The prevalence of demarcated opacities in permanent first molars in a group of Swedish children

Birgitta Jälevik, Gunilla Klingberg, Lars Barregård and Jörgen G. Norén

Department of Pedodontics, Faculty of Odontology, Göteborg University; Department of Occupational and Environmental Medicine, Sahlgrenska University Hospital; and Mun-H-Center, National Orofacial Centre for Rare Disorders; Göteborg, and Specialist Clinic of Pedodontics, Sahlgrenska University Hospital, Mölndal, Sweden

Jälevik B, Klingberg G, Barregård L, Norén JG. The prevalence of demarcated opacities in permanent first molars in a group of Swedish children. Acta Odontol Scand 2001;59:255–260. Oslo. ISSN 0001-6357.

The permanent teeth of 516 7- and 8-year-old Swedish children from a low-fluoride area were examined for developmental enamel defects. Special attention was paid to demarcated opacities in permanent first molars and permanent incisors (MIH). The examination was done in their schools, using a portable light, a mirror, and a probe. The modified DDE index of 1992 was used for recording the enamel defects, supplemented with a further classification into severe, moderate, and mild defects. Demarcated opacities in permanent first molars were present in 18.4% of the children. The mean number of hypomineralized teeth of the affected children was 3.2 (standard deviation, 1.8), of which 2.4 were first molars. Of the children 6.5% had severe defects, 5% had moderate defects, whereas 7% had only mildly hypomineralized teeth. In conclusion, hypomineralized first molars appeared to be common and require considerable treatment in the Swedish child population. □ *Developmental defects of the enamel; epidemiology; hypomineralization*

Birgitta Jälevik, Specialist Clinic of Pedodontics, Sahlgrenska University Hospital, Mölndal, SE-431 80 Mölndal, Sweden. Tel: +46 31-861500, e-mail: birgitta.jalevik@vgregion.se

Since the late seventies Swedish dentists have been concerned about newly erupted first molars with disintegrating enamel (1). The clinical experience is that the occurrence of these defects has varied over the years since the seventies and that they are common again after some years of more sparse presence.

Clinically, these fairly large, whitish-yellow or yellowish-brown demarcated enamel opacities affect the permanent first molars, often in combination with the incisors. One, two, three, or all four first molars can be affected, and the severity and extension of the lesions often vary with the individual. The affected molars often require extensive treatment and create problems both for the patients and for the dentists owing to hypersensibility and difficulties in performing adequate filling therapy. The incisors are not as seriously affected as the first molars, and there is seldom any disintegration of the enamel. The permanent second molars and the bicuspids are very seldom impaired by these enamel defects.

Histologically, the disturbed enamel showed a severe hypomineralized enamel localized in the cuspal part of the tooth with a well-defined border between hypomineralized and normal enamel. The cervical third of the enamel always had a normal appearance compared with teeth without opacities (2).

In spite of the time-consuming demand for treatment, there is sparse knowledge about the prevalence of this condition and the etiology. Koch et al. (1) have published an epidemiological study of the prevalence of such enamel defects in children born in the late sixties and early seventies. There was considerable variation in the prevalence among the different age groups (3.6%–15.4%). A prevalence study of hypomineralized first molars was recently performed in Finland and reported that 19.3% of the surveyed children were affected (3). No other epidemiological studies have been performed specifically on developmental defects of permanent first molars.

Although a similar clinical description, various terms, such as idiopathic enamel hypomineralization in permanent first molars, 'nonfluoride hypomineralization in the first molar, and cheese molars' have been used to describe the defects (1–4). Therefore, the denomination molar-incisor hypomineralization (MIH) is proposed in consultation with Professor Alaluusua, Finland, and Doctor Weerheijm, The Netherlands.

The aim of this study was to determine the prevalence of enamel defects of permanent teeth and especially demarcated opacities in first molars and incisors—that is, molar-incisor hypomineralization—in a group of 7- and 8-year-old Swedish children.

