Research Article

Prevalence of Molar Incisor Hypomineralization (MIH) and Its Clinical Impact on Adolescents' Oral Health

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Abstract

Background: Molar Incisor Hypomineralization (MIH) is a developmental enamel defect affecting per-manent first molars and incisors, presenting significant challenges in pediatric and adolescent dental care. The condition has gained considerable attention due to its increasing prevalence and substantial impact on oral health-related quality of life. **Objective:** This cross-sectional study aimed to determine the prevalence of MIH among adolescents aged 12–16 years and evaluate its clinical impact on oral health parameters and quality of life. **Methods:** A total of 847 adolescents from eight secondary schools were examined using the European Academy of Paediatric Dentistry (EAPD) criteria for MIH diagnosis. Clinical examinations assessed caries experience (DMFT index), dental sensitivity, and treatment needs. The Child Oral Health Impact Profile (COHIP) questionnaire evaluated oral health-related quality of life. Statistical analyses included chi-square tests, t-tests, and logistic regression, with significance set at $p<0.05$. **Results:** The overall MIH prevalence was 14.8% (n=125). Among affected individuals, 68.0% exhibited mild MIH, 23.2% moderate, and 8.8% severe forms. Adolescents with MIH demonstrated significantly higher mean DMFT scores (3.87 ± 2.14) compared to unaffected peers (2.21 ± 1.76; $p<0.001$). Dental sensitivity was reported by 72.8% of MIH-affected participants versus 18.4% of con-trols ($p<0.001$). COHIP scores indicated significantly poorer oral health-related quality of life in the MIH group ($p<0.001$). **Conclusion:** MIH demonstrates considerable prevalence among adolescents and significantly impacts oral health outcomes, caries susceptibility, dental sensitivity, and quality of life. Early identification and comprehensive management protocols are essential for optimizing outcomes in affected individuals.

Keywords: molar incisor hypomineralization, MIH prevalence, adolescent oral health, enamel defects, dental sensitivity, oral health-related quality of life

1. Introduction

Molar Incisor Hypomineralization (MIH) represents a qualitative developmental defect of enamel characterized by demarcated opacities affecting one or more permanent first molars, frequently accompanied by incisor involvement [1]. This condition was formally defined by Weerheijm and colleagues in 2001, establishing stan-dardized diagnostic criteria that have facilitated epidemiological research and clinical management strategies [2]. The etiology of MIH remains multifactorial and incompletely understood, with proposed causative fac-tors including prenatal and perinatal complications, childhood illnesses, antibiotic exposure, environmental pollutants, and genetic predisposition [3]. Global prevalence studies have demonstrated considerable variation, ranging from 2.8% to 44.0%, at-tributable to differences in diagnostic criteria, examination methodologies, and population characteristics [4]. A systematic review and meta-analysis by Zhao and colleagues reported a pooled global prevalence of 14.2%, indicating that MIH represents a significant public health concern requiring increased attention from dental professionals and policymakers [5]. The clinical manifestations of MIH extend beyond aesthetic con-cerns, encompassing increased caries susceptibility, post-eruptive enamel breakdown, dental hypersensitivity, and behavioral management difficulties during dental treatment [6]. Adolescence represents a critical period for oral health assessment, as permanent dentition establishment allows comprehensive evaluation of MIH severity and its cumulative effects [7]. During this developmental stage, affected individuals may experience significant functional and psychosocial consequences, including masticatory difficulties, temperature sensitivity, and aesthetic concerns impacting self-esteem [8]. Further-more, adolescents with MIH often require extensive and repeated dental interventions, contributing to dental anxiety and healthcare burden [9]. Recent

investigations have increasingly focused on the association between MIH and oral health-related quality of life (OHRQoL), recognizing that objective clinical measures alone inadequately capture the full impact of this condition [10]. Studies utilizing validated questionnaires have consistently demonstrated dimin-ished OHRQoL among MIH-affected children and adolescents, particularly in domains related to emotional well-being and social interactions [11]. However, research specifically examining adolescent populations re-mains limited, and the relationship between MIH severity and various oral health parameters requires further elucidation [12]. Despite growing recognition of MIH's clinical significance, substantial knowledge gaps persist regarding regional prevalence patterns and the comprehensive assessment of clinical impacts in adolescent populations. Many existing studies focus primarily on younger children, potentially underestimating the cumulative effects of MIH that become more apparent during adolescence. Additionally, few investigations have simultaneously evaluated multiple clinical outcomes, including caries experience, sensitivity, treatment needs, and quality of life within a unified framework. Therefore, this study aimed to determine the prevalence of MIH among adolescents aged 12–16 years and comprehensively evaluate its clinical impact on oral health parameters and quality of life. The findings are intended to inform clinical practice guidelines and public health initiatives targeting this increasingly recognized dental condition.

