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Prevalence of Molar Incisor Hypomineralization in over 30,000 Schoolchildren in Switzerland

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Objectives: *To quantify the prevalence of Molar Incisor Hypomineralization (MIH) in the canton of Geneva, Switzerland.* ***Study design:*** *Thirty-eight dentists of the state school dental services were trained to detect and classify MIH cases. All children (32,142) from age 4 to 12 were examined during the annual dental screening offered by the state. Cases were scored as mild, moderate or severe.* ***Results:*** *The prevalence of hypomineralizations was found to be 7.45% when all hypomineralized teeth were taken into consideration. MIH cases were found to be at 6.6%. Out of the MIH cases, 51% scored as mild, 36% as moderate and 13% as severe.* ***Conclusion:*** *The mean prevalence of MIH in Geneva school children was found to be 6.6%. This seems to be lower than the European and the global average. However, with almost half cases being moderate or severe, asserting a proper management protocol is necessary.*

Keywords: *Molar incisor hypomineralisation, MIH, prevalence, enamel defects*

INTRODUCTION

A recent publication showed that molar-incisor hypomineralization (MIH) appears to be highly prevalent globally 13.1% (11.8–14.5%), affecting 878 million people, with 17.5 million new cases each year[1]. Regions with limited access to dental care, show the majority of new cases of MIH [1].

In 1987, Koch *et al* described for the first time an idiopathic enamel defect affecting mostly Permanent molars and incisors. In the late seventies, an increasing number of children showing extensive and severe idiopathic hypomineralization of the enamel of incisors and permanent first molars were reported within the Public Dental Services in Sweden. An epidemiologic study analyzed the prevalence, extension, and severity of the problem in Swedish children and the prevalence was found to be 15.4% of the children born in 1970 [2]. Thereafter, the nomenclature has been repeatedly changed as well as the way of clinical entity differentiation, but consistently it was referred to as non-fluoride hypomineralization or cheese molars[3-5]. Finally, in 2001, the term molar-incisor hypomineralization (MIH) was adopted[6,7].

The enamel of MIH affected teeth is less mineralized than the one of sound teeth but it has a normal thickness. The drop of mineralization, up to 70%, goes hand in hand with an increased protein and carbonated mineral content, which has a negative impact on mechanical properties. Consequently, the enamel of MIH teeth is more fragile and prone to mechanical breakdown and to caries development[8,9].

More recently, hypomineralized second primary molars (HSPM) have been described, also known as deciduous molar hypomineralization (DMH). They may affect one to four second primary molars and just like MIH, the degree of the defect is variable and ranges from change in opacity to severe hypomineralization which may

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lead to rapid enamel breakdown after eruption. HSPM affected children may or may not present MIH, however some authors considered HSPM as a predictive factor of MIH [10,11].

MIH is still an active research issue. There is still more to uncover about its worldwide prevalence, exact etiology, best method of classification and optimal treatment options.

Epidemiological data from studies conducted in European countries reported the prevalence of MIH varying from 3.6 to 25% [12,13]. A systematic review revealed a wide variation in the prevalence of MIH (2.4–40.2 %) and specified that the cross comparison of the results between the various studies was difficult because studies used different indices, diagnosis criteria, examination procedures, methods of recording and different age groups[14].

At the moment, no information is available about the prevalence of MIH and HSPM in Geneva, and more specifically in the canton of Geneva. This is why this study aimed to determine the prevalence in all children of 4 to12 years of age in Geneva.

MATERIALS AND METHOD

The Geneva public school dental services provides a compulsory dental screening of all students in Geneva schools between the age of 4 and 12. Around 32,000 students are screened every year. In 2016 the screening process became digitalized and the possibility to extract anonymized information became feasible.

The 38 examiners performing the dental screening were trained prior to the start of the screening to detect and score MIH cases during a 4h workshop supervised by the authors. Images of MIH cases from the university and authors library were used. A collective exercise at the end of the session helped evaluate the participants understanding of the index.

The examination was done on a dental chair with appropriate illumination, compressed air syringe and sterile instruments. In the group of 4-5 years old children some school classes were screened using a hand lamp and biting on cotton rolls to dry.

The scoring system was based on multiple studies that used simplified categories based on the severity of the defect [7,15.17].

Compared to the European Academy of Paediatric Dentistry (EAPD)[18] and other comprehensive recommended scoring systems[15], the chosen scoring system had the advantage of simplicity considering the number of children screened and the time available for each child.

The software-based scoring procedure provided the choice between the 3 following classes of MIH:

1st degree (Mild): Lesion was considered mild when less than one third of the tooth's enamel surface area was affected. In general, these defects were discrete demarcated white spots, limited to the surface, with no or very little tooth sensitivity.

