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Original Research Article

The Prevalence of Molar-Incisor Hypomineralization in Students Aged 8-12 Years In Aydın

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ABSTRACT

Aim: To evaluate the prevalence of molar incisor hypomineralization (MIH) and its association with caries in students living in Aydın.

Materials and Methods: This cross-sectional study included children aged 8 to 12 years from nine different primary and secondary schools in Aydın. Intraoral examinations were conducted in the classroom using a headlight, a sterile mirror, and a probe. The DMFT/dft index was evaluated by the criteria established by the World Health Organization (WHO), and MIH was diagnosed and scored according to the European Academy of Pediatric Dentistry (EAPD) criteria.

Results: A total of 1,010 children, with a mean age of 10 ± 1.4 years, participated in the study. The prevalence of molar incisor hypomineralization (MIH) was 5.2%. Specifically, MIH was observed in 5.1% of posterior teeth, 4.9% of anterior teeth, and concurrently in both anterior and posterior teeth in 2.5% of cases. The mean DMFT score was 0.7 ± 1.5, whereas the mean dft score for students aged 8–10 years (n = 632) was 3.1 ± 2.9. Among the students with MIH, the mean DMFT score (1.3 ± 2.0) was higher than that of the students without MIH (0.7 ± 1.5).

Conclusion: The prevalence of MIH in Aydın was found to be low, with most cases classified as severe MIH, and a correlation was observed between MIH lesions and caries. Understanding the correlation between MIH and caries, along with their respective prevalence, will contribute to the development of effective prevention strategies.

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INTRODUCTION

Molar incisor hypomineralization (MIH) is a type of dental defect characterized by enamel hypomineralization affecting the first permanent molars and incisors.[1] The etiology of MIH involves both genetic predisposition and environmental exposure during enamel development. Recent evidence suggests that genetic polymorphisms involved in enamel formation may increase susceptibility to developmental enamel defects.[2] MIH appears to be particularly influenced by adverse events occurring during the late stages of pregnancy and the first three years of life—a critical period for enamel mineralization in these teeth.[3,4] Environmental factors such as perinatal complications, systemic diseases, and frequent childhood illnesses have also been implicated in its development.[3] Associations have also been reported between MIH and chronic skin conditions[5], as well as vitamin D deficiency[6] during early childhood.Despite increasing scientific interest, the underlying etiological mechanisms of MIH remain elusive.

Clinically, MIH is characterized by distinct, asymmetric hypomineralized opacities that range in color from white and creamy to yellowish-brown.[1] These features can contribute to hypersensitivity, which may lead to reluctance in brushing, increased

plaque accumulation, the development of caries, and chronic pulp inflammation.[7] In molars affected by MIH, chewing forces can lead to posteruptive enamel breakdown, whereas aesthetic concerns may compromise incisors.[1] MIH can negatively impact children's self-perception of their oral health and influence parents' perceptions of their children's oral health.[8] It has also been associated with decreased oral health–related quality of life and increased emotional distress in affected children.[9] Clinicians and pediatric patients encounter significant challenges when managing MIH.[10] As lesion severity increases, so does the complexity of treatment, with many cases requiring extensive restorations or even extractions of affected molars.[11] Consequently, MIH is widely recognized as a prevalent global health concern, imposing a significant treatment burden.[12]

A recent meta-analysis published in 2025 estimated the global prevalence of molar incisor hypomineralization (MIH) at 15.5% in pooled data from a wide range of geographically diverse populations.[13] Research on the prevalence of MIH in Turkey is limited. Evaluations of these studies indicate that the prevalence of MIH ranges from 7.7% to 14.2%.[14-18] Furthermore, the Turkey Oral and Dental Health Profile Research Report [14], published in 2018, noted a prevalence of developmental enamel defects of 16.4% among 12-year-old children, with an even higher prevalence of 25.9% observed in rural areas. However, no study has been conducted on the prevalence of MIH in Aydın.

This study aimed to determine the prevalence of molar incisor hypomineralization and to investigate the association between MIH and caries in children aged 8-12 years living in Aydın Province, Turkey.

