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Knowledge, perceptions, and clinical experience regarding Molar-Incisor Hypomineralization among a group of general dental practitioners, pediatric dentists, and other dental specialists in Egypt: a cross-sectional study

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Abstract

Background: Molar-Incisor Hypomineralization (MIH) is a prevalent clinical condition which is associated with a high burden of disease. The present study aimed to assess and compare the knowledge, perceptions, and clinical experience of general dental practitioners (GDPs), pediatric dentists (PDs), and other dental specialists (DSs) in Egypt about MIH.

Methods: Online and paper-based survey administration methods were used to collect the responses from Egyptian dentists regarding their knowledge, and perceptions about MIH. The survey tool focused on participants' socio-demographics, clinical experience, perceptions, clinical management, and preferences for further training. The level of knowledge regarding MIH was compared among the three groups. Data analysis utilized Chi-square and one-way ANOVA followed by Tukey's post hoc test using SPSS[®] Statistics Version 26.

Results: The majority of respondents had observed MIH in their practice (86%). The participants who had a postgraduate degree had a significantly higher knowledge score value (51.01 ± 5.74) than GDPs (43.05 ± 7.04) ($p < 0.001$). PDs (51.13 ± 4.76) had a significantly higher knowledge score value than other DSs (50.91 ± 6.46) ($p < 0.001$).

Conclusions: Dissemination of evidence on MIH to dental practitioners especially to GDPs is highly needed to assure confidence in MIH diagnosis at an early stage when it can be best managed.

Keywords: Molar-Incisor Hypomineralization, Perception, General dental practitioners, Questionnaire, Post-eruptive enamel breakdown

Background

Molar-Incisor Hypomineralization (MIH) is defined as "a qualitative defect of systematic origin of the enamel, involving one or more first permanent molars (FPMs), which is usually associated with affected incisors." Similar

lesions may be visible in second primary molars, and their presence has been stated as a predictive factor for MIH development (Elfrink et al. 2012). Based on the previous literature, MIH was found to affect the quality of life and the social capital of individuals since it disturbs both aesthetics and the function of teeth and leads to psychological impact as well (Portella et al. 2019; Fernandes et al. 2021). A wide range of prevalence of MIH has been

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reported worldwide (Jälevik 2010); a prevalence of 2.8% in Hong Kong (Cho and Ki 2008), 7.3% in India (Krishnan et al. 2015), and 11.5% in Turkey (Kılınç et al. 2019). This wide range may be due to the use of various indices, variability of examination criteria, lack of standardized methods of recording lesions and various age groups (Elfrink et al. 2015). Prevalence investigating research in Africa and the Middle East are very uncommon. However, a recent study in Egypt reported 2.3% MIH prevalence rate in a group of “8 to 12 years” Egyptian adolescents (Saber et al. 2018).

The etiology of MIH is not well known. Several studies were performed and reported that possible etiological factors may occur during the antenatal, perinatal or post-natal period (Almuallem and Busuttill-Naudi 2018). The following factors showed an association with MIH: urinary infection throughout the last trimester (Alaluusua 2010), antibiotics used during pregnancy or within the initial year of life (Giuca et al. 2018), genetic factors, environmental factors (Teixeira et al. 2018), any traumatic birth event (Alaluusua 2010), and illness throughout the primary 4 years of life (Silva et al. 2016b).

MIH is manifested clinically as white, white-yellow or yellow brown-colored enamel opacities with a demarcated line between the lesion and healthy enamel. The affected enamel can be chipped under functional masticatory forces which is called post-eruptive breakdown (PEB) (Fagrell et al. 2010; Almuallem and Busuttill-Naudi 2018). This can lead to various complications and difficulties for both patients and dental professionals in the form of difficulty in anaesthetizing and bonding to enamel, complexity of treatment, pain, sensitivity, disturbance in aesthetics, and psychological distress (Almuallem and Busuttill-Naudi 2018). Considering all previously mentioned aspects, MIH is considered to be one of the biggest challenges in dentistry, which has a significant impact on the oral health and quality of life (QoL) of affected patients.

Early diagnosis of MIH by dentists is the main step in the recommended six-step approach of MIH management (risk identification, early diagnosis, remineralization, prevention of dental caries and PEB, restorations or extractions, and maintenance) (Garg et al. 2012). Therefore, we need to evaluate the dentists’ knowledge, opinions, and experience as regards to MIH around the world. Worldwide studies investigating knowledge, experience, attitudes, and perceptions of dentists about MIH have been conducted in UK, Australia, USA, and Hong Kong (Gambetta-Tessini et al. 2016; Kalkani et al. 2016; Gamboa et al. 2018; Tagelsir et al. 2018). However, there is inadequate information regarding this condition in Egypt. Therefore, the purpose of this study is to assess the knowledge, perceptions and clinical experience regarding

MIH condition within Egyptian GDPs, PDs, and other DSs.

