The prevalence of Molar Incisor Hypomineralisation (MIH) in a group of Italian school children


ABSTRACT: **Aim** This epidemiological study in a group of Italian children was undertaken in order to increase our knowledge of the prevalence of Molar Incisor Hypomineralisation (MIH) in different European countries. **Method** A population of school children aged 7.3 – 8.3 years, living in Lissone, Northern Italy, was examined for the presence and severity of MIH. **Results** Of a total of 227 children (113 females), 31 (13.7%) had MIH, the tooth prevalence in the permanent first molars being 5.8%. Fifteen children (6.6%) had demarcated opacities in the incisors with a tooth prevalence of 2.1%. The defects in the molars were mild with the exception of one child who had severe defects. **Conclusion** MIH was quite common in this Italian town, and the prevalence figures were near those reported in Scandinavian countries but clearly higher than those from Dresden, Germany.

**KEYWORDS:** Enamel opacities, Enamel hypomineralisation.

Introduction

Molar Incisor Hypomineralisation (MIH) is a clinical condition, where enamel defects ranging from demarcated opacities to broken, severely hypomineralised enamel, is seen in one or more permanent first molars and frequently also in incisors [Weerheijm et al., 2001b]. The colour of the affected enamel is white, whitish-yellow or yellowish-brown and the defect has usually a clear border between affected and sound enamel. The condition is widely reported in Europe and is considered to be a clinical problem in many countries [Weerheijm and Mejare, 2003].

The aetiology of these lesions is not clear. In a Swedish study a peak in the prevalence of MIH in a certain year suggested that an environmental factor had been involved [Koch et al., 1987]. Recently, a comparable peak was found in a German study in a large child population [Dietrich et al., 2003]. We also evaluated the association between human exposure to environmental toxicants and MIH [Alaluusua et al., 1996b, 1999; Hölttä et al., 2001]. The results suggest that an exposure of a child via mother’s milk to dioxins may be associated with the prevalence and severity of hypomineralisation defects in the permanent first molars of the child [Alaluusua et al., 1999]. Also, accidental exposure to dioxins was associated with an increased prevalence of dental enamel defects in subjects exposed in their childhood in Seveso, Italy, in 1976 [Alaluusua et al., 2003].

If environmental factors are involved in the aetiology of MIH, it is important to obtain comparable information on the prevalence of the condition in different countries. The aim of this study was, therefore, to determine the prevalence of developmental defects of enamel in permanent teeth in a group of 7 to 8 year old children living in Italy, with special emphasis on MIH.
Materials and methods

All children attending the second year in primary schools and living in the town of Lissone, Northern Italy, were invited to participate in the study. Lissone has about 35,000 inhabitants and lies in an industrialised area on the outskirts of Milan. The study was approved by the local institutional review board and written informed consent was obtained from the parents.

The children were examined for the presence and severity of MIH according to the descriptions given in earlier publications [Koch et al., 1987; Alaluusua et al., 1996a, b; Weerheijm et al., 2001a, b] using the following criteria:

- each permanent first molar and incisor was screened for demarcated white, yellow or brown opacities,
- the colour changes were categorized as mild defects in mineralisation,
- surface changes were categorized as moderate or severe,
- loss of stained enamel represented a moderate defect and loss of enamel with affected dentine (need for a restorative treatment for a broken down hypomineralised enamel or atypical restoration replacing broken down hypomineralised enamel) was categorized as a severe defect.

In the case that more than one defect was present, the most severe defect was chosen to represent the tooth. Teeth with lesions less than 2 mm in diameter were not included. Only teeth with more than half of the crown erupted were included. Only permanent teeth were examined (incisors and first molars), and in addition to MIH lesions diagnosed according to criteria presented above, diagnostic criteria and the terms of diffuse opacity and hypoplasia were used [FDI Commission on Oral Health, Research and Epidemiology, 1992; Clarkson and O’Mullane, 1989].

All examinations took place in the nursing room of the study school. The teeth were inspected visually in daylight with a torch (Maglite) while each child was lying on an examination bed. A dental mirror was used and, when necessary, a probe for removing the plaque. Teeth were not dried before inspection.

One examiner (PC) performed the dental examinations. He was previously trained and calibrated for the screening of MIH and other developmental defects of enamel. Intra-examiner calibration was performed by repeat examinations of 22 (Finnish) children aged 8-9 years old at an interval of three months. Inter-examiner calibration with another author (SA) was performed by examining dentitions of 20 subjects participating in the present study [Pine et al., 1997]. The kappa statistics on tooth basis was 0.97 and 0.98, respectively.

Results

Of the 240 pupils attending the second year at school in Lissone, 9 were absent on the day of the visit. Four did not have the signed permission of their parents and therefore were not examined. Thus, a total of 227 (113 females) children (95%) were included. All children were born in 1994 and their ages ranged from 7.3 to 8.3 years with a mean of 7.7 years.

