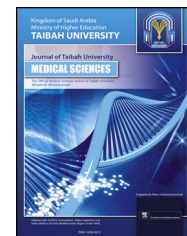




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Original Article

## Knowledge and attitude of dentists toward minimally invasive caries management in Almadinah Almunawwarah province, KSA

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### المخلص

**أهداف البحث:** يتم تحويل إدارة تسوس الأسنان نحو طب الأسنان لطيف التوغل، واستراتيجيات أكثر تحفظاً وقائمة على الأدلة. على الرغم من أن معظم مدارس طب الأسنان تبدأ في دمج استراتيجيات إدارة تسوس الأسنان طفيفة التوغل في مناهجها الدراسية؛ ليس معروفاً جيداً ما إذا كان يتم تنفيذها في الممارسة اليومية. هدفت هذه الدراسة إلى تقييم معرفة وموقف أطباء الأسنان العاملين في منطقة المدينة المنورة في المملكة العربية السعودية فيما يتعلق بتطبيق طب الأسنان لطيف التوغل في إدارة تسوس الأسنان.

**طريقة البحث:** أجريت دراسة مقطعية باستخدام استبانة إلكترونية بين أطباء الأسنان الممارسين في كل من العيادات الخاصة والعامة في المدينة المنورة، المملكة العربية السعودية. تتكون الاستبانة من 4 أقسام بما في ذلك البيانات الديموغرافية وتعليم الأسنان والخبرة السريرية والمعرفة والموقف فيما يتعلق بطب الأسنان لطيف التوغل وإدارة تسوس الأسنان. بالنسبة للتحليل الإحصائي، تم حساب إحصائيات وصفية بسيطة مثل التوزيعات المتوسطة والترددية؛ بينما تم إجراء المقارنات باستخدام اختبار كاي سكوير.

**النتائج:** شارك في الدراسة ما مجموعه 130 طبيب أسنان، غالبية من أطباء الأسنان السعوديين العاملين في عيادات الأسنان الخاصة مع توزيع مماثل بين الذكور والإناث الذين تتراوح أعمارهم بين 25 و 35 سنة. فيما يتعلق بمعرفة إزالة التسوس الانتقائي، اختار 20 % فقط أن إزالة التسوس الانتقائي يعتمد على عمق الآفة، بينما أجاب 74.6 % أن تناسق الأسنان الملتهب مهم لإزالة التسوس الانتقائي. على الرغم من أن 60 % كشفوا أنهم سيقومون بمخاطر تسوس المريض

قبل بدء العلاج، إلا أن 11.5 % فقط سيقومون بتقييم المخاطر والعلاج غير الجراحي في الزيارة الأولى لإدارة التسوس. يستخدم 4.6 % فقط معايير النظام الدولي للكشف عن التسوس وتقييمه 2 في تشخيص تسوس الأسنان، بينما يستخدم 46.2 % معايير "جي في بلاك". بالإضافة إلى ذلك، وافق 53.8 % من المشاركين على أنه يجب إزالة التسوس بالكامل لوقف تقدم التسوس.

**الاستنتاجات:** حصل أطباء الأسنان في المدينة المنورة على معرفة معقولة فيما يتعلق بأهمية طب الأسنان لطيف التوغل في إدارة تسوس الأسنان، لكنهم لا يطبقون بشكل كامل مفاهيم مثل تقييم مخاطر التسوس ومعايير تشخيص تسوس الأسنان الموصى بها مؤخراً في الممارسة السريرية اليومية.

**الكلمات المفتاحية:** آفات نخرية؛ تسوس الأسنان؛ العلاج؛ المينا؛ تقييم المخاطر؛ إجراء لطيف التوغل

### Abstract

**Objective:** Over time, the management of dental caries has shifted towards minimally invasive dentistry (MID) and more conservative and evidence-based strategies. Although most dental schools have begun to incorporate MID caries management strategies in their curriculum; it has yet to be established whether these strategies are being implemented in everyday practice. In this study, we aimed to evaluate the knowledge and attitude of dentists working in Almadinah Almunawwarah province in KSA with regards to the implementation of MID in caries management.

**Methods:** This was a cross-sectional study which involved sending a self-administered and anonymous questionnaire to dentists practicing in both private and public clinics in Almadinah Almunawwarah, KSA. The questionnaire consisted of four sections: demographic

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data, dental education, clinical experience, and knowledge and attitude with regards to MID and the management of caries. For statistical analysis, we calculated simple descriptive statistics, including mean and frequency distributions; comparisons were performed using the Chi-squared test.

**Results:** A total of 130 dentists participated in the study; the majority of respondents were Saudi general dentists working in private dental clinics; there was a similar distribution of males and females and the age of the dentists ranged from 25 to 35 years. With regards to knowledge relating to selective caries removal (SCR), only 20% of subjects responded that SCR is based on lesion depth, while 74.6% reported that carious dentin consistency is important for SCR. Although 60% of respondents reported that they would assess a patient's risk of caries before commencing treatment, only 11.5% would perform risk assessment and non-surgical treatment in the first visit for caries management. Only 4.6% reported that they used the International Caries Detection and Assessment System (ICDAS) II criteria for the diagnosis of caries while 46.2% used the G.V. Black criteria. In addition, 53.8% of participants agreed that caries must be completely removed to prevent the progression of caries.