MATERIALS AND METHODS

Study population, sample size, and participants

This cross-sectional observational study was conducted in Aydın, Türkiye, from April to June 2023. Across the surveyed area, 85 primary and secondary schools were identified. To improve geographic and sociodemographic representativeness, the district was divided into four subregions—north, south, east, and west—based on school location. The number of schools to be selected from each subregion was determined proportionally according to the total student population in that subregion. Once the number of schools per region was calculated, 11 schools were selected via simple random sampling within each subregion using computer-generated random numbers. Within the selected schools, cluster sampling was applied to identify participating classes, with selection probabilities adjusted according to student density.

The minimum required sample size was calculated using the Statcalc program. The following parameters were entered into the program to determine the sample size: population size, anticipated frequency, confidence limits, and design effect. The program utilizes the following formula to determine the minimum sample size:

$$n = [DEFF*Np(1-p)]/ [(d_2/Z_{21-\alpha/2}*(N-1)+p*(1-p)]$$

Children in good health and aged 8-12 years, an age range selected to allow reliable diagnosis of molar incisor hypomineralization (MIH) following the eruption of all first permanent molars and permanent incisors, were included in the study. Those absent during the clinical examination or did not provide an informed consent were excluded.

Ethics Permissions

Ethical approval was obtained from the Ethics Committee of Aydın Adnan Menderes University Faculty of Dentistry with number AADUDHF 2023/01, and the study was carried out following the Declaration of Helsinki principles. After approval was obtained from the Aydın Provincial Directorate of National Education, information letters and written informed consent forms were sent to the schools one week prior to the clinical examinations. These forms were distributed to parents via the school administration. Only the children whose parents returned signed consent forms were included in the study. In addition, verbal assent was obtained from each child before the examination.

Intraoral examinations

Intraoral examinations were conducted in designated rooms within the school buildings to standardize conditions and reduce environmental variability. Examinations were performed using a light-pen, sterile dental mirror, and WHO periodontal probe after the children brushed their teeth. Each child

Table 1. EAPD Molar Incisor Hypomineralization (MIH) Scoring Criteria[1,19]

0 = No visible enamel defect.
1 = Enamel defect, non-MIH/HSPM 11 = Diffuse opacities 12 = Hypoplasia 13 = Amelogenesis imperfecta 14= Hypomineralization defect (not MIH/HSPM)
2 = Demarcated opacities 21 = White or creamy demarcated opacities 22 = Yellow or brown demarcated opacities
3 = Posteruptive enamel breakdown (PEB)
4 = Atypical restoration
5 = Atypical caries
6 = Missing due to MIH/HSPM
7 = Cannot be scored
Lesion extension criteria (index teeth only for scores from 2 to 6)
I = less than one third of the tooth surface affected.
II = at least one third but less than two thirds of the surface affected.
III = at least two thirds of the tooth surface affected.

was seated upright in a school chair during the assessment. Clinical evaluations were performed by two calibrated pediatric dentists using the diagnostic criteria of the European Academy of Paediatric Dentistry (EAPD) for molar incisor hypomineralization (MIH).[1] Lesion severity was classified according to the MIH lesion extension system proposed by Ghanim *et al*.[19] (Table 1). Caries status was recorded using the DMFT/dft index in accordance with World Health Organization (WHO) guidelines.

Prior to data collection, a calibration process was conducted to ensure diagnostic reliability. Two pediatric dentists (N.S. and R.K.Ö.) independently assessed 50 standardized photographs representing different MIH categories. This was followed by joint clinical evaluations of 60 children under examination conditions. The interexaminer agreement for MIH diagnosis was measured via the kappa statistics, which yielded a value of 0.77 ($p<0.001$), indicating substantial agreement. All data during the main study were recorded by a second researcher (B.M.A.) who was not involved in the clinical examinations, minimizing examiner bias.

Statistical analysis

Statistical analysis was conducted via SPSS software (version 19 for Windows, SPSS Inc., Chicago, Illinois, USA). Normal distribution compliance was assessed via the Kolmogorov–Smirnov test. Descriptive statistics, including numbers, percentages, means, and standard deviations, were utilized for data evaluation. The Mann–Whitney U test was used to assess the associations between measurement data and the presence of MIH. The chi-square test was conducted to examine the relationships between categorical data and the occurrence of MIH. Correlations were assessed using the Spearman correlation test. The statistical significance level (type I error rate) was set at 0.05.

