPM extracted		Two FPMs extracted		Total	
	N	%	N	%	N	%	N	%
5-6 years	4	4.9	0	0	0	0	4	4.6
6-7 years	16	19.8	0	0	0	0	16	18.4
7-8 years	15	18.5	0	0	0	0	15	17.2
8-9 years	15	18.5	1	20	0	0	16	18.4
9-10 years	9	11.1	1	20	0	0	10	11.5
10-11 years	16	19.8	1	20	1	100	18	20.7
11-12 years	4	4.9	1	20	0	0	5	5.8
>12 years	2	2.5	1	20	0	0	3	3.4
Total	81	93.1	5	5.7	1	1.1	87	100

Chi square test; $p = 0.570$

N=number of subjects.

TABLE 8.
Distribution of
FPM extraction by
age

Gender	No FPM extraction		One FPM extracted		Two FPMs extracted		Total	
	N	%	N	%	N	%	N	%
Girls	41	50.6	2	40	1	100	44	50.6
Boys	40	49.4	3	60	0	0	43	49.4
Total	81	93.1	5	5.8	1	1.1	87	100

Chi square test; $p = 0.549$

N=number of subjects.

TABLE 9. Distribution
of FPM extraction in
relation to
subjects' gender

prevalence of its consequences that may occur if it is either not treated or treated incorrectly, namely pulp injury and FPM extraction, in a sample of Romanian pediatric population.

There was a high overall prevalence of FPM dental caries in the study sample (60.9%). Other authors who explored FPM dental caries in a group of Sudanese children aged 6-14 years reported a prevalence of 61% (23), which was very close to our finding. In 2012, a higher prevalence was reported by Al-Samadani and Ahmad; they found that among the 432 children aged 9 to 12 years, who were examined by them in Jeddah, Kingdom of Saudi Arabia, 326 (75.5%) had FPM dental caries (24). In contrast, Zhu *et al* investigated a pediatric population aged six- to eight-year-old from Zhejiang Province, China, between 2013-2017, and found lower prevalence rates for FPM dental caries: 20.4% in 2013, 25.3% in 2014, 24.5% in 2015, 27.0% in 2016 and 29.0% in 2017 (25); however, there was an increase in FPM dental caries prevalence from 2013 to 2017 (25). A lower distribution for FPM dental caries as compared to that found in the present study was also reported by Phipps *et al* in their study on American Indian and Alaska native children aged 4 to 11 years (26); thus, among kindergarteners who had all four FPMs erupted, 7% exhibited decayed, missing and filled FPMs

(26), with the same pathologic conditions in the FPM being found in 21%, 31% and 38% of the first, second, and third graders, respectively (26).

In the present study, there were no significant differences concerning FPM caries susceptibility by gender during the mixed dentition stage. Similar findings were reported by Al-Samadani and Ahmad in 2012 (24), Que *et al* in 2021 (8) and Agrawal *et al* in 2023 (20). On the contrary, in 2023, Urvasizoglu *et al* found statistically significant differences in gender-wise distribution of FPM dental caries in 7-10-year-old children in Erzurum, Turkey (27); thus, girls had a higher number of decayed FPMs and restored FPMs than boys, with statistical significances being given by $p < 0.001$ and $p = 0.024$, respectively (27). The above-mentioned study conducted by Zhu *et al* in 2021 also described a higher prevalence of FPM dental caries in girls compared to boys (OR = 1.38) (25).

In the present study, the most affected FPM surface was the mesial one (in 36.8% of subjects). Several researchers explained the high caries susceptibility of the FPM mesial surface by the presence of adjacent decayed distal surface of the second primary molar (28, 29). In 2001, Mejare *et al* found that the prevalence of FPM caries during the mixed dentition stage was 15 times higher in cases of enamel/enamel-den-