The number of permanent teeth screened was 2,186 out of the theoretical count of 2,724 incisors and first molars. Of these teeth, 856 were first molars (425 maxillary and 431 mandibular) and 1,330 were incisors (549 maxillary and 781 mandibular incisors). A total of 39 molars (4.3%) and 486 incisors (27%) were partially erupted (less than half of the crown visible) or unerupted and not included in the data. In addition, 13 molars of 5 children were not included because of orthodontic bands.

Thirty-nine children (13.7%) had MIH. There was no difference in the prevalence between boys (N=16) and girls (N=15). The overall tooth prevalence was 5.8%. Seventeen children (7.5%) had lesions only in one molar and 10 in two molars. Two children had three and two children had all four molars affected. The lesions were almost as frequent in the mandible (6.5%) as in the maxilla (5.2%) (Fig. 1). All except one child had mild lesions (0.4%). His lesions were severe and required restorative care.

The mean number of defective teeth in children with MIH was 2.0 (SD±1.2) of which 1.6 (SD±0.88) were the permanent first molars.

Some kind of developmental enamel defects in the permanent incisors and first molars were found in 61 children (26.9%). Defects were present in 6.5% of the teeth. The mandibular first molars were most frequently affected (11.1%) followed by the maxillary first molars (9.6%) and the upper central incisors (8.2%). The maxillary lateral incisors were affected in 3.5% and the mandibular laterals in only 1.2%.

The most common type of defects, which were present in 19.4% of the children, was demarcated opacities. Diffuse opacities were seen in 6.6% of the children and were present in 4.4, 4.0, 3.8 and 2.4% of the lower first molars, upper central incisors, first molars and laterals, respectively (Fig. 1). Diffuse opacities in mandibular incisors were present in less than 1%. Hypoplasia occurred only in 1.3% of the children and hypoplastic defects in all tooth types were rare (Fig. 1).
Discussion

We found that MIH was quite common among children attending the second year at school in Lissone. MIH was seen in 13.7% of them. The defects were mild with only one exception.

In a recent study, definitions of judgement criteria to be used in diagnosing MIH for prevalence studies were suggested [Weerheijm et al., 2003]. This judgement included the following criteria: presence of demarcated opacities, posteruptive breakdown, atypical restorations and extraction of molars due to MIH.

We would like to add two important points that would make comparisons of the prevalence of MIH easier. The first is the size of the lesion. The impact of size is crucial, as small demarcated opacities are common and they have been either included or excluded in previous MIH studies. When studying 9 year old New Zealand children, Suckling et al. [1985] found that in 45% of the 520 teeth affected with white or yellow demarcated opacities, the opacities were less than 2 mm in diameter. In another child population, aged 12-14 years, Suckling and Pearce [1984] found that 29% of the 520 teeth affected with white or yellow demarcated opacities, the opacities were less than 2 mm in diameter. In another study, Dietrich et al. [2003] found that 5.6% of the teeth affected with white or yellow demarcated opacities were smaller than 2 mm in diameter. In the report of FDI Working Group on DDE [1992] it was recommended that any single defect less than 1 mm in diameter should not be recorded. However, Suckling et al. [1985] also found that the reproducibility of screening small demarcated opacities is low. In our study we included only lesions equal or larger than 2 mm in diameter [Alaluusua et al., 1996a; Alaluusua et al., 1996b; Hölttä et al., 2001; Leppäniemi et al., 2001]. The same size criterion was also used by Jälevik et al. [2001] in assessing the prevalence of MIH and it has been already used in earlier studies of demarcated opacities [Jackson et al., 1975; Murray and Shaw, 1979]. We therefore suggest that in future epidemiological studies researchers assessing the prevalence of MIH should use the present size criterion, as it may increase reproducibility of the assessments and make the results more comparable.

A useful tool for measuring the size of the lesion is a periodontal probe with millimetre marks.

The second point to which we urge researchers to pay attention is the eruption status of the tooth. It is important to agree when a tooth has erupted enough for the evaluation of the presence of a lesion to be made. In these types of studies we are dealing with children (the optimal age for screening is around 8 years) whose teeth are erupting and we suggest that only teeth with more than half of the crown visible should be included in the assessment. This criterion has been set earlier by others [Suckling et al., 1985], but it was not included in the definitions of judgement criteria suggested by Weerheijm et al. [2003].

Using the above mentioned criteria here, we found MIH in 13.7% of 7 to 8 year old children born in 1994 and living in Lissone. Comparable studies in Sweden [Jälevik et al., 2001] and Finland showed a somewhat higher prevalence [Alaluusua et al., 1996a; Hölttä et al., 2001; Leppäniemi et al., 2001] ranging from 14.2% to 19.3%. In a German study on children living in Dresden, very low prevalence of MIH, namely 5.6%, was found [Dietrich et al., 2003]. Also in a Dutch study on 11 year old children, only 9.7% had MIH [Weerheijm et al., 2001a]. The criteria applied in the two last mentioned studies were adapted from DDE index. When taking into account that presumably smaller lesions (equal or larger than 1 mm but not 2 mm in diameter) than in the present study were included, the prevalence figures of the two studies are clearly lower than in our study. A low prevalence of MIH (5.6%) but high prevalence of fluorosis was also found in a Finnish child group living in an area where the fluoride content in the households was exceptionally high (mean 2.3 mg/l) [Hölttä et al., 2001]. We speculate that the presence of fluorosis may have masked the demarcated opacities.