RESULTS

Based on the calculations performed using the Statcalc program, the minimum sample size required for the study was determined to be 755 individuals. This calculation assumed a 50% prevalence, a design effect (DEFF) of 2, a 95% confidence level, and 80% statistical power.

Demographics

A total of 7,342 students were initially identified, and 1,036 were invited to participate in the study. Of those invited, 1,010 agreed to participate, whereas 26 declined. The mean age of the participants was 10.0 ± 1.4 years, with 50.9% male and 49.1% female children.

Table 2. The distribution of patients with MIH according to sex and age

Sex	MIH None (n,%)	MIH Yes (n,%)	Total (n,%*)	p
Female	467 (94.2)	29 (5.8)	496 (49.1)	0.40
Male	490 (95.3)	24 (4.7)	514 (50.9)	
Age				
8 years- old	172 (90.5)	18 (9.5)	190 (18.8)	0.02
9 years- old	174 (95.6)	8 (4.4)	182 (18.0)	
10 years- old	254 (97.7)	6 (2.3)	260 (25.7)	
11 years- old	190 (94.1)	12 (5.9)	202 (20.0)	
12 years- old	167 (94.9)	9 (5.1)	176 (17.4)	
Total	957 (94.8)	53 (5.2)	1010 (100.0)	

*Column percentages. Statistical analysis was by the Chi-squared test. $p < 0.05$ was considered statistically significant.

Table 3. Distribution of the Number of MIH-Affected Incisors According to the Number of MIH-Affected Molars

	Number of Incisors with MIH										
	Total	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean no. of incisors affected**
Number of Molars with MIH	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	Mean±SD
1	25 (2.5)	16 (64.0)	5 (20.0)	2 (8.0)	1(4.0)	0 (0.0)	1 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.68 ± 1.22
2	12 (1.2)	6 (50.0)	1(8.3)	1(8.3)	0 (0.0)	4 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1.58 ± 1.88
3	5 (0.5)	1 (20.0)	1 (20.0)	3 (60.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1.40 ± 0.89
4	11 (1.1)	5 (45.5)	0 (0.0)	1 (5.0)	0 (0.0)	3 (27.3)	0 (0.0)	0 (0.0)	0 (0.0)	2 (18.2)	2.73 ± 3.13
Total (%)	**53 (100)**	**28 (52.8)**	**7 (13.2)**	**7 (13.2)**	**1 (1.9)**	**7(13.2)**	**1 (1.9)**	**0 (0.0)**	**0 (0.0)**	**2(3.8)**	**-**

The values indicate the frequency (n) and percentage (%). The final column shows the mean±SD number of affected incisors for each group by the number of affected first molars.

Prevalence of MIH

The prevalence of MIH in the Aydın Efeler district was 5.2%. There was no significant difference in MIH prevalence between female (5.8%) and male (4.7%) ($p = 0.40$) children. The prevalence of MIH was greater in 8-year-old children (9.5%) than in those aged 10 years (2.3%) ($p = 0.02$) (Table 2).

Among the participants with one MIH-affected molar, 36.0% also had at least one affected incisor. This rate was 50.0% for those with two affected molars, 80.0% for those with three affected molars, and 55.0% for those with four affected molars (Table 3). There was a moderate positive correlation between the number of affected molar teeth and the number of incisors (Spearman correlation rho = 0.31 p=0.02).

Lesion extension

The distribution of MIH lesion extension revealed that 58.5% of the cases were classified as MIH lesion extension III, indicating the involvement of more than two-thirds of the tooth surface or posteruptive enamel breakdown. MIH lesion extension II, involving one-third to two-thirds of the surface, was observed in 26.4% of the children. MIH lesion extension I, limited to less than one-third of the surface without enamel loss, was present in 15.1% of patients.

MIH Severity and Caries Experience

The distribution of MIH severity by tooth number indicated a greater prevalence of mild lesions, affecting 6.6% of the total sample, than severe lesions, which were observed in 2.8% of participants. Mild MIH was most common in tooth 42 (4.0%) and tooth 11 (3.3%), whereas severe MIH was most frequently detected in tooth 12 (1.5%) and tooth 36 (1.4%) (Figure 1).