tin border caries of the second deciduous molars compared to cases of sound primary molars (28). In 2004, Vanderas *et al* also emphasized the strong correlation between the development of caries on FPM mesial surface and the presence of decay on the distal surface of the second primary molar (29); all the same, the authors showed that this correlation was more evident for the mandibular FPM, which has a direct surface contact with the neighboring second deciduous molar during the entire period of the eruption, as a consequence of its mesial and lingual eruption path, while the maxillary FPM erupts on a distal and buccal direction, reaching the mesial contact after the end of the eruption (29). In contrast to our findings, those reported by Agrawal *et al* after investigating 655 children aged 6-11 years from Sunsari, Nepal showed that the occlusal surface was the most affected area, while the mesial surface was in the penultimate place in descending order of dental caries prevalence by location at the tooth level (20). Different results from those of the present study were also reported by Abuaffan *et al*, who found that the FPM occlusal surface was the most susceptible area, while the mesial surface was among the locations least prone to dental caries in Sudanese children aged 6-14 years (23). In 2021, Que *et al* described a significantly higher prevalence for caries occurrence on FPM occlusal surface (66.68%) than on other molar sites (8). Other authors mentioned that the FPM occlusal surface and the buccal pit of mandibular FPM represented the most frequent locations of dental caries occurrence during the mixed dentition period (3). These observations are not in accordance with ours.

Screening the number of affected FPMs *per* subject, as it was carried out by the present study, is an important component of the evaluation for caries activity in mixed dentition children. According to scientific evidence, the presence of all FPMs being affected indicates a high probability for further occurrence of dental caries on second permanent molars (30). In 2006, Skeie *et al* investigated 186 Norwegian children aged 10 and found that 61 of them (32.8%) had all four FPMs decayed and 27 (14.5%) had three affected FPMs – hence, such frequencies were higher than those depicted in the current research for the same categories by the number of affected FPMs *per* subject (10). Higher prevalences than

those obtained in the present study were also reported by Al-Samadani and Ahmad in 2012 for subjects with one decayed FPM [112 (26%)], with two decayed FPMs [120 (28%)] and with three affected FPMs [67 (15.5%)], while all four affected FPMs were seen in only 27 (6%) of the 432 participants (24). The last category represents a much lower percentage than in the present study.

There is a paucity of epidemiological data on the prevalence of dental caries with pulp involvement of the FPM. This finding could stem from the fact that pulp pathology as a consequence of dental caries on the FPM is scarce, owing to the preventive and treatment programs carried out in certain developing and developed countries. However, several studies assessed the prevalence of various treatments performed at the FPM level in the pediatric population and reported dental pulp therapy (as a treatment needed for dental caries with pulp involvement). Thus, in 2022 Noueiri and Aboujaoude conducted a study on a sample of 7-10-year-old Lebanese children, who were evaluated for the severity of previous lesions by treatments carried out on the FPM, and found 11 pulpotomies (the therapy of reversible injury to the dental pulp), representing only 0.5% of all 2145 registered treatments, hence a low prevalence of caries with pulp involvement (only the inflamed pulp stage) (31). Ebrahimi *et al* reported that among the 700 pediatric subjects aged seven to nine years from Mashhad, Iran, only 2.4% needed pulp treatment (32), which indicated a much lower prevalence of caries with pulp involvement than in the current study. The results of a research conducted in two areas (rural and urban) in North-Western Romania, concerning caries pathology of the FPM among 9-12-year-old subjects, showed that 30.95% of children from the urban area and 20.41% of those from the rural community had caries with pulp involvement (33). This is an interesting result, because a lower prevalence of caries with pulp involvement would have been expected in urban children, as compared to their rural counterparts, since the former had a better access to oral health services than the latter. In 2020, Stanciu *et al* investigated 200 Romanian patients aged 6-9 years from the Pediatric Dentistry Clinic of “Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania (34). Among the 319 decayed FPMs found by the authors, 33 (10.35%)

had caries with pulp involvement distributed in the following way: 39.39% with vital inflamed pulps, 9.09% necrotic pulps and 51.52% necrotic pulps associated with periradicular changes (34). The authors also reported the presence of caries with pulp involvement in the FPM as a consequence of the so-called molar incisor hypomineralization (MIH) pathology: of the 63 MIH affected FPMs, 12.69% had caries with pulp involvement (34).

