Molar incisor hypomineralization: results of the 6th German Oral Health Study (DMS • 6)

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Objectives: The aim of this study was to determine the prevalence of molar incisor hypomineralization (MIH) in Germany. A secondary goal was to analyze a possible connection between MIH and caries, as well as to investigate the influence of MIH on oral health-related quality of life (OHRQoL). **Method and materials:** All younger adolescents (12-year-olds) from the 6th German Oral Health Study (DMS • 6) were examined for MIH according to the criteria of the European Academy of Paediatric Dentistry (EAPD). The caries experience and OHRQoL were also determined. **Results:** In total, 922 younger adolescents were included in the analysis. The prevalence of MIH was 15.3%; 63.3% of cases were mild forms; 8.2% of affected subjects had a caries experience. OHRQoL did not vary significantly between healthy and MIH-affected children. **Conclusion:** In Germany, every seventh 12-year-old suffers from MIH. These data on MIH in younger adolescents in Germany conform to data from regional studies; the prevalence is in the upper middle range in an international comparison. *(Quintessence Int 2025;56 (Suppl):S70–S74; doi: 10.3290/j.qi.b5986273)*

Keywords: dental care, dentists, DMS 6, epidemiology, molar hypomineralization, prevalence, quality of life

Molar incisor hypomineralization (MIH) is a developmental defect of the hard tissue of the tooth that results in reduced mineralization of the enamel. It usually occurs on one to all four first permanent molars; the permanent incisors may also be affected.[1] The condition is characterized by demarcated opacities, posteruptive enamel breakdowns, and sometimes the occurrence of hypersensitivity. The etiology has not been fully identified.[2]

MIH is prevalent globally. It is estimated to affect between 13% and 14% of children.[3-5] However, the frequency reported in the literature varies greatly.[6,7] For Germany, data are available from various regional studies as well as nationally from the Fifth German Oral Health Study (DMS V). There are regional variances in the prevalence from 4.3%[8] to 17.4%.[9] However, according to the latest DMS V, in 2014 almost 30% of 12-year-olds had MIH.[10]

The aim of the 6th German Oral Health Study (DMS • 6) was to determine the current prevalence of MIH among 12-year-olds. A second goal was to analyze the associations between MIH and the occurrence of caries, and the effect that hypomineralization can have on oral health-related quality of life (OHRQoL).

Method and materials

The general methodology of the study is presented in separate articles.[11,12] The DMS • 6 has been approved by the institutional review board (IRB) of the Witten/Herdecke University, Witten, Germany (registration number S-249/2021). This study is registered at the German Clinical Trials Register (registration number DRKS00028701).

Sample

In total, 36 younger adolescents from the DMS • 6 analysis set were excluded either because there were indications for a disease other than MIH (n = 4 children with suspected fluorosis) or because they were undergoing orthodontic treatment and the

Table 1 Epidemiologic description and care of molar incisor hypomineralization (MIH) by gender and education groups in younger adolescents (12-year-olds)