Methods

Study design

The present cross-sectional study employed a survey to solicit responses from dentists in Egypt about their knowledge regarding MIH. Ethical approval has been sought from the Research Ethical Committee at Faculty of Dentistry, Ain Shams University (FDASU-RecEM031818). Data were collected from September 2018 to October 2019.

Participants and sample

The sample size estimation was done using Steven K. Thompson equation and assuming power of the study 95% and alpha error 0.05. The estimated resultant *n* was 348 participants; then, 20% were added to the sample size to compensate for non-responses and incomplete forms of the survey resulting in a minimum sample of 384 participants. Egyptian dental practitioners who have studied or practiced dentistry outside Egypt were excluded from the study.

Recruitment of the study participants

Two methods of survey administration were used: online electronic survey and paper-based survey. The online form of the questionnaire was created by the principal investigator through Google Forms. Known colleagues of dental practitioners (GDPs, PDs and other DSs) were invited to participate in the survey by sending the online questionnaire’s link via e-mails. Participants were also asked to forward the invitation link of the survey to their colleagues in Egypt. Dental practitioners who agreed to participate voluntarily have completed and submitted the online questionnaire anonymously and confidentially. In the cover information sheet, participants were asked not to fill the questionnaire again if they had already done before. Two e-mails, which were two to three weeks apart from the first e-mail, were sent as reminders. Printed copies were prepared and administrated to dental practitioners who prefer this form more than the online form. Out of 855 invited dental practitioners, a total of 257 Egyptian GDPs, 110 PDs, and 133 other DSs completed the questionnaire.

Data collection tool

The questionnaire used for the present study was a modified version of the instrument used in a previous study in Australia and Chile (Gambetta-Tessini et al. 2016). Some questions were added from other questionnaires to check the availability and the source of MIH information so as to expand the knowledge of all dental practitioners

who can initially diagnose this condition. For instance, a question asking about the source of information regarding MIH was added from a Saudi Arabia study (Silva et al. 2016a). Likewise, questions asking about interest in additional training on MIH diagnosis, etiology, and treatment were also added from Hong Kong study (Gamboa et al. 2018).

The questionnaire consisted of a cover information sheet which included an invitation for participation, the aim of this study, and a definition of the condition under investigation. There were five sections of questions; participants were asked to report socio-demographic and professional information in the first section. Before the second section, there were photographs of hypomineralized FPMs & incisors and hypomineralized second primary molars as well which were used in similar previous studies in Australia and Iraq (Ghanim et al. 2011; Gambetta-Tessini et al. 2016).

The second section included questions regarding knowledge, perceptions, and clinical experience of the clinical appearance, diagnosis, and prevalence of MIH. The third section included questions regarding etiological factors and time of insult occurrence of MIH. Based on the answers to the knowledge questions in sections two and three, the knowledge score variable (KS) has been

calculated. Delphi scores were adapted from the original questionnaires and used thereafter. The Delphi scores have also been adjusted for the prevalence question so as to appropriately reflect MIH prevalence in Egypt (Saber et al. 2018). A total of 9 points were awarded for each answer where the sum of all ten answers scores resulted in a single continuous variable of KS for the participant (ranged from 20 to 60) (Gambetta-Tessini et al. 2016; Gamboa et al. 2018) as shown in (Table 1) where higher scores showed higher knowledge level. The fourth section included questions regarding MIH management considerations. The fifth part of the questionnaire included questions about preferences in regards to continuing education and clinical training aspects on MIH.

Statistical analysis

A descriptive profile for the dental practitioners was provided as the first part of data analysis then the responses of the three groups of dental practitioners based on their specialties, and the practice profiles were compared by using Chi-square tests. Only complete responses were counted in the statistical analysis. One-way analysis of variance (ANOVA test) has been used to model the relationship between a dependent variable (knowledge score variable) and each of the following independent variables

Table 1 Scores for each of the MIH knowledge questions as agreed using Delphi methods