Regarding the FPM loss, in 2023 Urvasizoglu *et al* found 52 missing FPMs, representing only 0.1% of the total examined FPMs in 17,208 pediatric patients aged 7-10 years from Erzurum (27), which was a much lower prevalence than in the present study. In 2021, Alraqiq *et al* investigated 1934 children from Tripoli and reported a higher prevalence of missing FPMs than in the current research; thus, 5.3% of the screened FPMs in the 6-7-year age group and 6.7% in the 11-12-year-olds were missing due to caries (35). Therefore, the number of missing FPMs increased with age (35). In 2022, Noueiri and Aboujaoude found 15 extracted FPMs when tabulated the dental records of 753 Lebanese children aged 7-10 years (31), which was a lower prevalence of missing FPM than that in the current research. In a study carried out on three groups totalizing 300 children with an average age of 10-11 years from three different cities in the United Kingdom, a high prevalence was determined for the situation with four FPMs extracted *per subject*; thus, 48% of subjects had four FPMs extracted in Sheffield, 45% in Manchester and 25% in Liverpool (36). The authors showed that the main reason for the FPM extraction was dental caries with a poor prognosis, in 89% of all studied cases (36). A 2020 study by Karthikeson *et al* reported that FPM extraction was carried out in 21.05% of children in the mixed dentition stage (8-12 years) and that pulp inflammation was the most common reason for extraction (37).

Missing FPM was found in 6.9% of participants in the current research and, according to dental history and examination, the loss of FPM was due to caries. Scientific evidence indicates that extraction during mixed dentition stage is preferable to restoration for FPM with poor long-term prognosis due to extensive caries, provided that the space closure is monitored and the need for orthodontic treatment is assessed (9). Plan-

ning the proper moment for extraction is an important component of a comprehensive management of FPM extensive dental caries in children. Researchers have shown that the ideal time for extraction is the beginning of calcification of the bifurcation of the roots of the lower second permanent molar (between eight and a half years to nine and a half years) (38). Among children with missing FPM identified in the present study, five were older than the age recommended for achieving spontaneous space closure, which indicated the need for immediate intervention.

Limitations of the present study stem from the small number of participants, and therefore, further research in this area is needed. The influence of social and behavioral factors as well as the impact of dietary habits on the prevalence of dental caries should be also investigated. ▣

CONCLUSIONS

Considering the results of the present study, it can be stated that FPM dental caries represents a highly prevalent pathology during the mixed dentition stage. Our findings are relevant and useful for the current clinical dental practice, emphasizing the importance of caries detection and diagnosis in developing a comprehensive dental treatment plan tailored to the specific needs of pediatric patients. ▣