2nd degree (Moderate): The affected area was between more than one third but less than two thirds of the enamel surface. The aspect was a yellowish-brownish lesion that could already show post eruptive enamel breakdown according to its extent. Some tooth sensitivity might ***be present.***

3rd degree (Severe): More than two thirds of the enamel surface were affected. At this point, the hypomineralization was so advanced that enamel breakdown and hypersensitivity were almost always present. The general aspect was a wide yellowish-brownish lesion with loss of enamel and possible dentine exposition.

Affected primary second molars and other teeth with enamel defects were also recorded. It was also possible for the examiner to specify the tooth affected in each case and score the severity.

A case was considered MIH when there was at least one permanent molar showing the defect. Children under 6 years old were excluded. In total 32,142 children were screened.

MIH prevalence was calculated after the exclusion of all cases without at least one permanent molar affected and after excluding the 1st primary class (4 to 5 years old) and the special need classes. This is why the final number of children screened for MIH was 23,320.

RESULTS

In 2017, the prevalence of overall enamel hypomineralization defects was 7.49%, while for MIH the prevalence was 6.6%. Out of the MIH cases, 51% scored as mild, 36% as moderate and 13% as severe.

Descriptive statistics per severity, per age and per tooth type are presented in Tables 1, 2 and 3.

DISCUSSION

In 2017, a comprehensive meta-analysis including 70 epidemiological studies with 89,520 individuals in total was the first review summarizing the prevalence of MIH globally, with results showing a mean prevalence of showed a 14.2%[19]. In the present study, the prevalence of hypomineralized enamel defects was 7.49%. MIH prevalence was shown to be 6.6%. This value is lower than other areas in Europe, where prevalence rates between 6.3% and 19.3% were found, with an average of 14%, as recently published. The reason of this lower percentage is unknow for the moment.

Even though Geneva seems to be less affected than other European countries, this study supports the assumption that MIH is an important problem in Europe. Previous studies from surrounding countries like Germany, Finland, Sweden, and the Netherlands underline this[2,6,20,21] . MIH prevalence was found to be 10.5%(95% CI: 7.4–13.6) for Germany, 16.0% (95%CI: 11.9–20.2) for Finland, 21.1% (95% CI:17.7–24.6) for Spain, and 17.1% for the Netherlands[19].

The disease can affect molars only, but it is more frequent to see a combination of affected molars and incisors [22]. MIH prevalence can vary between maxillary or mandibular teeth, molars or incisors, permanent or primary teeth; recent studies showed that mandibular molars are more frequently affected than the maxillary ones and upper and lower incisors are generally less affected than molars [23-25]. Our results show that upper molars are the most frequently affected ones in the canton of Geneva, followed by lower molars and the upper incisors. The least affected teeth are the lower incisors. In the primary dentition the upper and lower molars were equally affected in our study (Table 3). However, in other studies the maxillary deciduous molars were the most commonly affected teeth[26].

HSPM appears to be the result of the disruption of the mineralization of enamel in the second primary molar during its development [13, 27]. Clinically, HSPM is similar to MIH lesions. With a prevalence ranging from 4.6% to 6.6%, HSPM could be a significant risk factor for early loss of second primary molars [20,26,28,29]. It

Table 1: The count and prevalence of hypomineralization in each year.

Hypomin. defect	Count 2017 (%)	Prevalence 2017	Count 2016 (%)	Prevalence 2016
Mild	1335(56%)	4.2%	1375(57%)	4.3%
Moderate	782 (32.8%)	2.4%	760 (31.5%)	2.4%
Severe	265 (11.2%)	0.8%	275(11.4%)	0.9%
Total MIH	2382	7.4%	2410	7.5%

Table 2: The number of children screened per age and MIH classes (mild, moderate, severe) in 2017.

	6/7YO	7/8YO	8/9YO	9/10YO	10/11YO	11/12YO	Total	% MIH per degree
Screened	4121	4010	3882	3714	3600	3993	23320	
Mild	146	132	144	112	138	109	781	3.3%
Moderate	100	104	102	85	92	75	558	2.4%
Severe	26	36	35	39	34	30	200	0.9%
Tot. MIH	**272**	**272**	**281**	**236**	**264**	**214**	**1539**	
% MIH per age	6.6%	6.8%	7.2%	6.4%	7.3%	5.4%	6.6%	

Table 3: The distribution of cases affected by MIH per type of tooth in 2017.