Knowledge questions	Answers	Delphi Scores		Percentage of (yes) answers		
		Yes	No	GDPs N (%)	PDs N (%)	DSs N (%)
Have you been aware that MIH is a Developmental defect that differs from fluorosis and hypoplasia?		9	0	185 (72.0)	108 (98.2)	128 (96.2)
How prevalent do you think MIH might be in your community? (one option chosen)	< 5%	6	^	64 (24.9)	28 (25.5)	56 (42.1)
	5–10%	1	^	99 (38.5)	44 (40.0)	47 (35.3)
	10–20%	1	^	61 (23.7)	22 (20.0)	25 (18.8)
	> 20%	1	^	8 (3.1)	12 (10.9)	2 (1.5)
	Not sure	0	^	25 (9.7)	4 (3.6)	3 (2.3)
Do you think they are involved in the etiology of MIH?	Genetic factors	5	4	203 (26.4)	82 (21.5)	114 (26.2)
	Environmental Contaminants	5	4	164 (21.3)	68 (17.8)	80 (18.4)
	Chronic medical conditions affecting mother and children	6	3	110 (14.3)	77 (20.2)	86 (19.8)
	Acute medical conditions affecting mother or children	6	3	103 (13.4)	67 (17.5)	69 (15.9)
	Antibiotics or Medications	5	4	110 (14.3)	79 (20.7)	66 (15.2)
	Fluoride exposure	1	8	79 (10.3)	9 (2.4)	20 (4.6)
What time/period do you think the insult occurs? (One option chosen)	During pregnancy	1	^	115 (44.7)	25 (22.7)	34 (25.6)
	1st year of life	3	^	26 (10.1)	14 (12.7)	12 (9.0)
	3rd year of life	0	^	0 (0)	0 (0)	0 (0)
	Pregnancy to 1st year of life	3	^	76 (29.6)	56 (50.9)	66 (49.6)
	Pregnancy to 3rd year of life	2	^	40 (15.6)	15 (13.6)	21 (15.8)
Do you think the pattern of caries related to MIH is different from the classical caries pattern?		7	1	144 (56.0)	95 (86.4)	121 (91.0)
Knowledge scores mean ± (S.D.)				43.05 ± 7.04	51.13 ± 4.76	50.91 ± 6.46
Ranges of Knowledge score	Min Max			20	60	

(postgraduate degree, dental specialty, and years of practice) in two or more groups. In all tests, the significance level was determined to be $p \leq 0.05$ within all tests. SPSS® Statistics Version 26 was used for the statistical analysis.

Results

As shown in (Fig. 1), the overall response rate of dental practitioners by the two administration methods was 58.5%. Most respondents were females (67.4%). The age profile of the respondents was directed toward the younger age where nearly two-thirds (58.2%) were ≤ 30 years, one-third (33%) were 31–40 years and a small percent represented the higher age groups. The vast majority of the dental practitioners worked in urban areas (90.4%) and only (9.6%) worked in rural ones. Nearly half of the respondents were GDPs (48.6%), and the remaining have a postgraduate degree, where about (45.3%) of them PDs and (54.7%) were other DSs. Most dental practitioners combined two working settings together (public and private sectors/ university and private sector) with only small percent worked in a single setting.

Most respondents had observed MIH in their practice (86%). However, GDPs had a significantly lower percentage than other groups ($p < 0.001$). The most common defects observed by the respondents were yellow/brown demarcations (58.8%) with no significance difference

between the three groups (Table 2). Nearly half of PDs and DSs had observed such hypomineralized defects in permanent teeth other than FPMs (48.2%) and (55.8%), respectively, while small percent of the GDPs had encountered such lesions (22.9%) with the majority of each choosing the canines as the most common permanent tooth they encountered affected by such lesions.

The vast majority of PDs and DSs felt either confident or very confident in MIH diagnosis, while nearly half of the GDPs felt unconfident or very unconfident diagnosing these defects. Furthermore, the nearly half of the GDPs (56%), the majority of PDs (86.4%), and DSs (91%) believed that MIH-related caries pattern was different from the classical caries pattern ($p < 0.001$).

Compared with GDPs (72%), more PDs (98.2%) and DSs (96.2%) realized that MIH is a developmental defect different from fluorosis and hypoplasia ($p < 0.001$). A considerable amount of the GDPs, PDs, and DSs reported MIH prevalence to be between 5 and 10%, while a higher percent of the DSs thought it to be less than 5%. Almost all respondents realized that MIH represented a clinical problem (94.4%) and reported that it would be necessary to investigate the prevalence of MIH in their communities (97.6%). Most of the three groups of respondents thought that the severity of MIH in the community to be moderate.