Variable		Total	Gender		Education group		
			Male	Female	Low	Medium	High
No. of participants (n)		922	469	453	83	404	370
MIH (prevalence)		15.3% (13.0; 17.6)	16.6% (13.6; 20.2)	13.7% (10.9; 17.3)	13.2% (7.1; 20.4)	12.2% (9.3; 15.8)	16.5% (12.9; 20.5)
Maximum degree of expression (%)	No MIH	84.7 (82.4; 87.0)	83.4 (79.8; 86.4)	86.3 (82.7; 89.1)	86.8 (78.4; 92.1)	87.8 (84.2; 90.7)	83.5 (79.2; 86.8)
	Demarcated opacity	9.7 (7.8; 11.6)	10.2 (7.6; 13.0)	9.1 (6.7; 12.0)	11.0 (5.5; 17.9)	7.2 (4.9; 10.0)	9.1 (6.5; 12.4)
	Posteruptive enamel breakdown, circumscribed	1.3 (0.7; 2.2)	1.4 (0.6; 2.8)	1.1 (0.4; 2.5)	1.3 (0.1; 4.8)	0.7 (0.2; 2.0)	2.1 (1.0; 4.0)
	Posteruptive enamel breakdown, extensive	0.1 (0.0; 0.5)	0.1 (0.0; 1.0)	0.1 (0.0; 1.1)	0.0 (NA)	0.0 (NA)	0.3 (0.0; 1.3)
	Atypical restoration	4.1 (3.0; 5.5)	4.6 (2.9; 6.7)	3.4 (2.0; 5.4)	0.9 (0.1; 4.8)	3.9 (2.3; 6.1)	5.0 (3.0; 7.4)
	Extraction due to MIH	0.1 (0.0; 0.5)	0.3 (0.0; 1.0)	0.0 (NA)	0.0 (NA)	0.3 (0.0; 1.2)	0.0 (NA)
Maximum degree of expression if ≥ 1 MIH tooth (%)	No MIH	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)	0.0 (NA)
	Demarcated opacity	63.3 (55.0; 70.8)	61.0 (49.6; 70.6)	66.2 (53.1; 76.6)	83.5 (56.4; 96.4)	58.9 (44.2; 71.5)	55.2 (43.2; 67.7)
	Posteruptive enamel breakdown, circumscribed	8.4 (4.7; 14.0)	8.7 (3.9; 16.2)	8.0 (3.2; 17.0)	9.8 (0.9; 32.8)	5.9 (1.8; 15.7)	12.9 (6.4; 23.2)
	Posteruptive enamel breakdown, extensive	0.8 (0.1; 3.3)	0.8 (0.1; 5.6)	0.8 (0.2; 7.4)	0.0 (NA)	0.0 (NA)	1.9 (0.2; 7.4)
	Atypical restoration	26.6 (20.1; 34.7)	27.8 (18.4; 37.5)	24.9 (15.1; 36.4)	6.6 (0.9; 32.8)	32.4 (19.5; 45.2)	30.1 (19.2; 41.7)
	Extraction due to MIH	0.9 (0.1; 3.3)	1.7 (0.1; 5.6)	0.0 (NA)	0.0 (NA)	2.8 (0.2; 9.3)	0.0 (NA)
MIH teeth among all children		0.5 (0.5; 0.6)	0.6 (0.5; 0.8)	0.4 (0.3; 0.6)	0.4 (0.2; 0.7)	0.5 (0.3; 0.6)	0.6 (0.4; 0.7)
MIH teeth if ≥ 1 MIH tooth		3.4 (3.1; 3.7)	3.7 (3.2; 4.1)	3.1 (2.7; 3.5)	3.2 (2.1; 4.2)	3.5 (2.8; 4.2)	3.5 (3.0; 3.9)

Data are presented as unweighted numbers (n) and weighted percentages or weighted means (with 95% confidence intervals).
NA, not available.

Table 2 Epidemiologic description and care of molar incisor hypomineralization (MIH) by caries (experience) in younger adolescents (12-year-olds)

Variable		Tooth decay		Caries experience	
		DT = 0	DT > 0	DMFT = 0	DMFT > 0
No. of participants (n)		854	68	736	186
MIH (prevalence)		16.3%	3.9%	17.3%	8.2%
Maximum degree of expression (%)	No MIH	83.7	96.1	82.7	91.8
	Demarcated opacity	10.3	2.5	11.5	3.2
	Posteruptive enamel breakdown, circumscribed	1.4	0.0	1.4	0.9
	Posteruptive enamel breakdown, extensive	0.1	0.0	0.2	0.0
	Atypical restoration	4.3	1.4	4.2	3.7
	Extraction due to MIH	0.2	0.0	0.1	0.3

Data are presented as unweighted numbers (n) and weighted percentages. 95% confidence intervals are not given due to low cell counts.
DMFT, decayed, missing, filled teeth; DT, decayed teeth.

first molars were banded and could not be assessed (n = 32). A total of 922 younger adolescents were included in the analysis.