**Conclusion:** Dentists in Almadinah Almunawwarah province had reasonable levels of knowledge regarding the importance of MID in caries management. However, they did not fully implement certain concepts, such as caries risk assessment and the recently recommended criteria for the diagnosis of caries, in their everyday clinical practice.

**Keywords:** Carious lesions; Dental caries; Dentin; Enamel; Minimally invasive procedure; Risk assessment

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## Introduction

Dental caries is one of the most significant oral health issues and its prevalence has increased notably in the Middle East.<sup>1</sup> In KSA, Al-Ansari showed that there had been a significant increase in the prevalence of caries to approximately 89% in adults.<sup>2</sup> Another study showed that Saudi females have high rates of caries due to inadequate oral hygiene.<sup>3</sup> Traditionally, dental caries used to be treated by complete surgical removal of the infected and affected carious tooth tissue, followed by final restoration. This approach, however, did not control disease progression and could eventually lead to the death of the affected teeth.<sup>4</sup> The successful management of dental caries, however, is mainly based on the current concept of minimally invasive dentistry (MID) which aims to provide maximum preservation of the healthy tooth structure.

MID strategies in caries management involve the specific diagnosis of caries, risk assessment, caries prevention, selective caries removal, along with restorative and non-restorative treatment options.<sup>5,6</sup> This management strategy can be accomplished at two levels; the patient and the lesion itself. The patient level mainly focuses on caries-risk assessment and management of the disease process by controlling causative factors, including biofilm control, cariogenic diets and increased resistance to demineralization by fluoride application.

At the level of the lesion, management is based on lesion cavitation and the stage of demineralization. According to the clinical guidelines provided by the American Dental Association (ADA) in 2018, initial non-cavitated lesions should be managed by non-restorative treatment, including remineralization, sealants, and by controlling the causative factor. In contrast, cavitated lesions should be treated by the application of minimally invasive modalities, including the selective removal of caries based on the specific depth of the lesion. In shallow or moderately deep lesions, selective removal to firm dentine should be performed. For deep lesions (extending into the inner third of the dentin), selective removal to soft dentine should be executed.<sup>6</sup>

Previous research in this area has reported the inadequate application of minimum invasive dentistry principles in clinical practice. For example, in France and Germany, less invasive strategies for managing deep caries lesions are widely preferred and most dentists believe that complete removal of caries was mandatory to prevent the progression of lesions.<sup>7</sup> A few studies have been conducted in different regions of KSA; these revealed a particular lack of knowledge among dentists with regards to MID caries management.<sup>8</sup> However, no previous study has focused on Almadinah Almunawwarah province. Therefore, in this study, we aimed to investigate the specific knowledge and attitude of dentists with regards to implementation of the current minimally invasive caries management in clinical practice in Almadinah Almunawwarah province in KSA.

According to the Consensus statement reported by Makkah in a symposium on the prevention of dental caries in 2017, research should promote evidence-based practice and develop a system to be implemented in clinical practice?<sup>9</sup>

## Material and Methods

We used an anonymous and self-administered questionnaire in this cross-sectional, observational and descriptive study. Ethical approval for the study was obtained from Taibah University College of Dentistry Research Ethics Committee (approval number: 20200327). To be included in the study, participating dentists needed to be practicing caries management and restorative dentistry in public or private clinical practice, and reside in Almadinah Almunawwarah province in KSA. They also needed to have reliable access to electronic communication (email or mobile number) accessible through their facility. The exclusion criteria were as follows: dentists residing outside of Almadinah Almunawwarah province in KSA, dentists who did not practice caries management, and dentists who provided incomplete questionnaires.

## Data collection methodology and tools

Data was obtained from anonymous self-administered questionnaires using Google forms software. Although participants were contacted directly by telephone or email, their responses were anonymous, and the participants could not be identified. The questionnaire was developed based on evidence-based and contemporary literature referring to the management of caries. The content focused mainly on the concept of diagnosing caries lesions based on International Caries Detection and Assessment System (ICDAS) II criteria and the ADA classification system, including lesion severity and activity.<sup>10</sup> Furthermore, the criteria focused on selective caries removal techniques based on well-established sources being used in dental education including Sturdevant's Art and Science of Operative of Dentistry,<sup>11</sup> as well as the Consensus recommendations on carious tissue removal.<sup>6</sup> Questions also covered the concept of caries risk assessment and the main current evidence-based caries management schools including Caries Management by Risk Assessment (CAMBRA) and International Caries Classification and Management System (ICCMS). Following initial construction, the questionnaire was revised by two experts in cariology. Then, the questionnaire was validated by 10 dentists and changes were made accordingly. The questionnaire was written in the English language and encompassed four sections including demographic data (gender, age, nationality, residence and working), dental education and experience, knowledge regarding MID, and attitude towards the management of caries.