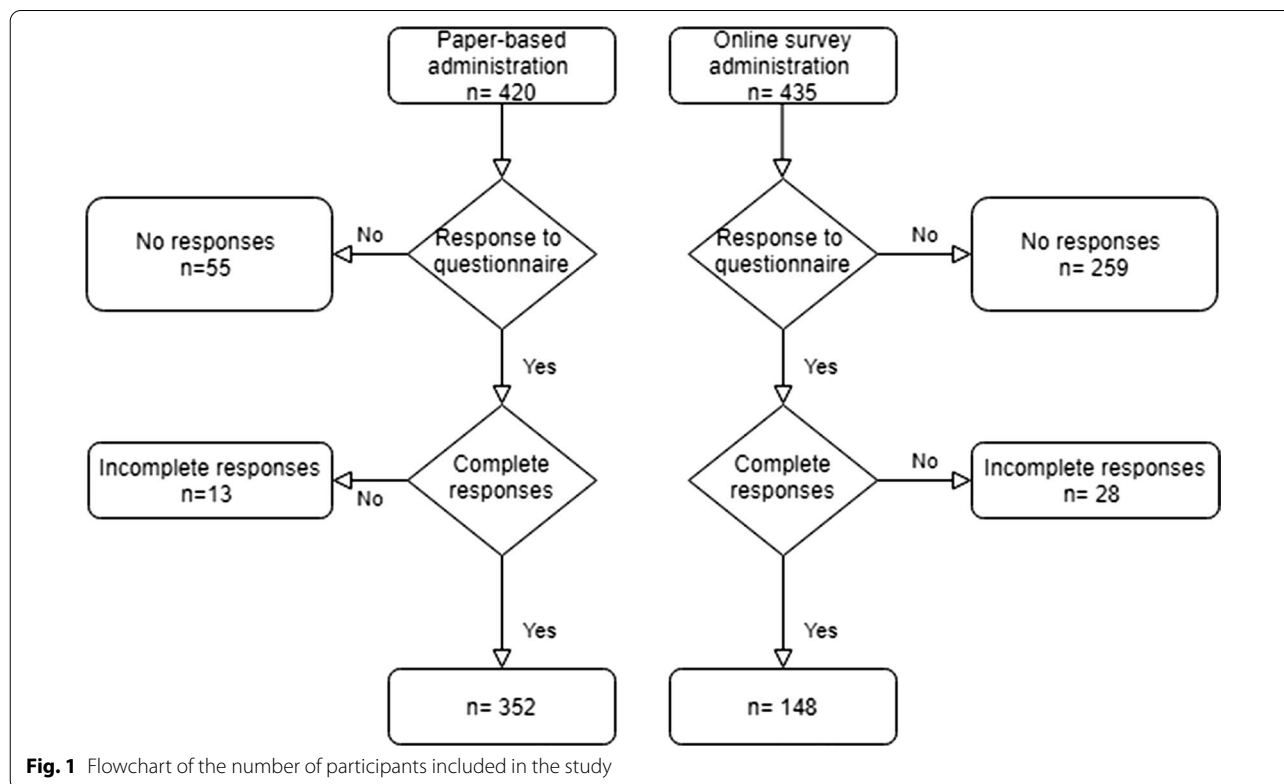


Table 2 Perceptions and clinical experience concerning the clinical appearance, diagnosis, and prevalence of MIH

Questions		GDPs N (%)	PDs N (%)	DSs N (%)	P value
Do you encounter teeth with MIH in your practice? (yes)		192 (74.7%)	110 (100%)	128 (96.2%)	< 0.001*
Regarding severity of the defect: which of the following do you most frequently observe in your practice?	White demarcation	28 (14.5%)	19 (17.3%)	11 (8.5%)	0.085
	Yellow/Brown demarcation	128 (66.3%)	78 (70.9%)	88 (68.2%)	
	Post-eruptive enamel breakdown	37 (19.2%)	13 (11.8%)	30 (23.3%)	
In your practice, do you encounter demarcated hypomineralized defects in permanent teeth other than the FPMs and incisors? (yes)		44 (22.9%)	53 (48.2%)	72 (55.8%)	< 0.001*
- If yes; please name the tooth/teeth	Canines	31 (70.5%)	24 (42.1%)	52 (58.4%)	0.047*
	Premolars	10 (22.7%)	20 (35.1%)	21 (23.6%)	
	Second permanent molars	3 (6.8%)	13 (22.8%)	16 (18%)	
How frequently do you observe this defect in the second primary molar in comparison to the first permanent molar?	More frequently	5 (2.6%)	3 (2.7%)	0 (0)	0.002*
	Less frequently	130 (67.4%)	95 (86.4%)	100 (78.1%)	
	The same as for the first permanent molar	5 (2.6%)	2 (1.8%)	0 (0)	
	Not sure	53 (27.5%)	10 (9.1%)	28 (21.9%)	
How confident do you feel when diagnosing teeth with MIH?	Very confident	10 (5.2%)	19 (17.3%)	16 (12.4%)	0.001*
	Confident	105 (54.4%)	77 (70.0%)	106 (82.2%)	
	Unconfident	76 (39.4%)	14 (12.7%)	7 (5.4%)	
	Very unconfident	2 (1%)	0 (0)	0 (0)	
Do you think that a significant percentage of caries is caused by MIH?	Yes	95 (37.0%)	59 (53.6%)	47 (35.3%)	< 0.001*
	No	66 (25.7%)	32 (29.1%)	66 (49.6%)	
	Not sure	96 (37.4%)	19 (17.3%)	20 (15.0%)	
Do you think teeth with MIH represent a clinical problem? (yes)		236 (91.8%)	106 (96.4%)	130 (97.7%)	0.133
- If yes, how serious/severe do you think is MIH in your community?	Mild	83 (33.9%)	25 (23.1%)	39 (29.5%)	0.022*
	Moderate	125 (51.0%)	64 (59.3%)	84 (63.6%)	
	Severe	24 (9.8%)	14 (13.0%)	3 (2.3%)	
	Not sure	13 (5.3%)	5 (4.6%)	6 (4.5%)	