Measurement methods and variables

The MIH findings for the permanent central and lateral incisors and first molars were used for the analyses. To be considered a case of MIH, at least one first molar had to show hypomineralization.[1] MIH was recorded and diagnosed according to the European Academy of Paediatric Dentistry (EAPD) criteria[13]:

- Demarcated opacity: clearly defined area with an altered coloration (whitish, yellowish to brownish) of the enamel; regular surface and thickness of the enamel; opacities of < 1 mm not recorded
- Posteruptive enamel breakdown, circumscribed (< ⅓ of the tooth surface): circumscribed, limited substance defect of the enamel, extending to less than ⅓ of the entire tooth crown, which only occurred after tooth eruption; loss is often associated with a preexisting demarcated opacity

Table 3 Assessment of oral health-related quality of life by molar incisor hypomineralization (MIH) prevalence in younger adolescents (12-year-olds)

	MIH (prevalence)	
OHIP	Yes	No
OHIP 1 (chewing)	1.4 (1.2; 1.5)	1.4 (1.4; 1.5)
OHIP 2 (taste)	1.0 (1.0; 1.0)	1.1 (1.1; 1.1)
OHIP 3 (everyday)	1.0 (1.0; 1.1)	1.1 (1.1; 1.1)
OHIP 4 (pain)	1.4 (1.3; 1.6)	1.6 (1.5; 1.6)
OHIP 5 (appearance)	1.3 (1.2; 1.5)	1.4 (1.4; 1.5)
OHIP total score	6.2 (5.8; 6.5)	6.7 (6.5; 6.8)

Data are presented as weighted means (with 95% confidence intervals).
OHIP, Oral Health Impact Profile.

Table 4 Trends in epidemiology and care of molar incisor hypomineralization (MIH) in younger adolescents (12-year-olds) from DMS V to DMS • 6

Variable		DMS V	DMS • 6
No. of participants (n)		1,468	922
MIH (prevalence)		28.7%	15.3%
Maximum degree of expression (%)	No MIH	71.3	84.7
	Demarcated opacity	23.3	9.7
	Posteruptive enamel breakdown, circumscribed	2.8	1.3
	Posteruptive enamel breakdown, extensive	0.4	0.1
	Atypical restoration	2.1	4.1
	Extraction due to MIH	0.1	0.1
MIH teeth among all children		0.8	0.5
MIH teeth if ≥ 1 MIH tooth		2.7	3.4

Data are presented as unweighted numbers (n) and weighted percentages or weighted means.

- Posteruptive enamel breakdown, extensive (> ⅓ of the tooth surface): extensive substance defect, extending to more than ⅓ of the entire tooth crown
- Atypical restoration: The size and shape of the restoration do not correspond to the typical extent of the caries; atypical restoration often extends to the buccal and palatal/lingual surface in molars; opacity is often visible at the restoration margin; a buccal restoration that cannot be attributed to trauma is visible in incisors
- Extraction due to MIH: Absence of a first molar to be viewed in relation to the other teeth; indications include simultaneous demarcated opacities or atypical restorations on the other first molars, or the absence of a first molar in an otherwise intact dentition if demarcated opacities are present on the incisors
- Tooth not erupted: The first molar or incisors have not yet erupted.

In addition, the caries experience (decayed, missing, filled teeth [DMFT]) and the care status as well as the OHRQoL were recorded. The latter was measured using the short version of the Oral Health Impact Profile for schoolchildren (OHIP-5).[14,15]

Statistical analysis

A descriptive analysis of the prevalence, the distribution of the clinical severities and the treatment of MIH following caries (experience), as well as of the OHRQoL, was carried out. For the epidemiologic description, prevalences and averages with associated 95% confidence intervals (CIs) were calculated using a weighted dataset. The aim was to compensate for different probabilities in the selection of subjects and differences in gender, age, and region compared to the population in Germany by using the weighted dataset. Numbers (n) are provided without weighting. Detailed information on data handling and statistical methods is described previously.[16]

Results

The study included 922 younger adolescents (49% female). The prevalence of MIH was 15.3% (Table 1).

Younger adolescents with a higher family education status were more frequently affected. The majority of those with MIH (63.3%) showed demarcated opacities (and thus mild forms of MIH). Just under a tenth (9.2%) had untreated enamel breakdowns. Of the younger adolescents with MIH, 26.6% had already undergone restoration. Only in rare cases (0.9 %) had the MIH-affected teeth already been extracted. On average, 3.4 teeth were affected in younger adolescents with MIH.

With regard to caries experience, 8.2% (n = 20) of younger adolescents with MIH also showed caries experience (DMFT > 0). Only four of them (3.9%) also had decayed teeth (DT > 0) (Table 2).