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REFERENCES

1. **Van der Linden FPGM.** *Development of the human dentition.* USA, Hanover Park, IL: Quintessence Publishing Co. 2013.
2. **American Academy of Pediatric Dentistry.** Management of the developing dentition and occlusion in pediatric dentistry. In: *The Reference Manual of Pediatric Dentistry.* USA, Chicago, IL: American Academy of Pediatric Dentistry. 2021.
3. **Llena C, Calabuig E, Sanz JL, et al.** Risk Factors Associated with Carious Lesions in Permanent First Molars in Children: A Seven-Year Retrospective Cohort Study. *Int J Environ Res Public Health* 2020;17:1421. doi: 10.3390/ijerph17041421.
4. **Stoica SN, Nimigean V, Virlean MJR, et al.** The Pathology of the First Permanent Molar during the Mixed Dentition Stage—Review. *Appl Sci Section Applied Dentistry and Oral Sciences* 2023;13:483. <https://doi.org/10.3390/app13010483>.
5. **Chenicheri SRU, Ramachandran R, et al.** Insight into Oral Biofilm: Primary, Secondary and Residual Caries and Phyto-Challenged Solutions. *Open Dent J* 2017;11:312-333. doi: 10.2174/1874210601711010312.
6. **Rathee M, Sapra A.** Dental Caries. [Updated 2023 Mar 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK551699/> (Accessed on the 1st of April 2023).
7. **Chen X, Daliri EB, Kim N, et al.** Microbial Etiology and Prevention of Dental Caries: Exploiting Natural Products to Inhibit Cariogenic Biofilms. *Pathogens* 2020;9:569. doi: 10.3390/pathogens9070569.
8. **Que L, Jia M, You Z, et al.** Prevalence of dental caries in the first permanent molar and associated risk factors among sixth-grade students in São Tomé Island. *BMC Oral Health* 2021;21:483. doi: 10.1186/s12903-021-01846-z.
9. **Gill DS, Lee RT, Tredwin CJ.** Treatment planning for the loss of first permanent molars. *Dent Update* 2001;28:304-308. doi: 10.12968/denu.2001.28.6.304.
10. **Skeie MS, Raadal M, Strand GV, et al.** The relationship between caries in the primary dentition at 5 years of age and permanent dentition at 10 years of age - a longitudinal study. *Int J Paediatr Dent* 2006;16:152-160. doi: 10.1111/j.1365-263X.2006.00720.x.
11. **Teo TK, Ashley PF, Parekh S, et al.** The evaluation of spontaneous space closure after the extraction of first permanent molars. *Eur Arch Paediatr Dent* 2013;14:207-212. doi: 10.1007/s40368-013-0042-7.
12. **Jihène Z, Imene J, Badiaa J.** Extraction of decayed and dilapidated first permanent molars in mixed dentition and spontaneous space closure: a case report. *Int J Cur Res Rev* 2018;10:6-9. doi: <http://dx.doi.org/10.31782/IJCRR.2018.10182>.
13. **Zarnea L.** *Pedodontics.* Didactic and pedagogical Publishing House, Bucharest, Romania. 1983, pp 178-187 (in Romanian).
14. **Alves LS, Zenkner JE, Wagner MB, et al.** Eruption stage of permanent molars and occlusal caries activity/arrest. *J Dent Res* 2014;93(7 Suppl):114S-119S. doi: 10.1177/0022034514537646.
15. **Carvalho JC, Ekstrand KR, Thylstrup A.** Dental plaque and caries on occlusal surfaces of first permanent molars in relation to stage of eruption. *J Dent Res* 1989;68:773-779. doi: 10.1177/00220345890680050401.
16. **Brailsford SR, Sheehy EC, Gilbert SC, et al.** The microflora of the erupting first permanent molar. *Caries Res* 2005;39:78-84. doi: 10.1159/000081661.
17. **Hamza M, Chlyah A, Bousfiha B, et al.** Pathology and Abnormality of the First Permanent Molar among Children. In: Akarslan Z, Bourzugui, F. (Eds). *Human Teeth - Key Skills and Clinical Illustrations* [Internet]; London: IntechOpen; 2019. Available from: <https://www.intechopen.com/chapters/69760>. (Accessed on the 15th of September 2022). doi: 10.5772/intechopen.89725.
18. **Wang Z, Rong W, Zhang Y, et al.** Prevalence and contributing factors of dental caries of 6-year-old children in four regions of China. *Peer J* 2019;7:e6997. doi: 10.7717/peerj.6997.
19. **World Health Organization (1997).** Oral health surveys: basic methods, 4th ed. World Health Organization. <https://apps.who.int/iris/handle/10665/41905> (Accessed on the 7th of December 2022).
20. **Agrawal SK, Bhagat T, Shrestha A.** Dental Caries in Permanent First Molar and Its Association with Carious Primary Second Molar among 6-11-Year-Old School Children in Sunsari, Nepal. *Int J Dent* 2023;2023:9192167. doi: 10.1155/2023/9192167.
21. **Demirci M, Tuncer S, Yuceokur AA.** Prevalence of caries on individual tooth surfaces and its distribution by age and gender in university clinic patients. *Eur J Dent* 2010;4:270-279.
22. **American Academy of Pediatric Dentistry.** Pulp therapy for primary and immature permanent teeth. The Reference Manual of Pediatric Dentistry. Chicago, Ill. American Academy of Pediatric Dentistry. 2022, pp 415-423.
23. **Abuaffan AH, Hayder S, Hussien AA, et al.** Prevalence of Dental Caries of the First Permanent Molars among 6-14 Years Old Sudanese Children. *Indian J Dent Educ* 2018;11:13-16. doi.org/10.21088/ijde.0974.6099.11118.2.
24. **Al-Samadani KH, Ahmad MS.** Prevalence of first permanent molar caries in and its relationship to the dental knowledge of 9-12-year olds from jeddah, kingdom of saudi arabia. *ISRN Dent* 2012;2012:391068. doi: 10.5402/2012/391068.
25. **Zhu F, Chen Y, Yu Y, et al.** Caries prevalence of the first permanent molars in 6-8 years old children. *PLoS One* 2021;16:e0245345. doi: 10.1371/journal.pone.0245345.
26. **Phipps KR, Ricks TL, Blahut P.** Permanent first molar eruption and caries patterns in American Indian and Alaska Native children: challenging the concept of targeting second grade for school-based sealant programs. *J Public Health Dent* 2013;73:175-178. doi: 10.1111/jphd.12011.
27. **Urvasisoglu G, Bas A, Sarac F, et al.** Assessment of Permanent First Molars in Children Aged 7 to 10 Years Old. *Children* (Basel) 2022;10:61. doi: 10.3390/children10010061.
28. **Mejäre I, Stenlund H, Julihn A, et al.** Influence of approximal caries in primary molars on caries rate for the mesial surface of the first permanent molar in swedish children from 6 to 12 years of age. *Caries Res* 2001;35:178-185. doi: 10.1159/000047453.
29. **Vanderas AP, Kavvadia K, Papagiannoulis L.** Development of caries in permanent first molars adjacent to primary second molars with interproximal caries: four-year prospective radiographic study. *Pediatr Dent* 2004;26:362-368.
30. **Sheiham A, Sabbah W.** Using universal