* $p < 0.05$ = significant difference

The vast majority of all groups of dental practitioners have selected more than one possible etiological factor, supporting the common belief that MIH is a multifactorial defect. Most of the time, genetic factors were the most common cause identified by most GDPs (78.9%), PDs (74.5%), and DSs (85.7%). Environmental contaminants were the second most commonly identified cause (62.4%). Chronic disorders of the mother or child were more commonly identified as an etiological factor by PDs and DSs (67%) than GDPs (42.8%). GDPs and (PDs and DSs) had different views on the timing or duration of the insults that caused MIH. Approximately half of the GDPs (44.7%) assumed that the insults that cause MIH might occur during pregnancy; while half of PDs and DSs (50.9% and 49.6%), respectively, postulated that the insults that cause MIH would occur during the pregnancy period or in the first year of life (Table 1).

Regarding MIH management considerations, the majority of the respondents (95%) believed that early examination is important to treat MIH. Most GDPs and DSs (62.6% and 78.9%, respectively) and a small proportion of PDs (19.1%) were unwilling to provide administrative care for MIH-affected children. Similarly, most

of GDPs (73.9%) and DSs (70.7%) considered referral of children with MIH signs to a pediatric dental specialist. Significantly more PDs reported using preformed crowns to restore MIH-affected teeth when compared to GDPs and DSs ($p > 0.001$), while most of other groups choose composite resin as the material of choice (Table 3). Child behavior was reported as the biggest hindrance in managing MIH by the majority of respondents (78%). As well, insufficient training to treat children with MIH was reported by considerable number of GDPs and DSs (65.3%, 67.6%), respectively, as an obstacle.

Most of the respondents showed they had received information about MIH with more PDs (86.4%) reported receiving such information when compared to GDPs and DSs (52.5%, 65.4%). Significantly more GDPs (96.1%) than PDs and DSs (85.5%, 76.7%), respectively, indicated the need for additional training on MIH ($p > 0.002$). In general, the area that most needed additional training was the MIH treatment, which was represented by 91% of GDPs, 81.8% of PDs, and 75.9% of DSs.

The knowledge score (KS) range for all the respondents was 24–59 (Table 1). One-way ANOVA test revealed that participants who had a postgraduate degree had a