The prevalence of severe lesions was low in the present study (0.4%), since in the comparable age group of Finnish children the prevalence was 2.0%

**Fig. 1 - Percentage of maxillary and mandibular first molars (6), central incisors (1) and lateral incisors (2) affected with a demarcated opacity, diffuse opacity or hypoplasia in 227 children living in Lissone, Northern Italy.**
variations in the prevalence. Developmental time tables may partly explain differences in the mandibular central and lateral incisors whereas upper laterals, most frequently affected by demarcated opacities. Jälevik et al., 2001] the first molars were the teeth of development, obtained from a limited data, it is believed that mineralisation of the permanent first molars begins at the 32nd week in utero and the crowns are completed at about 4 years of age [Proffit, 2000]. Eruption takes place around 6 years. Development of the incisors occurs somewhat later. Especially, mineralisation of the maxillary lateral incisors starts around 11 months, crowns are completed at about 5.5 years and these teeth erupt at 8 years on average. MIH is most likely systemic in origin and, therefore, due to overlapping in the time of development, it is logical that such dental defects occur concomitantly in the incisors and the first molars. However, in the present and in earlier studies [Suckling et al., 1985; Koch et al., 1987; Jälevik et al., 2001] the first molars were the teeth most frequently affected by demarcated opacities. The first molars were closely followed by the maxillary central incisors whereas upper laterals, mandibular central and lateral incisors were less frequently affected. Differences in the developmental time tables may partly explain variations in the prevalence.

However, based on the finding that the prevalence of developmental enamel defects is highest at locations where the enamel is thickest [Needleman et al., 1991; Jälevik, 2001], it has been suggested that the vulnerability of ameloblasts is related to thickness of enamel [Needleman et al., 1991]. After all, the length of the time period from the beginning of mineralisation to eruption of tooth is very similar in molars and incisors. This may indicate a faster enamel formation in thicker than in thinner teeth/enamel surfaces and locations. Our results on higher prevalence of demarcated opacities in molars and maxillary incisors than in thinner mandibular incisors are in line with this hypothesis. Greater metabolic demand of ameloblasts in the thicker and hence faster formed enamel areas might make them especially vulnerable to any insult. According to Needleman et al. [1991] a severe metabolic disturbance is likely to affect all teeth and surfaces, while a milder perturbation might preferentially affect the metabolically most active ameloblasts or the most rapidly maturing enamel. Experimental support for the generalized effect of a severe insult comes from our recent finding that lactational exposure of rat pups to 2,3,7,8-tetrachlorodibenzo-p-dioxin interfered with enamel maturation on all surfaces of the second molar teeth and totally arrested the development of the third molar teeth [Gao et al., 2004].

In the present study, 26.9% of the children examined had at least one permanent tooth affected with a developmental defect of enamel. As the diagnostic criteria have differed between studies, also as regards other defects than demarcated opacities, the prevalence figures are difficult to compare. Similar criteria were used and children of the same age as in our study were included in the study by Jälevik et al. [2001], who found a slightly higher prevalence of defective teeth, namely 33.3%, in Swedish children. In that study, demarcated opacities predominated with a prevalence of 25%. In our study they were also the most frequently seen, the prevalence being 19.4%.

Hypoplastic defects were rare in both studies with a prevalence of 0.8% and 1.3%, respectively. Diffuse opacities, often connected with initial changes of fluoride origin [FDI Commission on Oral Health, Research and Epidemiology, 1992], were found in 6.6% in our study and in 7.5% of the children in the Swedish study where municipal drinking water contained less than 0.10 mg/l fluoride. Unfortunately, in our study there was no precise information about the level of fluoride in
drinking water, as in the area studied people usually drink bottled mineral water coming from different parts of the country. The uptake of fluoride from other sources such as toothpaste and fluoride tablets may, as well, vary greatly between individuals, due to the lack of a public dental preventive program.

Conclusion
In children living in Lissone, Northern Italy, MIH was a quite common finding. The prevalence was nearly the same as that seen in Scandinavian children, somewhat higher than in Dutch children and clearly higher than in Dresden children, Germany. Further studies applying the same diagnostic criteria are needed to make them comparable studies and to confirm that MIH is related to specific environmental conditions or living areas.

Acknowledgements
This work was supported by EU (QLK4-1999-01446), Regione Lombardia, Italy (2896) and Academy of Finland (Contract No. 206689).

References