The measurement of the OHRQoL showed no relevant differences between younger adolescents with and without MIH, both in the total score (6.2 vs 6.7) and in the five dimensions (Table 3).

Discussion

The DMS • 6 shows that 15.3% of 12-year-olds in Germany have at least one first molar with hypomineralization. MIH findings are therefore no longer as prevalent as in the last DMS V. In the

latter, MIH was diagnosed in 28.7% of cases (Table 4).[10] The recent data thus correspond better to the regional prevalences found in Germany at different points in time than the last DMS. In a four-city study, Petrou et al[8] found an average prevalence of 10.1% (range 4.3% to 14.6%). In Munich, 14.7% were affected by MIH,[17] while in Frankfurt and its surroundings the prevalence was calculated as 13.1% (range 9.4% to 17.4%).[9] With around 15%, the current figures for 12-year-olds lie in the upper range of the regional figures; internationally, the percentage is in the middle range. Globally, the figures vary greatly, but the mean is estimated at 13% to 14%,[3-5] which corresponds approximately to the new data for Germany. It should, however, be noted that the German data may be higher and may even reach the 20% mark as orthodontic cases were excluded because the first molars could not be evaluated.

The assessment of the severity of MIH shows that in most of the younger adolescents with MIH the maximum severity is a demarcated opacity (63.3%). This finding is also in line with the regional studies carried out in Germany and with the international literature. Both, in the four-city study,[8] in Munich[17] and in the Frankfurt area,[9] demarcated opacities dominated – albeit in higher percentages of up to over 90%. However, these studies in part looked at younger children (from age 6). In the 12-year-olds, the first molars and incisors have erupted several years previously and have thus been subjected to (chewing) forces. There is therefore more time for the opacity to develop a possible posteruptive breakdown or to require restoration.

With regard to caries experience, it could be shown that 8.2% of younger adolescents with MIH had caries experience. Fortunately, untreated carious teeth were only found in four younger adolescents (DT > 0). This is also consistent with the literature, which states that younger adolescents with MIH have up to a 4.6-fold higher risk of caries.[18]

The measurement of OHRQoL did not find systematic differences between MIH-affected and healthy younger adolescents. There is currently no consensus in the literature as to whether MIH has a negative impact on a person's OHRQoL. Studies both in Germany as well as internationally have confirmed a lower OHRQoL with MIH,[19-21] but other international studies have not found this to be true.[22,23]

Conclusion

More than one adolescent in seven in Germany aged 12 years is affected by MIH. This confirms regional observations of the existence of an MIH problem epidemiologically. This high prevalence shows the need for further research on the causes and on ways to prevent the disease.

Disclosure

ARJ and KK are employed by the National Association of Statutory Health Insurance Dentists (KZBV). The authors declare that there are no conflicts of interest according to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. The interpretation of data and presentation of information is not influenced by any personal or financial relationship with any individual or organization.

Author contributions

All authors listed in the paper have contributed sufficiently to fulfill the criteria for authorship according to Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals (ICMJE Recommendations). All authors read and approved the final manuscript. KB is a member of the scientific advisory board of DMS • 6, responsible for the development of the clinical examinations, and is the author of the manuscript. HML and US are members of the scientific advisory board of the DMS • 6 and responsible for the development of the clinical examinations. ARJ is the principal investigator of DMS • 6, responsible for developing the clinical examinations, and a co-author of the manuscript. KK is the deputy principal investigator of DMS • 6, responsible for the data analysis, and a co-author of the manuscript.

References

1. Weerheijm KL, Jälevik B, Alaluusua S. Molar-incisor hypomineralisation. Caries Res 2001;35:390–391.
2. Garot E, Rouas P, Somani C, Taylor GD, Wong F, Lygidakis NA. An update of the aetiological factors involved in molar incisor hypomineralisation (MIH): a systematic review and meta-analysis. Eur Arch Paediatr Dent 2022;23:23–38.
3. Schwendicke F, Elhennawy K, Reda S, Bekes K, Manton DJ, Krois J. Global burden of molar incisor hypomineralization. J Dent 2018;68:10–18.

4. Schwendicke F, Elhennawy K, Reda S, Bekes K, Manton DJ, Krois J. Corrigendum to "Global burden of molar incisor hypomineralization", J Dent 2018;68C:10–18. J Dent 2019;80:89–92.