The overall DMFT score among the students was 0.7 ± 1.5, whereas the dft score for the students aged 8–10 years (n = 632) was 3.1 ± 2.9. Children with MIH had a significantly higher DMFT score (1.3 ± 2.0) compared to those without MIH (0.7 ± 1.5, p = 0.001). However, no significant difference in dft scores was detected between children with MIH (2.6 ± 2.8) and those without MIH (3.1 ± 2.9, p = 0.28) (Table 4).

When MIH severity was analyzed, children with severe MIH had significantly higher DMFT scores (2.3±2.4) than those with mild MIH (0.3±0.7) (p<0.001). However, the dft scores did not significantly differ between mild MIH (3.4±2.9) and severe MIH (1.8±2.5) (p=0.11) (Table 4).

Table 4. Associations among MIH presence, severity, and DMFT/dft scores

MIH Presence	DMFT (Mean ± SD)	DMFT p value	dft* (Mean ± SD)	dft p value
None	0.7±1.5	0.001	3.1±2.9	0.28
Yes	1.3±2.0		2.6±2.8	
MIH Severity				
Mild	0.3±0.7	<0.001	3.4±2.9	0.11
Severe	2.3±2.4		1.8±2.5	

*The age group of —8 to 10 years was included in the dft score analysis. Statistical analysis was by the Mann–Whitney U test. p < 0.05 was considered statistically significant.