Materials and methods

All children in the 2nd grade of compulsory school in the communities of Kållered and Mölndal, born in 1990, were invited to participate in the study, in total 569 children. The two communities are situated on the Swedish west coast neighboring Göteborg, the second largest city in Sweden. All 11 schools in the 2 communities were included. Ninety-five percent of the children have had

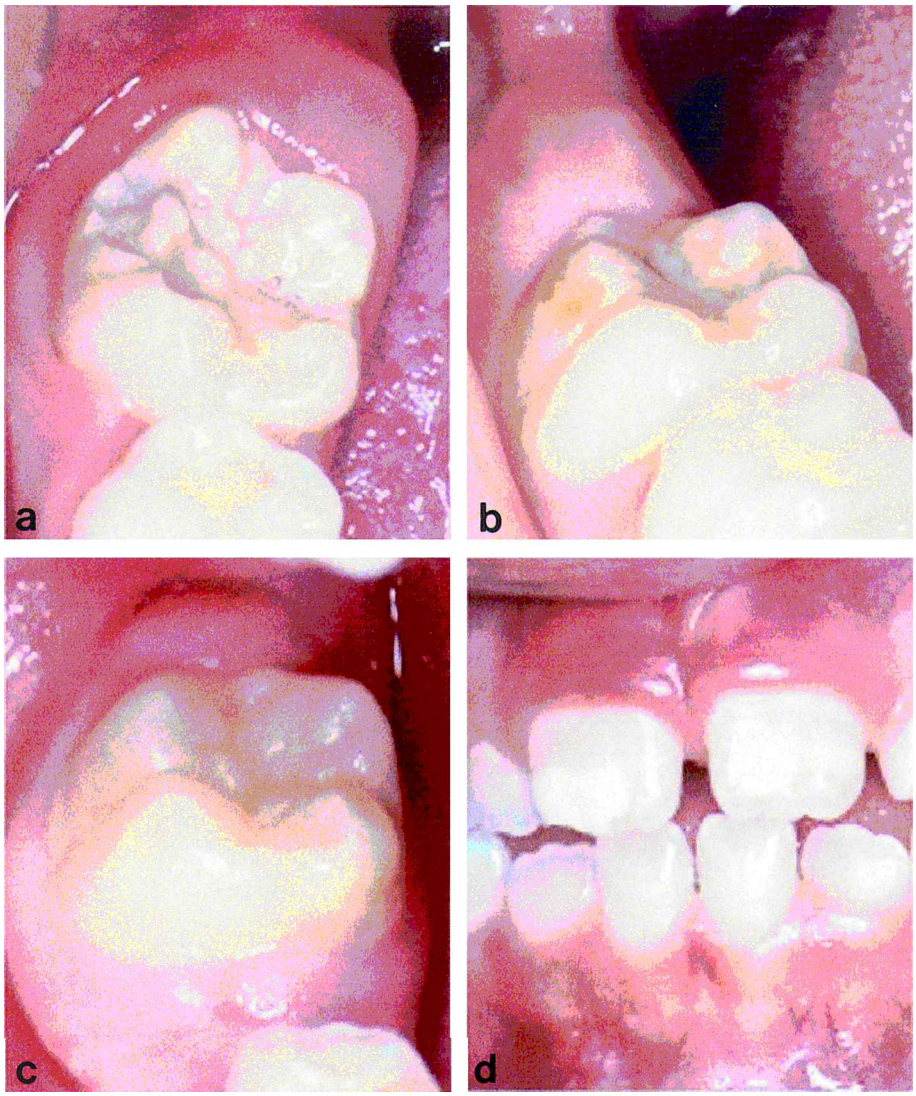

Fig. 1a. A permanent first molar with severe hypomineralization of the enamel. Areas of the enamel have disintegrated, and the tooth is in the need of treatment. 1b. A permanent first molar with moderate hypomineralization. The surface has become partly dull, and there is minor enamel disintegration. 1c. A permanent first molar with mild hypomineralization. Demarcated opacities with a hard and translucent surface. 1d. Incisors with demarcated opacities.

municipal drinking water with a low level of fluoride (<0.10 mg/l).

A calibration study was performed before the examination. After training, 63 children aged 8–10 years were examined by the three dentists (B. Jälevik, G. Klingberg, and J. G. Norén) independently. A total of 15 hypomineralized first molars were detected, and the authors agreed on classifications in all cases.

Two weeks before the intended examination the parents and the child were informed by mail about the purpose of the study. They were also asked for consent to participate.

The Ethics Committee at Göteborg University approved the study.