Affected teeth	Total	Mild	%	Moderate	%	Severe	%
Upper molars (16 or 26)	1217	605	50%	435	36%	177	15%
Lower molars (36 or 46)	704	341	48%	251	36%	112	16%
Upper centrals (12 or 21)	503	345	69%	134	27%	24	5%
Lower centrals (31 or 41)	184	112	61%	61	33%	9	5%
Primary UM (55 or 65)	212	91	43%	97	46%	24	11%
Primary LM (75 or 85)	198	98	49%	86	43%	23	12%

is important for dental care providers to realize that often children who have HSPM also have MIH. So, detecting HSPM should alert the dentist to anticipate MIH on the definitive molars and to inform parents about the risks[10].

The prevalence of mild hypomineralization cases was 56%, while moderate cases were at 33% compared to severe cases that represented 11% of the screened cases. It is important to notice that moderate and severe cases thus represented 44% of the total MIH cases. These cases are more prone to post eruptive enamel breakdown (PEB) which increases the risk of further tissue loss due to mechanical breakdown, caries or aggressive restorations.

While most studies consider scoring MIH only when one or more first permanent molar meet the diagnostic criteria, others [30] indicated that in the absence of first permanent molars, MIH diagnosis should be based on anterior teeth. Balmer *et al* [31] introduced other terms for these hypomineralization enamel defects, such as Incisor Hypomineralization (IH) and Molar Hypomineralization (MH). This paper indicated that the definition of all three conditions (MIH, IH and MH) are mutually exclusive and that demarcated opacities named as IH, MH, and deciduous molar incisor hypomineralization (DMH) should all be considered parts of a spectrum that includes MIH, given the fact that these defects share common characteristics and risk factors which overlap with MIH and are expected to have the same etiology.

Like our study, in some studies scoring demarcated opacities was not limited to the permanent first molar and incisors. Similar lesions may also be observed on second primary molars, permanent canines, second permanent molars and premolars [16, 30].

Some authors [32] even described the terminology MIH as "misleading" and claimed that this greatly contributes to an under-estimation of the defects. This can be observed in our results from 2017, when comparing the total hypomineralization results to the MIH only cases. These authors also suggested that mineralization defects on all teeth should be recorded in order to reflect the extent of involvement and if sufficient evidence will become available that MIH is not predominantly restricted to molars and incisors, revising the name should be considered [32].

The advantage of our study is that it comprised the entire cohort of Geneva and not a simple cross-sectional representative sample. Even though the simplified criteria we used was based on multiple studies Is not considered validated, the reason it was chosen was restricted time availability. The screening of each class was done within a limited slot of time. By using the EAPD or the DDE criteria would have increased the time needed, making the realization of this study financially impossible.

The authors recognize that using simplified criteria and not calculating the intra- and inter examiner agreement before the study may have compromised the results. To overcome the shortcomings of this study, we are planning a second study where we will 1) reduce the number of schools included, 2) focus more on the training and calibration to obtain an inter and intra observer agreement, and 3) use the approved scoring MIH criteria proposed in the recent literature.

In this study we did not differentiate between the gender, while calculating the prevalence. In terms of the MIH prevalence in different genders, studies by Preusser [33], and Garcia–Margarit[34] indicated a slightly higher prevalence in male children, while Zawaideh [35]

and Chawla[36] found the prevalence of MIH being higher in female children. However, by synthesizing all existing evidence, the above-mentioned meta-analysis result confirmed that no sex predilection has been detected.

Another factor that was not investigated in this study was the origin of the child. Geneva is a very international city with a high percentage of expats and immigrants, which may affect the presented results. It would be therefore interesting to compare the prevalence in the canton of Geneva to the prevalence of MIH in other Swiss cities and in rural areas of Geneva.

With 6.6% of children affected in Geneva, it is important to sensibilize and educate the dentists properly on the management of this kind of enamel defect, especially in the field of moderate and sever cases. A minimally invasive management protocol using remineralisation and maintainable long term temporary restoration has been developed few years ago based on evidence based studies [37]. This protocol is part of the pre-graduate education and is what is currently practiced by the dentists working in the public-school dental services in Geneva.

CONCLUSIONS

This study is the first to provide the information on prevalence of hypomineralization enamel defects and MIH in canton of Geneva schoolchildren. With an average of 6.6%, the prevalence of MIH is lower than the European and global average. However, with almost half cases being moderate or severe, asserting a proper management protocol is necessary.

Compliance with Ethical Standards

Ethical approval: Using irreversibly anonymous epidemiological data provided by the public health department, the study is not included in the swiss ethical comity review requirements according to the article 2 of the LRH, which applies only to personal health related data. If necessary, a non-objection decision can be requested.

Consent: Not requested, the information is collected during the annual dental screening with the knowledge of the parents and is part of the public library.

Conflicts of interest: The authors declare no conflict of interest.

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Data: Data can be provided if requested but will not be made public, further analysis are in progress on this dataset for a subsequent publication.

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