- patterns of caries for planning and evaluating dental care.
Caries Res 2010;44:141-150.
doi: 10.1159/000308091.
31. **Noeiri BE, Aboujaoude S.** Treatments Performed on First Permanent Molars in a Sample of Lebanese Children: A Five-Year Retrospective Analysis.
Mater Sociomed 2022;34:211-215.
doi: 10.5455/msm.2022.34.211-215.
32. **Ebrahimi M, Ajami BA, Sarraf Shirazi AR, et al.** Dental treatment needs of permanent first molars in mashhad schoolchildren.
J Dent Res Dent Clin Dent Prospects 2010;4:52-55.
doi: 10.5681/joddd.2010.014.
33. **Todor BI, Vaida L, Moca A, et al.** Correlations between the dental status of permanent first molar and hygiene status in children of mixed dentition.
HVM Bioflux 2019;11:52-56. Available at: <http://www.hvm.bioflux.com.ro/docs/2019.52-56.pdf> (Accessed on the 12th of January 2023).
34. **Stanciu IA, Luca R, Salahat E, et al.** Treatment needs on immature first permanent molar.
Romanian Journal of Dental Medicine 2020;XXIII:204-220. Available at: <https://rjd.ro/volume-xxiii/no-3-4-2020/treatment-needs-on-immature-first-permanent-molar/>. (Accessed on the 20th of March 2023).
35. **Alraqiq H, Eddali A, Boufis R.** Prevalence of dental caries and associated factors among school-aged children in Tripoli, Libya: a cross-sectional study.
BMC Oral Health 2021;21:224.
doi: 10.1186/s12903-021-01545-9.
36. **Albadri S, Zaitoun H, Mc Donnell ST, et al.** Extraction of first permanent molar teeth: results from three dental hospitals.
Br Dent J 2007;203:408-409.
doi: 10.1038/bdj.2007.679.
37. **Karthikeson PS, Vignesh R, Kiran Kumar P.** Reasons for extraction of permanent first molars in children between 6-17 years of age – a retrospective study.
Eur J Mol Clin Med 2020;7:3282-3294.
38. **Weerheijm KL.** Molar incisor hypomineralization (MIH): clinical presentation, aetiology and management.
Dent Update 2004;31:9-12.
doi: 10.12968/denu.2004.31.1.9.