5. Zhao D, Dong B, Yu D, Ren Q, Sun Y. The prevalence of molar incisor hypomineralization: evidence from 70 studies. Int J Paediatr Dent 2018;28:170–179.

6. Soviero V, Haubek D, Trindade C, Da Matta T, Poulsen S. Prevalence and distribution of demarcated opacities and their sequelae in permanent 1st molars and incisors in 7 to 13-year-old Brazilian children. Acta Odontol Scand 2009;67:170–175.

7. Subramaniam P, Gupta T, Sharma A. Prevalence of molar incisor hypomineralization in 7–9-year-old children of Bengaluru City, India. Contemp Clin Dent 2016;7:11–15.

8. Petrou MA, Giraki M, Bissar A-R, et al. Prevalence of Molar-Incisor-Hypomineralisation among school children in four German cities. Int J Paediatr Dent 2014;24:434–440.

9. Amend S, Nossol C, Bausback-Schomakers S, et al. Prevalence of molar-incisor-hypomineralisation (MIH) among 6-12-year-old children in Central Hesse (Germany). Clin Oral Invest 2021;25:2093–2100.

10. Jordan AR, Micheelis W (eds). Fünfte Deutsche Mundgesundheitsstudie (DMS V). Cologne: Deutscher Zahnärzte Verl., 2016.

11. Jordan AR, Frenzel Baudisch N, Ohm C, et al. 6th German Oral Health Study (DMS • 6): rationale, study design, and baseline characteristics. Quintessence Int 2025;56(Suppl):S4–S12.

12. Ohm C, Kuhr K, Zimmermann F, et al. 6th German Oral Health Study (DMS • 6): fieldwork, data collection, and quality assurance. Quintessence Int 2025;56(Suppl): S14–S21.

13. Weerheijm KL, Duggal M, Mejàre IA, et al. Judgement criteria for molar incisor hypomineralization (MIH) in epidemiologic studies: a summary of the European meeting on MIH held in Athens, 2003. Eur J Paediatr Dent 2003;4:110–113.

14. John MT, Miglioretti DL, LeResche L, Koepsell TD, Hujoel P, Micheelis W. German short forms of the Oral Health Impact Profile. Community Dent Oral Epidemiol 2006;34:277–288.

15. Solanke C, John MT, Ebel M, Altner S, Bekes K. OHIP-5 for school-aged children. J Evid Based Dent Pract 2024;24(1S):101947.

16. Kuhr K, Sasunna D, Frenzel Baudisch N, et al. 6th German Oral Health Study (DMS • 6): data processing and statistical methods. Quintessence Int 2025;56(Suppl):S22–S29.

17. Kühnisch J, Heitmüller D, Thiering E, et al. Proportion and extent of manifestation of molar-incisor-hypomineralizations according to different phenotypes. J Public Health Dent 2014;74:42–49.

18. Americano GCA, Jacobsen PE, Soviero VM, Haubek D. A systematic review on the association between molar incisor hypomineralization and dental caries. Int J Paediatr Dent 2017;27:11–21.

19. Joshi T, Rahman A, Rienhoff S, Rienhoff J, Stamm T, Bekes K. Impact of molar incisor hypomineralization on oral health-related quality of life in 8–10-year-old children. Clin Oral Invest 2022;26:1753–1759.

20. Reissenberger T, Ebel M, Klode C, Hirsch C, Bekes K. Hypomineralized teeth and their impact on oral-health-related quality of life in primary school children. Int J Environ Res Public Health 2022;19:10409.

21. Dantas-Neta NB, Moura LdFAdD, Cruz PF, et al. Impact of molar-incisor hypomineralization on oral health-related quality of life in schoolchildren. Braz Oral Res 2016;30:e117.

22. Dias FMCS, Gradella CMF, Ferreira MC, Oliveira LB. Molar-incisor hypomineralization: parent's and children's impact perceptions on the oral health-related quality of life. Eur Arch Paediatr Dent 2021;22:273–282.

23. Folayan MO, Chukwumah NM, Popoola BO, et al. Developmental defects of the enamel and its impact on the oral health quality of life of children resident in Southwest Nigeria. BMC Oral Health 2018;18:160.

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