Table 3 Management considerations and continuing education aspects

Questions		GDPs N (%)	PDs N (%)	DSs N (%)	P value
Do you believe that early examinations are important to treat MIH?	Yes	239 (93.0%)	107 (97.3%)	129 (97.0%)	0.168
	No	5 (1.9%)	0 (0)	0 (0)	
	Not sure	13 (5.1%)	3 (2.7%)	4 (3%)	
Are you comfortable providing management care for children with MIH? (yes)		96 (37.4%)	89 (80.9%)	28 (21.1%)	< 0.001*
Would you refer a child who has signs of MIH to a pediatric dentist for treatment?	Yes	190 (73.9%)	55 (50.0%)	94 (70.7%)	< 0.001*
	No	13 (5.1%)	22 (20.0%)	5 (3.8%)	
	Sometime	54 (21.0%)	33 (30.0%)	34 (25.6%)	
What type of material do you frequently use in treating these teeth?	Amalgam	9 (1.8%)	3 (1%)	5 (1.8%)	< 0.001*
	Composite Resin	173 (34.1%)	82 (27.2%)	115 (42.0%)	
	GIC	70 (13.8%)	38 (12.6%)	34 (12.4%)	
	Resin modified GIC	126 (24.8%)	61 (20.2%)	54 (19.7%)	
	Compomer	16 (3.1%)	16 (5.3%)	17 (6.2%)	
	Preformed crowns	90 (17.7%)	87 (28.8%)	31 (11.3%)	
	Cast restorations	20 (3.9%)	15 (5.0%)	17 (6.2%)	
	Others (never treated a case)	4 (0.8%)	0 (0)	1 (0.4%)	
Would any of the following be a barrier to you for managing MIH teeth?	Dental treatment that need long time to be accomplished	66 (12.6%)	39 (19.9%)	19 (7.5%)	< 0.001*
	Child's behavior	211 (40.3%)	74 (37.8%)	105 (41.3%)	
	Difficulty in achieving local anesthesia	77 (14.7%)	43 (21.9%)	38 (15.0%)	
	Insufficient training to treat children with MIH	168 (32.1%)	9 (19.9%)	91 (35.8%)	
	Others: Lack of bonding	2 (0.4%)	0	0 (0)	
	Non restorable	0 (0)	0 (0)	1 (0.4%)	
	Financial constraints	0 (0)	1 (0.5%)	0 (0)	
	Are you receiving any information on MIH? (yes)		135 (52.5%)	95 (86.4%)	
If yes, what is/are your source/s?	Dental Journals	31 (12.1%)	49 (32.0%)	47 (35.1%)	< 0.001*
	Continuing education	66 (25.8%)	41 (26.8%)	24 (17.9%)	
	Brochures or Pamphlets	2 (0.8%)	0 (0)	0 (0)	
	Internet	122 (47.7%)	39 (25.5%)	52 (38.8%)	
	Books	35 (13.7%)	24 (15.7%)	11 (8.2%)	
Would you like clinical training regarding tooth hypomineralization? (yes)		247 (96.1%)	94 (85.5%)	102 (76.7%)	< 0.001*
If yes, in which part/s do you think you need further training?	Diagnosis	167 (32.9%)	50 (29.2%)	44 (25.7%)	0.053
	Etiology	107 (21.1%)	31 (18.1%)	26 (15.2%)	
	Treatment	234 (46.1%)	90 (52.6%)	101 (59.1%)	

* $p < 0.05 =$ significant difference

significantly higher knowledge score value (51.01 ± 5.74) than GDPs (43.05 ± 7.04) ($p < 0.001$). PDs (51.13 ± 4.76) had a significantly higher knowledge score value than other DSs (50.91 ± 6.46) ($p < 0.001$). Dentists within the age groups 21–30 and ≥ 31 years of practice had a significantly higher value than all other groups except (11–20 years) ($p < 0.001$). In addition, they showed dentists with (≤ 5 years) of practice to have a significantly lower value than all other groups ($p < 0.001$).

Discussion

To our knowledge, this study is one of very few studies to investigate the knowledge and perceptions of MIH among Egyptian dental practitioners. The importance of this research is to highlight the knowledge gaps in

the diagnosis and management of MIH that need to be improved to increase the level of care delivery. In the present study, the response rate for online survey was 34% and 84% for the traditional paper-based survey with the overall response rate of dental practitioners by the two methods 58.5%, similar to other studies where response rates ranged from 58.2 to 58.8% (Crombie et al. 2008; Hussein et al. 2014).

The results of this cross-sectional survey showed that the vast majority of PDs, DSs, and most of the GDPs in Egypt have encountered MIH in their practices, which are consistent with the findings of previous studies (Crombie et al. 2008; Ghanim et al. 2011; Bagheri et al. 2014; Gamboa et al. 2018). In line with previous reports, participants indicated that demarcated opacities of

yellow/brown color were the most frequently encountered enamel defect (Bagheri et al. 2014; Hussein et al. 2014; Silva et al. 2016a; Alanzi et al. 2018; Gamboa et al. 2018; Wall and Leith 2020). This might be due to the unique and obvious manifestations of the lesion at this stage, which should not be confused with tooth decay, white spot lesions, or other developmental enamel defects. Significantly more DSs, especially endodontists, orthodontists, and operative dentistry specialists, and PDs, have reported encountering MIH in permanent teeth other than the first permanent molars (FPMs) and incisors which is consistent with that reported in similar studies in Australia and Hong Kong (Gambetta-Tessini et al. 2016; Gamboa et al. 2018). This may be due to the fact that in practice, PDs encounter higher number of young patients who have recently erupted permanent teeth than GDPs, who encounter a smaller proportion of young patients.

Most of the respondents reported that MIH-like defects were observed in second primary molars, called “Hypomineralized Second Primary Molars” (HSPM), less frequently than those defects in FPMs. Pediatric dentists’ perception of HSPM was higher than that of other dental specialists and GDPs (86.4%, 78.1%, and 67.4%, respectively). This may be attributed to the fact that PDs are more in contact with pediatric patients in their practices, have a higher degree of knowledge or awareness of the problem, and have better access to MIH information. This finding is consistent with the results reported in Australia, Hong Kong, and Kuwait (Gambetta-Tessini et al. 2016; Alanzi et al. 2018; Gamboa et al. 2018).