Dental examinations of the children were undertaken in the schools and carried out by one of the dentists (B. Jälevik). The children were examined in daylight supplemented with a portable light and a torch (MagLite) while sitting in an ordinary chair. A dental mirror and a probe were used to examine all visible tooth surfaces. The teeth were not dried before inspection. When necessary, cotton rolls were used to remove food debris.

Only permanent teeth were examined, and the diagnostic criteria recommended in the FDI report of 1992 (5) were used, with the terms demarcated opacities, diffuse opacities, and hypoplasia. Demarcated opacities

Table 1. Prevalence of enamel defects of the permanent teeth of 516 8-year-old children

Enamel development defect	No. of affected individuals	Percentage of the total sample			95% CI
Diffuse opacities, two or more teeth	37	7.1%			
Diffuse patchy, all teeth	1*	0.2%			
Generally opaque teeth	1†	0.2%			
Total diffuse opacities	39	7.5%			5.2%–9.8%
Demarcated opacities, single front tooth	22	4.3%			
Demarcated opacities, two or more front teeth	12	2.3%			
Demarcated opacities, single molar	18	3.5%			
Demarcated opacities, two or more molars	32	6.2%	14.9%	18.4% MIH	
Demarcated opacities, both molars and incisors	45	8.7%			
Total demarcated opacities	129	25%			21.3%–28.7%
Hypoplasia, single front tooth	2	0.4%			
Hypoplasia, two or more front teeth	2	0.4%			
Total hypoplasia	4	0.8%			
Total enamel developmental defects	172	33.3%			29.2%–37.4%

* Verified severe fluorosis.
† Congenital heart malformation.

are defined as an alteration in the translucency of the enamel. When the tooth erupts, the defective enamel is of normal thickness with a smooth surface. Demarcated opacities have a distinct and clear boundary with the adjacent enamel and can be white, cream, yellow, or brown in color. Some maintain a surface translucency, whereas others become dull in appearance or, in severe defects, even disintegrate. The diffuse opacities are defined as an alteration of the translucency of the enamel, but there is no clear boundary with the adjacent enamel. They can have a linear, patchy, or confluent distribution and are white. Hypoplasias involve the surface and are associated with a reduced thickness of the enamel. Teeth with demarcated opacities were classified into three degrees: mild, moderate, and seriously affected teeth (Fig. 1a–c). Teeth with mild defects had a normal hard surface; teeth with moderate defects had a partly dull surface or a minor loss of substance without need of restoration, and teeth with serious defects were already disintegrated and in need of restoration or already restored to some extent. Teeth with an affected area of less than 2 mm were not registered. Nine children with enamel developmental defects were re-examined in the clinic by one of the authors (B. Jälevik). There was no divergence from the prior classification.

Statistical analyses of differences between groups were performed with the chi-square test. A probability value of less than 0.05 was regarded as statistically significant. The 95% confidence intervals were calculated by using the standard normal approximation.

Results

Of the 569 children, 11 did not have any permanent teeth and were therefore excluded. Thus, 558 children were eligible. Of these, 20 children abstained from participation, and 22 were absent on the day of examination, mostly due to illness. Thus, in total 516 (92.5%) children participated in the study. Forty-nine percent were girls and 51% boys. The mean age was 8.3 years (range, 7.6–8.8 years).

In total, 172 (33.3%) children had some developmental enamel defect of their permanent teeth (Table 1). Ninety-five children (18.4%) had demarcated opacities in their permanent first molars (MIH). There was no difference between boys ($n = 46$) and girls ($n = 49$) with regard to prevalence. The mean number of defective teeth in children with MIH was 3.2 (standard deviation (s), 1.8), 2.4 (s, 1.1) of which were first molars. Seventy-seven children with MIH (14.9%) had also at least one more of the contemporaneously mineralized teeth affected, indicating systemic causation. Considering tooth prevalence, demarcated opacities were found in 11.1% of the children's permanent first molars. The lesions were more frequent in the lower jaw (11.5%) than in the upper jaw (10.8%); however, the differences were not statistically significant.

Thirty-three children with MIH had at least one tooth with severe defects, and 25 had moderate defects, whereas 37 had only mildly hypomineralized teeth (Fig. 1a–c).