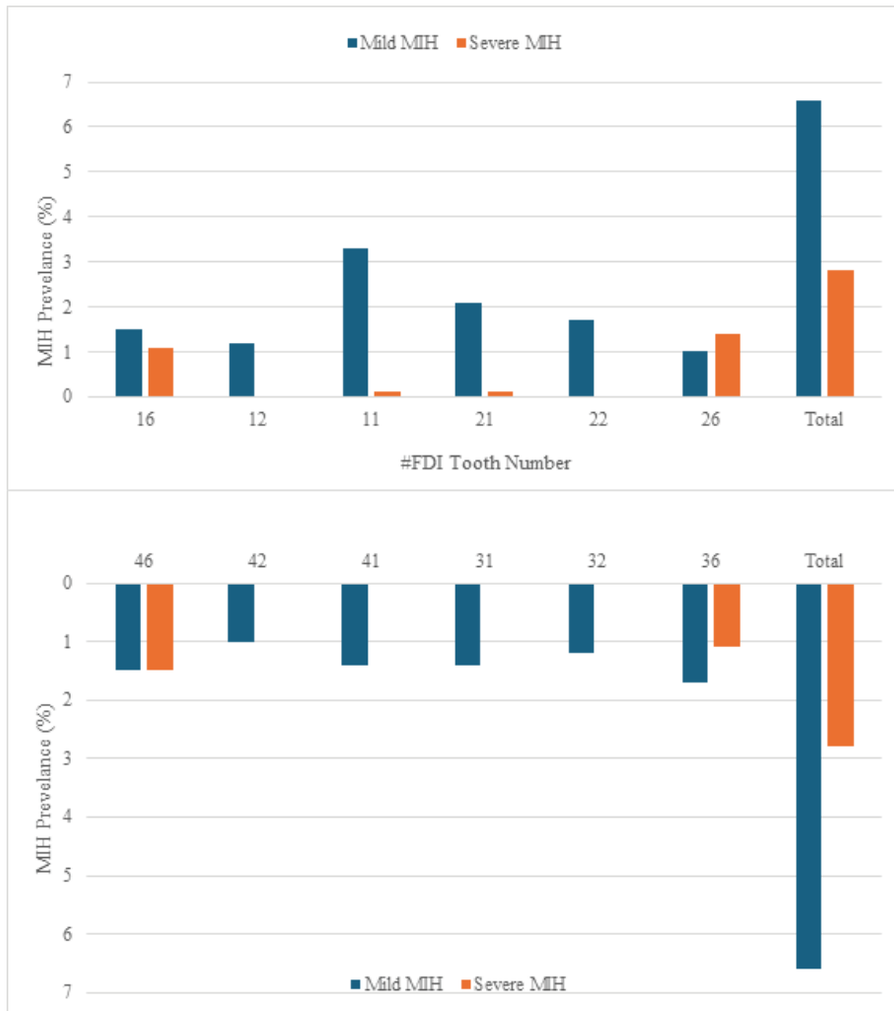

Figure 1. Distribution of Mild and Severe MIH by FDI Tooth Number

DISCUSSION

This study aimed to determine the prevalence of molar incisor hypomineralization (MIH) and investigate its association with dental caries in children aged 8 to 12 years residing in Aydın, Turkey. To the best of our knowledge, this is the first study to assess MIH prevalence and its correlation with dental caries in this region.

MIH is increasingly recognized as a condition that can negatively impact oral health and quality of life and ultimately result in tooth loss worldwide.[9] A recent meta-analysis published in 2025 estimated the global prevalence of molar incisor hypomineralization (MIH) at 15.5% in 135 studies from 53 countries. North America reported the highest continental prevalence (23.9%), followed by Oceania (17.4%), South America (17.1%), Europe (15.4%), Asia (13.7%), and Africa (12.8%).[13] Among individual countries, Brazil (up to 46.6%) and Spain (20.5%) had the highest reported national prevalence. There has been no significant increase in global MIH prevalence from 2018 to 2025.[13,20] Currently, there is no comprehensive nationwide study on the prevalence of MIH conducted in Turkey. However, the 2018 Turkish Oral and Dental Health Profile Research Report indicated that the prevalence of developmental enamel defects among 12-year-old children was 16.4%, with a notably higher prevalence (25.9%) in rural areas.[14] Several regional studies have examined MIH prevalence in Turkey.[15-18] Kuşcu et al.[16] conducted a study in Istanbul that compared industrialized and non-industrialized areas and reported MIH prevalence rates of 9.1% and 9.2%, respectively. Similarly, Sönmez et al.[17] reported a prevalence rate of 7.7% in Ankara. Koruyucu et al.[15] reported a prevalence rate of 14.2% in Istanbul. Kılınç et al.[18] reported a prevalence rate of 11.5% in Izmir. Our study revealed that the prevalence of MIH was lower than that reported in other regions of Turkey. The variability in reported MIH prevalence across studies can be attributed to differences in age group distributions, diagnostic criteria, and examination methods. To minimize variability, our study utilized a single examiner and applied the widely accepted European Academy of Paediatric Dentistry (EAPD) criteria.

MIH prevalence has been studied across different age groups[21-23], with age 8 identified as optimal for diagnosis.[24] Longitudinal evaluations between the ages of 6 and 14 are recommended to monitor MIH progression[25-27], and extending follow-up to later mixed dentition may help detect hypomineralization in teeth beyond molars and incisors, including the possible involvement of permanent canines.[28] Children aged 8 to 12 years were included in our study, as this age range corresponds with the full eruption of all four first permanent molars and most incisors. Additionally, this minimizes the risk of enamel hypomineralization being masked by caries. Our findings revealed no significant difference in MIH prevalence between age groups. This result contradicts the studies by Ghanim et al.,[19] Oydele et al.,[29] and Abdalla et al.[30] but is consistent with the study by Saitoh et al[31]. which reported significant age-related variations. Previous studies indicate that MIH is more commonly diagnosed in children under 10 years of age than in older children.[19,23] This may be because, in younger children, the first permanent molars have recently erupted, and enamel breakdown has not yet progressed significantly, making opacities easier to detect.

Sex differences in MIH prevalence remain controversial. In our study, MIH was observed in 4.7% of males and 5.8% of females, not a statistically significant difference. This result aligns with studies conducted in Istanbul and a meta-analysis that reported no association between MIH and sex.[15,33] However, a study in Italy reported[34] that MIH was twice as prevalent in females than in males. While evidence on sex differences remains inconclusive, further research is needed to clarify these discrepancies.