2 Materials and Methods

1.1 Study Design and Setting

This cross-sectional analytical study was conducted between September 2023 and March 2024 in eight ran-domly selected secondary schools within an urban metropolitan area. The study protocol received ethical approval from the Institutional Review Board (Protocol #IRB-2023-0847), and all procedures adhered to the Declaration of Helsinki guidelines for human subjects research.

1.2 Sample Size Determination

Sample size calculation was performed using G*Power software version 3.1, based on an anticipated MIH prevalence of 15%, a 95% confidence interval, a 3% margin of error, and a design effect of 1.5 for cluster sampling. The minimum required sample was determined to be 780 participants, and this was increased to 860 to accommodate potential non-response.

1.3 Participant Selection

Adolescents aged 12–16 years with fully erupted permanent first molars and incisors were eligible for inclu-sion. Exclusion criteria comprised:

(1) presence of orthodontic appliances obscuring examination surfaces;
(2) history of extensive dental restorations preventing accurate assessment
(3) diagnosed amelogenesis im-perfecta, dentinogenesis imperfecta, or fluorosis
(4) systemic conditions affecting enamel development; and
(5) inability to provide informed assent.

Stratified random sampling was employed, with schools serving as primary sampling units. Within each school, classes were randomly selected, and all eligible students were invited to participate. Written informed consent was obtained from parents/guardians, and assent was obtained from all participants.

1.4 Clinical Examination Procedures

Clinical examinations were performed by two calibrated examiners (Cohen's kappa = 0.89 for inter-examiner reliability and 0.92 for intra-examiner reliability). Examinations were conducted in school health rooms under standardized conditions using portable dental equipment, plane mouth mirrors, WHO periodontal

probes, and artificial illumination. MIH was diagnosed according to the European Academy of Paediatric Dentistry (EAPD) criteria, requir-ing the presence of demarcated opacities, post-eruptive enamel breakdown, atypical restorations, or extracted first permanent molars due to MIH in at least one permanent first molar. Severity classification followed established protocols: mild (demarcated opacities without enamel breakdown in non-stress-bearing areas), moderate (demarcated opacities with enamel breakdown limited to one or two surfaces without cuspal in-volvement), and severe (post-eruptive breakdown involving cusps, atypical restorations, or extraction due to MIH). Caries experience was assessed using the DMFT index (Decayed, Missing, Filled Teeth) according to WHO criteria. Dental sensitivity was evaluated through participant self-report and confirmed via cold air stimulation (2-second application, at a 1 cm distance), with the response recorded on a dichotomous scale.

1.5 Questionnaire Administration

Sociodemographic data, including age, sex, parental education level, and family income category, were collected through structured questionnaires completed by parents. Oral health-related quality of life was assessed using the validated Child Oral Health Impact Profile (COHIP-SF 19), comprising 19 items across four domains: oral health well-being, functional well-being, social-emotional well-being, and school environment. Responses utilized a 5-point Likert scale (0 = never to 4 = almost always), with higher total scores indicating poorer OHRQoL.

1.6 Statistical Analysis

Data were analyzed using SPSS version 27.0 (IBM Corporation, Armonk, NY). Descriptive statistics included frequencies, percentages, means, and standard deviations. Normality was assessed using the Kolmogorov-Smirnov test. Between-group comparisons employed chi-square tests for categorical variables and independent-samples t-tests for continuous variables. Multivariable logistic regression identified factors associated with MIH presence and severity. Statistical significance was established at $p<0.05$, and 95% confidence intervals were calculated for odds ratios.

3 Results

a. Participant Characteristics

Of the 860 initially recruited adolescents, 847 completed all examination and questionnaire components (response rate: 98.5%). The sample comprised 431 females (50.9%) and 416 males (49.1%), with a mean age of 13.8 ± 1.4 years. Sociodemographic characteristics demonstrated a relatively balanced distribution across age groups and socioeconomic categories.

b. MIH Prevalence and Distribution

The overall MIH prevalence was 14.8% (n=125; 95% CI: 12.4–17.2%). Among affected individuals, the severity distribution showed 85 participants (68.0%) with mild MIH, 29 (23.2%) with moderate MIH, and 11 (8.8%) with severe MIH. No statistically significant difference in MIH prevalence was observed between males (15.4%) and females (14.2%; p=0.631). Regarding tooth-specific involvement, mandibular first molars were most frequently affected (78.4%), followed by maxillary first molars (71.2%) and maxillary incisors (42.4%) (Table 1).