With an increasing number of affected molars there were also more severe defects ($P < 0.001$) (Fig. 2). Seventy percent of the children with severe defects also had affected incisors (Fig. 1d). Corresponding figures for children with moderate and mild defects were 52% and 24%, respectively.

Discussion

This study showed that MIH was a common clinical finding in a Swedish child population, and that many children had severe defects with disintegrating enamel.

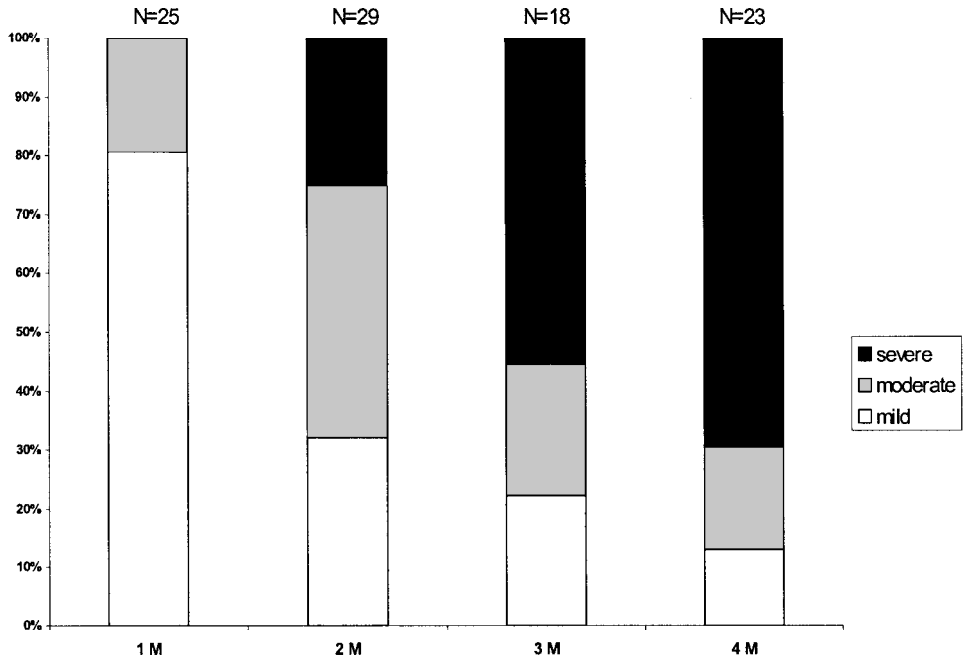

Fig. 2. Distribution of number of hypomineralized first molars (M) in relation to the seriousness of the defects.

Seven- and 8-year-old children were chosen as study subjects, as we wanted to minimize the risk that the enamel defects would be masked by caries and/or fillings and at the same time ensure that the first molars had erupted in most of the children. The prevalence of more than 18% of MIH was higher than expected and showed a hitherto seldom discussed dental health problem. All children with severe defects, and probably soon most children with moderate defects—that is, approximately 10% of all children—had been subjected to or were in need of extensive treatment of their first molars despite a general good dental health with low caries activity. Moreover, most of the affected children also had demarcated opacities on their front teeth. Some of them were very conspicuous and will certainly require future veneering (Fig. 1d).

To ensure good reproducibility, the teeth were examined under wet conditions, and opacities less than 2 mm were not recorded. Small, demarcated opacities are very common, especially when the teeth are dried, and the reproducibility of these has been found doubtful (6). The re-examination agreement in determining MIH is in accordance with the Finnish prevalence study (3).

The purpose of classifying the enamel defects in three degrees of severity—mild, moderate, and severe—was primarily to elucidate the demand for treatment. Further, it was also an attempt to translate the histological picture into a clinical one, since morphological studies of the enamel of these teeth (2) have shown zones of various degrees of hypomineralization.

One of the previous epidemiological studies focusing on severe hypomineralization of permanent first molars and incisors was performed in Sweden (1). Six age groups of children (born in 1966, 1969, 1970, 1971, 1972, and 1974) were examined when they were 8–13 years old. Children born in 1970 (9 years of age) had a prevalence of 15.4%, which is near the prevalence of our study (18.4%). In the other age groups the prevalence was only 3.6%–7.3%, with no tendency to higher figures for the children examined at a younger age. The other prevalence study was performed in a group of 7- to 13-year-old children born in 1983–89 in Finland. The prevalence was 19.3%.