As expected, the PDs and DSs seemed to be more confident in MIH diagnosis than GDPs, with the majority of the two former groups felt either “confident” or “very confident.” These results are consistent with those of previous studies (Ghanim et al. 2011; Hussein et al. 2014; Gambetta-Tessini et al. 2016; Wall and Leith 2020), who found that almost half of the GDPs in their studies did not have confidence in MIH diagnosis, which explains their need for additional training on the diagnostic field of MIH condition.

In the present study, most of the PDs and DSs and about half of GDPs reported the difference between MIH breakdown pattern and classical caries pattern. Encouragingly, similar results of other studies have been reported and agreed with those of the present study (Gambetta-Tessini et al. 2016; Gamboa et al. 2018; Wall and Leith 2020). Likewise, more PDs (98.2%) and DSs (96.2%) realized that MIH is different from fluorosis and enamel hypoplasia ($p < 0.01$) than GDPs (72%). These results are consistent with those of previous studies (Gamboa et al. 2018; Aidasani 2019). This could be explained by the findings that the majority of the PDs

reported receiving information regarding MIH compared to almost half of the GDPs.

Regarding the respondents’ perception about MIH prevalence within the community, about 40% of PDs, 38.5% of GDPs, and 35.3% of DSs felt it was between 5 and 10%. A further 25.5%, 24.9%, and 42.1%, respectively, felt it was less prevalent than 5% with less amount thought about higher prevalence rates. The variation of the perceived MIH prevalence may illustrate the lack of certain evidence of the actual MIH prevalence in Egypt where only two studies reported 2.3% and 9.9% prevalence rates, respectively, in different cities (Saber et al. 2018; Abo ElSoud and Mahfouz 2019). Although the two studies have been conducted in different regions with relatively different results, most of the respondents reported perceived prevalence within the range reported in the literature. Surprisingly, a vast majority of the three groups of dental practitioners recommended further investigation of MIH prevalence. These results, which are consistent with previous evidence, support the fact that dental practitioners are still uncertain about MIH prevalence in their communities (Crombie et al. 2008; Gambetta-Tessini et al. 2016; Alanzi et al. 2018).

The vast majority of the participants have selected more than one possible etiological factor which supports the common belief that MIH is a multifactorial condition, with systemic, environmental, and genetic components (Silva et al. 2016b; Teixeira et al. 2018). In the present study, more than two-thirds (about 79%) of the participants indicated the genetic factors as etiologic factors. It must also be emphasized that nearly 62.4% of the participants reported that environmental contaminants play an important role in the causation of MIH defects consistent with the literature (Jan et al. 2007). Chronic/acute disorders of the mother or child were also identified as important factors in the occurrence of MIH. These results are in agreement with those of the previous literature (Bagheri et al. 2014; Gambetta-Tessini et al. 2016; Silva et al. 2016a).

GDPs, PDs, and DSs had different views on the time or the duration of the insults leading to MIH occurrence. More than two-thirds of the GDPs, PDs, and DSs indicated that the insults causing MIH might occur during pregnancy and can be extended to the first year of life; while a small percentage of the GDPs, PDs, and DSs indicated that the insults causing MIH could only appear after birth (in the first/third year of life). These results are consistent with similar studies (Crombie et al. 2008; Ghanim et al. 2011; Gamboa et al. 2018; Tagelsir et al. 2018).

As expected, PDs have been shown to be more comfortable in managing MIH when compared to DSs and GDPs. This could be explained by the finding that they

receive more information on MIH in their continuing education programs or because of the higher rate of their professional practice on pediatric patients. Thus, most of DSs and GDPs expressed their tendency to refer MIH-affected children who need treatment to a specialist pediatric dentist, consistent with previous studies (Hussein et al. 2014; Gambetta-Tessini et al. 2016).

Agreed with other studies, a large proportion of the respondents, especially GDPs and DSs, listed the child's behavior as the main obstacle to manage these cases (Silva et al. 2016a; Alanzi et al. 2018; Wall and Leith 2020). This finding may not be surprising given that MIH-affected children have to endure multiple dental interventions and longer treatment times, which may lead to dental fear, anxiety, and negative behaviors (Jälevik and Klingberg 2002). PDs were the most prevalent to report difficulty with anesthesia as a barrier because these teeth are more sensitive, thus achieving adequate anesthesia is more difficult in them.