The relationship between molar incisor hypomineralization (MIH) and dental caries has been investigated in several studies.[35,36] Most studies have reported significantly higher DMFT scores in children with MIH.[36,37] This increase may be related to hypersensitivity caused by the defective enamel structure, which can lead to poor oral hygiene and increased plaque accumulation. However, some studies have reported no significant association between MIH and oral hygiene, suggesting that the link between MIH and caries cannot be explained by hygiene behaviors alone. In the present study,

children diagnosed with MIH tended to have higher DMFT scores, whereas no significant difference was observed in dft scores. This may be partly explained by the nature of MIH, which typically affects permanent first molars and incisors. Moreover, caries in primary teeth—as reflected in dft scores—could be underestimated because of the exfoliation of primary dentition at this age. Although the dft values were sometimes numerically higher than the DMFT values were, no consistent association with MIH was found. Nevertheless, it is possible that children with greater caries experience in their primary dentition may be more vulnerable to caries in MIH-affected permanent teeth, potentially because of overlapping biological or behavioral risk factors.

This study has several limitations. As a school-based screening method, clinical assessments were conducted under field conditions with limited equipment, and dental records were not available. The absence of teeth could not be attributed to MIH, as the reasons for tooth loss could not be verified. The cross-sectional design also limits the ability to assess lesion progression or treatment outcomes. Furthermore, the study was conducted in a single region, and the results may not be generalizable to other populations. Despite these limitations, the strengths of this study include the use of a large community-based sample, the use of standardized diagnostic criteria (EAPD), and the use of calibrated examiners with high intraexaminer agreement. Lesion severity was recorded via a validated classification system.

CONCLUSION

The prevalence of molar incisor hypomineralization (MIH) in the Aydın Efeler district was 5.2%, with the highest rate observed among 8-year-old children. Most affected teeth showed extensive lesion extension, and severe cases were frequently identified. As the number of affected molars increased, incisor involvement also became more common. Children with MIH had higher DMFT scores, indicating greater caries experience in the permanent dentition, whereas no association was found with dft scores. These findings offer insight into how MIH presents in a regional population and emphasize the value of continued research to better understand its clinical impact.

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The authors report that there are no competing interests to declare.

Aydın İlinde 8-12 Yaş Arası Çocuklarda Molar İnsizör Hipomineralizasyon Prevalansı

ÖZET

Amaç: Aydın'da yaşayan okul çocuklarında Molar İnsizör Hipomineralizasyonu (MIH) prevalansının ve çürük ile olan ilişkisinin değerlendirilmesi.

Gereç ve Yöntem: Bu kesitsel çalışmaya, Aydın'daki 9 farklı ilkokul ve ortaokula devam eden 8-12 yaş aralığındaki çocuklar dahil edilmiştir. Çocukların ağız içi muayeneleri sınıf ortamında, bir kafa lambası, steril ayna ve sond kullanılarak gerçekleştirilmiştir. DMFT/dft indeksi, Dünya Sağlık Örgütü (WHO) kriterlerine göre değerlendirilmiş; MIH ise Avrupa Pediatrik Diş Hekimliği Akademisi (EAPD) kriterlerine göre teşhis edilmiş ve derecelendirilmiştir.

Bulgular: Çalışmaya toplam 1010 çocuk dahil edilmiştir. Çocukların ortalama yaşı 10±1,4 yıl olarak belirlenmiştir. MIH prevalansı %5,2 olarak tespit edilmiştir. MIH prevalansı molar dişlerde %5,1, kesici dişlerde %4,9 olup, hem anterior hem de posterior dişlerde eş zamanlı olarak MIH görülme oranı %2,5'tir. DMFT skoru ortalaması 0,7±1,5, 8-10 yaş grubundaki öğrenciler (n=632) için dft skoru ortalaması 3,1±2,9 olarak hesaplanmıştır. MIH bulunan öğrencilerde DMFT skoru (1,3±2,0), MIH bulunmayan öğrencilere (0,7±1,5) kıyasla daha yüksek bulunmuştur.

Sonuç: Aydın'da MIH prevalansı düşük olarak saptanmış, vakaların çoğunun şiddetli MIH olarak sınıflandırıldığı belirlenmiştir. Ayrıca, MIH lezyonları ile çürük arasında bir korelasyon gözlemlenmiştir.

Anahtar Kelimeler: Çürük; Mine defektleri; Molar insizör hipomineralizasyonu; Prevalans

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