Children with only one affected molar were included in the prevalence figure as in the previous prevalence studies of MIH (1, 3). However, by definition developmental enamel defects can be considered systemic only if groups of teeth developing at the period of the disturbance are affected. (7). There are no possibilities from a clinical examination to judge, however, whether a disturbance is of systemic origin if only one tooth is affected. Nevertheless, the possibility cannot be excluded, which is why the higher prevalence figure (18.4%, compared with 14.9%) might be more correct.

Questions that should be raised are as follows: is this condition a new phenomenon since the 1970s, and is it occurring only in northern Europe? Owing to the lack of a well-defined and internationally accepted classification of enamel defects there has been much confusion, and it is almost impossible to compare studies of enamel defects. To remedy this state, a working group was established by the FDI, and their work in 1982 resulted in an epidemiological index of developmental defects of dental

enamel (DDE Index) (8) and in 1992 in a modified DDE Index (5). There is also a version of the modified DDE Index sometimes used in survey studies which only records the buccal surfaces of certain index teeth (9). Before these indices were published, true hypoplasia was not differentiated from loss of substance due to porous enamel. Therefore, it is not possible to evaluate whether hypomineralized first molars were included in older studies. However, Suckling et al. (10) described opacities as internal defects and grouped external defects into hypoplasias and missing enamel. They emphasized that nearly 5% of 7-year-old children living in New Zealand showed a combination of internal defects and missing enamel which would probably result in difficulties in obtaining adequate retention for restoration. Seven-year-old children had a tooth prevalence of approximately 10% of internal defects and internal defects plus missing enamel of the first molars. Twelve-year-old children had only a tooth prevalence of about 5%. The authors stated that these defects were often quickly obscured by restorative treatment, and the prevalence figures for the younger age group were probably more accurate.

In a study of children aged 12–14 years, published in 1984, Suckling & Pearce (11) used the DDE index. They found that maxillary first molars were affected most frequently by white and yellow opacities (14.4%), followed by maxillary centrals (10.5%), and mandibular first molars (9.0%). Nearly 9% had large restorations inserted because of defective enamel. All but three fillings were in first molars, and about 2% had all their first molars extracted, probably as a result of defective enamel. In a later study of 9-year-old children Suckling et al. (6) found that 11% of the maxillary first molars, 10.5% of the maxillary centrals, and 8% of the first mandibular molars had white or yellow opacities. About 3% had large restorations inserted because of defective enamel. The authors emphasized in another study (12) of the same group of children that there were irregular areas of missing enamel, sometimes associated with white and yellow opacities, in about 1% of the first molars.

Dummer et al. have performed prevalence studies using the DDE Index in a group of 11- and 12-year-old children (13, 14) and in a group of 15- and 16-year-old children living in South Wales (15). In these studies only about 4.5% of the upper first molars and about 3% of the lower first molars had white or yellow demarcated opacities. In the studies first molars were not more frequently affected than other teeth, and there were no reports of missing enamel or atypical restorations. In a study of dental enamel defects in 6-, 7-, and 8-year-old children living in Sandwell, UK, a similar prevalence (3.8%) of demarcated opacities of first molars was also found (16). A shortcoming of that study is that the version of the DDE Index just recording buccal surfaces of index teeth was used. However, both upper and lower first molars were index teeth, and it is therefore unlikely that MIH was frequent in that population.

In the present study 33.3% of the examined children had at least one affected tooth of any DDE (Table 1). Other comprehensive epidemiological studies using the DDE Index showed that 38%–63% of the examined children had at least one tooth with enamel developmental defects (6, 11, 13–16). One main reason for the lower prevalence in this study can be that only opacities $\geq$2 mm had been recorded. Moreover, the teeth had not been dried before inspection, and the drinking water had a low fluoride level.

A common finding in prevalence studies of DDE is that the upper first molars are more often affected than the lower first molars (3, 6, 11, 13). That was not the case in the present study.