In the present study, the most popular material choice was composite resin (74%), followed by Resin-modified GIC (RMGIC) (48.2%) and preformed crowns (41.6%). This is agreed with the results of similar studies in which composite resin was the preferred material of restoration for MIH-affected teeth (Hussein et al. 2014; Silva et al. 2016a; Tagelsir et al. 2018; Aidasani 2019). This is also consistent with the reported high success rates of composite in restoring MIH-affected teeth, because when bonded to hypomineralized FPMs, its microshear bond strength was significantly higher than that of RMGIC and GIC (Arab et al. 2019). Another interesting finding was that PDs preferred using pre-formed crowns to treat molars that are severely affected by MIH as compared with the other two groups, consistent with similar studies (Crombie et al. 2008; Gambetta-Tessini et al. 2016; Alanzi et al. 2018; Gamboa et al. 2018). This can be attributed to the training and familiarity with the use of prefabricated metal crowns among PDs.

All previous findings may indicate the differences in the information and training received by the GDPs and PDs regarding MIH. A significantly higher percentage of PDs received more information on MIH than DSs and GDPs, thus eliminating the need for additional training on certain aspects of MIH. These findings were in agreement with those in previous studies (Gambetta-Tessini et al. 2016; Silva et al. 2016a; Gamboa et al. 2018).

After comparing the attitudes of PDs, DSs, and PG, it was observed that a significantly higher percentage of GDPs (96.1%) expressed interest for additional training on MIH diagnosis, etiology, and treatment, when compared to PDs and DSs (85.5%, 76.7%), respectively. This is agreed with the common barriers for MIH management among GDPs, insufficient training. Similar findings

were reported among dentists in similar studies (Ghanim et al. 2011; Hussein et al. 2014; Alanzi et al. 2018; Aidasani 2019). Agreed with previous findings, high levels of interest in additional training regarding MIH treatment modalities were reported, which may reflect the need to establish effective intervention programs (Crombie et al. 2008; Ghanim et al. 2011; Hussein et al. 2014).

The present study illustrates that without a comprehensive understanding and knowledge of MIH clinical manifestations in the undergraduate training, future dental practitioners will face similar obstacles in MIH diagnosis and management. Due to this, many dentists especially GDPs were found to be not confident enough in diagnosing teeth with MIH. From the findings of the current study, it might be recommended that MIH associated case studies should be included within the undergraduate dental curriculum, and clinical training on MIH management should be carried out in the continuous dental education programs. It is also important to disseminate MIH diagnostic criteria not only among dental practitioners, but also among other medical specialties (such as pediatricians) who are caring for children, because they could diagnose this condition at an early stage.

Study limitations

The relatively low response rate of dental practitioners through the online administration method was the most apparent shortcoming. However, this was compensated by using mixed-mode administration of the survey and increasing the number of invited participants to reach the targeted sample size. Additionally, regarding the self-reporting nature of the research, due to social desirability, there may be response biases which may cause respondents to overreport their knowledge, attitudes, and practice habits (Wetzel et al. 2016). However, this study provides a benchmark database for future large-scale surveys in the Middle East.

Conclusions

MIH is a common oral health condition more frequently encountered by PDs and DSs than GDPs. Child behavior was the biggest hindrance in managing MIH for PDs, while insufficient training to treat children with MIH was the main obstacle for both GDPs and DSs. Postgraduate degrees among dental practitioners positively affect MIH knowledge scores and confidence in MIH diagnosis. The years of practice have a positive impact on the knowledge scores of dental practitioners. There is an urgent need to educate and train dental practitioners especially GDPs about MIH to assure confidence in MIH diagnosis at an early stage when it can be best managed.

Abbreviations

MIH: Molar-Incisor Hypomineralization; GDPs: General dental practitioners; PDs: Pediatric dentists; DSs: Dental specialists; FPMs: First permanent molars; PEB: Post-eruptive breakdown; KS: Knowledge score; SPSS: Statistical Package for Social Science; HSPM: Hypomineralized Second Primary Molars.

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Authors' contributions

All authors contributed to the conception and design of the work. AM contributed to the practical part of the study as well as writing the manuscript. AA contributed to the final revision. AB contributed to the final revision, interpretation of data and to the approval of the version to be published. All authors agree to be accountable for all aspects of the work. All authors read and approved the final manuscript.

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Availability of data and materials

Data are available from the corresponding author upon reasonable request. All authors had full access to all data in the study and take responsibility for the integrity of the data.

Declarations

Ethics approval and consent to participate

Ethical approval has been sought from the Research Ethical Committee in Faculty of Dentistry at Ain Shams University (FDASU-RecEM031818). Submitting a completed survey constituted a written consent for participation in the study as referred to in the cover page of the questionnaire "If we receive your completed survey, we will assume that we have your consent for participation in the study." Participants were informed that the obtained information was confidential and secure.

Consent for publication

Not applicable.

Competing interest

The authors declare that there is no conflict of interests.

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