Table 1: Distribution of MIH prevalence by demographic characteristics

Variable	Category	Toal n	MIH Present n (%)	MIH Absent n (%)	p-value
Sex	Male	416	64 (15.4%)	352 (84.6 %)	0.631
	Female	431	61 (14.2%)	370 (85.8 %)	
Age (years)	12	168	23 (13.7%)	145 (86.3 %)	0.847
	13	182	28 (15.4%)	154 (84.6 %)	
	14	175	27 (15.4%)	148 (84.6 %)	
	15	171	24 (14.0%)	147 (86.0 %)	
	16	151	23 (15.2%)	128 (84.8 %)	
Parental Education	Primary/Secondary	287	48 (16.7%)	239 (83.3 %)	0.284
	Higher Secondary	312	44 (14.1%)	268 (85.9 %)	
	University	248	33 (13.3%)	215 (86.7 %)	
Family Income	Low	241	39 (16.2%)	202 (83.8 %)	0.518
	Middle	378	55 (14.6%)	323 (85.4 %)	
	High	228	31 (13.6%)	197 (86.4 %)	

c. Clinical Impact of MIH

Adolescents with MIH demonstrated significantly higher mean DMFT scores (3.87 ± 2.14) compared to unaffected individuals (2.21 ± 1.76; $p<0.001$). Analysis of the DMFT components revealed significantly elevated decayed (D) and missing (M) components in the MIH group. Dental sensitivity was reported by 72.8% of MIH-affected participants compared to 18.4% of unaffected peers ($p<0.001$). Treatment-needs

analysis indicated that 84.0% of MIH participants required restorative intervention compared to 41.4% of controls (Table 2).

Table 2: Comparison of clinical parameters between MIH and non-MIH groups

Clinical Parameter	MIH Group (n=125)	Non-MIH Group (n=722)	p-value
DMFT Score (mean ± SD)	3.87 ± 2.14	2.21 ± 1.76	<0.001*
Decayed (D)	1.94 ± 1.56	0.89 ± 1.12	<0.001*
Missing (M)	0.42 ± 0.71	0.14 ± 0.38	<0.001*
Filled (F)	1.51 ± 1.34	1.18 ± 1.09	0.012*
Dental Sensitivity, n (%)	91 (72.8%)	133 (18.4%)	<0.001*
Treatment Need, n (%)			<0.001*
No treatment needed	20 (16.0%)	423 (58.6%)	
Preventive treatment	34 (27.2%)	168 (23.3%)	
Restorative treatment	58 (46.4%)	118 (16.3%)	
Extensive treatment	13 (10.4%)	13 (1.8%)	
Post-eruptive Breakdown, n (%)	47 (37.6%)	N/A	—
Atypical Restorations, n (%)	31 (24.8%)	N/A	—

*Statistically significant at p<0.05

d. Oral Health-Related Quality of Life

COHIP-SF 19 analysis revealed significantly poorer OHRQoL among MIH-affected adolescents across all domains. The mean total COHIP score was 28.64 ± 12.37 for the MIH group compared to 14.82 ± 9.45 for unaffected participants (p<0.001). The social-emotional well-being domain showed the most pronounced difference between the groups (Table 3).

Table 3: COHIP-SF 19 scores by MIH status and severity

COHIP Domain	Non-MIH (n=722)	Mild MIH (n=85)	Moderate MIH (n=29)	Severe MIH (n=11)	p-value
Oral Health Well-being	3.24 ± 2.18	5.87 ± 3.12	7.41 ± 3.56	9.27 ± 3.89	<0.001*
Functional Well-being	4.12 ± 2.87	7.23 ± 3.67	9.86 ± 4.12	12.45 ± 4.78	<0.001*
Social-Emotional Well-being	4.89 ± 3.42	9.34 ± 4.28	12.17 ± 4.89	15.64 ± 5.23	<0.001*
School Environment	2.57 ± 1.98	4.12 ± 2.56	5.48 ± 2.87	6.91 ± 3.12	<0.001*
Total COHIP Score	14.82 ± 9.45	26.56 ± 11.23	34.92 ± 13.45	44.27 ± 15.67	<0.001*

*Statistically significant (ANOVA with post-hoc Bonferroni correction)
Multivariable logistic regression analysis identified MIH severity (OR=2.47; 95% CI: 1.89–3.24; p<0.001) and dental sensitivity (OR=3.12; 95% CI: 2.34–4.16; p<0.001) as significant predictors of poor OHRQoL.