It is difficult to compare the prevalence figures, as the referred studies did not focus especially on the developmental defects of the first molars. However, it is obvious that the first molars seemed to be "target" teeth for developmental defects in most study samples. When older children have been studied, the defects could have been obscured by restorative treatment, and a high caries activity could have superimposed and hidden the developmental defects. Various results could also reflect variations among different age groups, as in the prevalence study by Koch et al. (1). It has been proposed that the etiology of MIH includes some environmental factor, acting during the years of life when the enamel of the permanent first molars develops (1, 17, 18). Possible etiologic factors in Swedish children will be discussed elsewhere, as will the psychological effects in terms of dental fear and behavior management problems.

In conclusion, hypomineralized first molars appear to be common in the present child population. To a great extent, the teeth are seriously affected and in need of restorative treatment or, in severe cases, even extraction. Consequently, these children are, despite a good oral health, exposed to extensive dental treatment involving difficulties in getting adequate retention for fillings and getting the teeth well anesthetized. Still, in some cases all treatment efforts will end in extraction of the tooth.

References

1. Koch G, Hallonsten A-L, Ludvigsson N, Hansson B-O, Holst A, Ullbro C. Epidemiology study of idiopathic enamel hypomineralization in permanent teeth of Swedish children. Community Dent Oral Epidemiol 1987;15:279–85.
2. Jälevik B, Norén JG. Enamel hypomineralisation of permanent first molars. A morphological study and survey of possible etiologic factors. Int J Paediatr Dent 2000;10:278–89.
3. Leppäniemi A, Lukinmaa PL, Alaluusua S. Nonfluoride hypomineralizations in the first molars and their impact on the treatment need. Caries Res 2001;35:36–40.
4. van Amerongen WE, Kreulen CM. Cheese molars: a pilot study of the etiology of hypocalcifications in first permanent molars. J Dent Child 1995;4:266–9.
5. FDI Commision on Oral Health, Research and Epidemiology. A review of the development defects of enamel index (DDE Index). Int Dent J 1992;42:411–26.
6. Suckling GW, Brown RH, Herbison GP. The prevalence of development defects of enamel in 696 nine-year-old New

Zealand children participating in a health and developmental study. Community Dent Health 1985;2:303–13.
7. Small BW, Murray JJ. Enamel opacities: prevalence, classification an aetiological considerations J Dent 1978;6:33–42.
8. FDI Commision on Oral Health, Research and Epidemiology. An epidemiological index of developmental defects of dental enamel (DDE Index). Int Dent J 1982;32:159–67.
9. Clarkson J, O'Mullane D. A modified DDE Index for use in epidemiological studies of enamel defects. J Dent Res 1989; 68:445–50.
10. Suckling GW, Pearce EIF, Cutress TW. Development defects of enamel in New Zealand children. N Z Dent J 1976;72:201–10.
11. Suckling GW, Pearce EIF. Developmental defects of enamel in a group of New Zealand children: their prevalence and some etiological factors. Community Dent Oral Epidemiol 1984;12: 177–84.
12. Suckling GW, Herbison GP, Brown RH. Etiological factors influencing the prevalence of developmental defects of dental enamel in nine-year-old New Zealand children participating in a health and developmental study. J Dent Res 1987;66:1466–9.
13. Dummer PM, Kingdon A, Kingdon R. Distribution of developmental defects of tooth enamel by tooth-type in 11-12-year-old children in South Wales. Community Dent Oral Epidemiol 1986;14:341–4.
14. Dummer PM, Kingdon A, Kingdon R. Prevalence of enamel developmental defects in a group of 11- and 12-year-old children in South Wales. Community Dent Oral Epidemiol 1986;14:119–22.
15. Dummer PM, Kingdon A, Kingdon R. Prevalence and distribution by tooth type and surface of developmental defects of dental enamel in a group of 15- to 16-year-old children in South Wales. Community Dent Health 1990;7:369–77.
16. Elley KM, Charlton J. Prevalence of dental enamel defects in 6, 7, and 8-year-old children resident in West Bromwich, Sandwell, UK. Community Dent Health 1992;10:11–21.
17. Alaluusua S, Lukinamaa P-L, Koskimies M, Pirinen S, Höltta P, Kallio M, et al. Development dental defects associated with long breast-feeding. Eur J Oral Sci 1996;104:493–7.
18. Alaluusua S, Lukinmaa PL, Torppa J, Tuomisto J, Vartiainen T. Developing teeth as biomarker of dioxin exposure. Lancet 1999;353:206.

Received for publication 29 November 2000
Accepted 16 March 2001