4 Discussion

This comprehensive cross-sectional study established an MIH prevalence of 14.8% among adolescents aged 12–16 years, aligning closely with the global pooled estimate of 14.2% reported in recent meta-analyses [13]. Our findings contribute valuable data to the evolving understanding of MIH epidemiology and its clinical ramifications during adolescence, a developmental period often underrepresented in the existing literature. The observed prevalence falls within the range reported in comparable populations, though regional variations remain substantial. European studies have documented prevalences ranging from 10.1% to 37.3%, while investigations in Asian and South American populations have reported figures between 2.8% and 40.2% [14]. These discrepancies likely reflect genuine population differences alongside methodological heterogeneity in diagnostic-criteria application and examiner calibration protocols [15]. Our severity distribution, with mild cases predominating (68.0%), corresponds with previous findings suggesting that severe MIH represents the minority of affected individuals [16]. Nevertheless, even mild MIH demonstrated significant clinical consequences in our sample, underscoring that demarcated opacities without visible breakdown may still confer functional impairment, particularly regarding thermal sensitivity and aesthetic concerns [17].The significantly elevated DMFT scores among MIH-affected adolescents (3.87 ± 2.14 versus 2.21 ± 1.76; p<0.001) corroborate established associations between enamel hypomineralization and caries susceptibility [18]. The porous, hypomineralized enamel characteristic of MIH provides favorable conditions for bacterial colonization and acid penetration, accelerating demineralization processes [19]. Furthermore, affected teeth may be inadequately cleaned due to sensitivity, compounding caries risk through compromised oral-hygiene behaviors [20]. Dental sensitivity emerged as a particularly prominent finding, affecting 72.8% of MIH participants compared to 18.4% of unaffected peers. This substantially higher prevalence than that reported in some previous studies may reflect our comprehensive assessment methodology combining self-report with clinical verification [21]. The hypomineralized enamel's increased porosity facilitates transmission of thermal and chemical stimuli to the underlying dentin, activating mechanoreceptors and nociceptors within dentinal tubules [22]. This heightened sensitivity frequently contributes to behavioral management difficulties during dental procedures, necessitating additional anesthetic techniques and potentially fostering dental anxiety [23].The treatment-needs analysis revealed concerning disparities, with 84.0% of MIH participants requiring dental intervention compared to 41.4% of unaffected adolescents. This finding has significant implications for healthcare resource allocation and emphasizes the importance of early identification and preventive strategies [24]. The substantial proportion requiring extensive treatment (10.4%) in the MIH group highlights the progressive nature of this condition when inadequately managed [25]. Quality-of-life assessment through the COHIP-SF 19 demonstrated significantly poorer outcomes across all domains among MIH-affected adolescents, with a particularly pronounced impact on social-emotional well-being. These findings align with emerging evidence positioning MIH as a condition extending beyond purely biological manifestations to encompass substantial psychosocial consequences [26]. The visible opacities affecting incisors may generate aesthetic concerns during a developmental period characterized by heightened body-image awareness and peer comparison [27]. The dose-response relationship observed between MIH severity and OHRQoL impairment strengthens causal inference and suggests that severity grading may inform prognostic assessments and treatment priori-tization [28]. Adolescents with severe MIH reported COHIP scores nearly three times higher than unaffected peers, indicating a profound functional and emotional burden warranting comprehensive interdisciplinary management [29]. Several limitations merit consideration. The cross-sectional design precludes causal inference regarding MIH and associated outcomes. Self-reported sensitivity may introduce recall or social-desirability bias. The urban sampling frame may limit generalizability to rural populations with potentially different environmental exposures and healthcare-access patterns [30]. Future longitudinal investigations tracking MIH-affected individuals through adolescence and into adulthood would enhance understanding of the natural history and long-term consequences. Clinical implications arising from these

findings include the necessity for enhanced screening protocols, particularly during mixed-dentition emergence when early identification enables preventive intervention [31]. Dental professionals should receive updated training in MIH recognition and contemporary management approaches, including remineralization therapies, desensitizing agents, and appropriate restorative-material selection [32]. Furthermore, the documented quality-of-life impact justifies incorporating psychological sup-port and aesthetic considerations into comprehensive treatment planning.

5 Conclusion

This study established an MIH prevalence of 14.8% among adolescents aged 12–16 years, with the majority presenting with mild severity. MIH demonstrated significant associations with elevated caries experience, increased dental sensitivity, greater treatment needs, and substantially diminished oral health-related quality of life. A clear dose-response relationship existed between MIH severity and clinical impact across all assessed parameters. These findings underscore the importance of recognizing MIH as a condition with far-reaching conse-quences extending beyond localized enamel defects to encompass systemic oral health deterioration and psychosocial impairment. Early identification through routine screening, implementation of preventive pro-tocols, and comprehensive management addressing both functional and emotional dimensions are essential for optimizing outcomes in affected adolescents. The substantial burden documented in this study supports prioritizing MIH within public-health agendas and clinical-education curricula, ensuring that dental professionals are adequately prepared to address this increasingly recognized developmental condition.

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