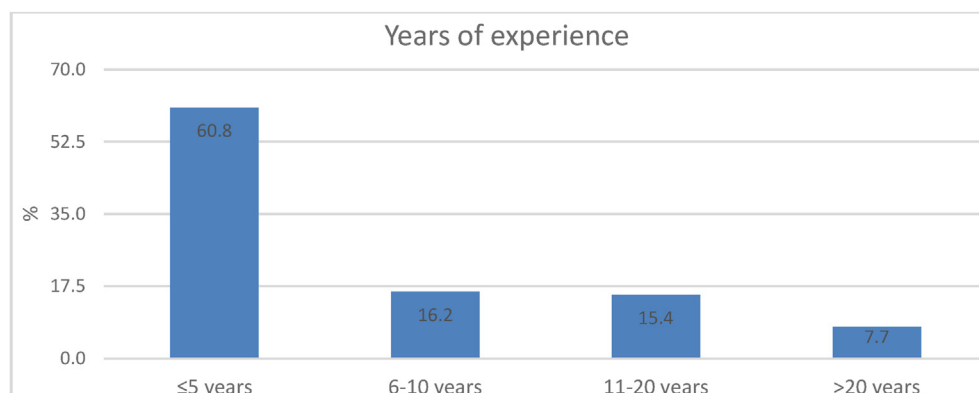
## Statistical analyses

Data were imported into IBM SPSS Statistics (version 28, IBM Corp, Armonk, NY, USA) for analysis. Categorical data are presented as percentages and frequencies to establish a general understanding of the study population. The chi-squared test was used to investigate the relationship between demographic variables, dental education/experience and the knowledge, attitude and practice of participants. This process was performed twice: once with the responses and then with knowledge regarding MID for caries management questions as the correct answers. Some statements were collected in the form of a Likert scale with three scores.

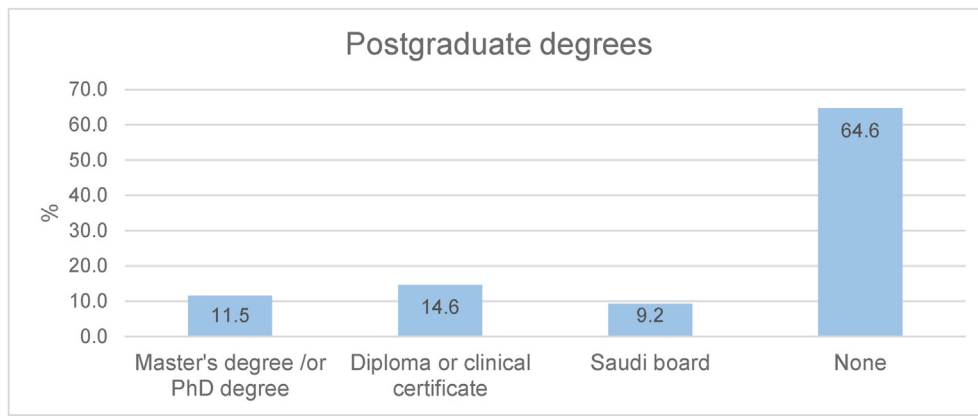
Power analysis (using GPower version 3.1, Faul, Erdfelder, Lang & Buchner, 2007) showed that to achieve a power of 80% with level of significance of 0.05, the sample size should be at least 108. Considering the probability of non-responding participants, we increased the sample size to 200 for our analysis.

## Results

The survey was sent randomly to 200 dentists who were registered with the Saudi Dental Society and working in the province of Almadinah Almunawwarah. The response rate was 65% as 130 dentists participated in the survey and met with the inclusion criteria. Sixty-seven of the dentists were male (51.5%) and 63 were female (48.5%). In total, 74.6% of the respondents were Saudi dentists and age ranged from 25 to 35 years. The majority were general practitioners (73.1%). Most of the participants (60.8%) had experience ranging from 5 years or less (Figure 1). Overall, 74.6% of respondents completed their degree at a Saudi university. Most of the respondents (64.6%) did not have a postgraduate degree (Figure 2). The majority of the participants (59.2%) were working in private clinics, while 24.6% worked in a governmental health facility and 16.2% in an academic institution (a university hospital). With regards to continuous education, over the previous 5 years, 63.1% of dentists had been exposed to recent articles related to minimally invasive dentistry, while 36.9% had not been exposed to such material. More than half of the participants (54.6%) responded that the concept of selective caries removal is based on the removal of active caries but not the arrest of caries. With regards to cavitated carious lesions, only 23.1% of respondents reported that this would present with a broken enamel surface; the majority (46.2%) reported that caries could reach the dentin. With regards to the consistency of carious dentin, the majority of respondents (74.6%) said that it is important in selective caries removal; this was the correct answer (Table 1). With regards to the attitude of participants towards minimally invasive caries management, most respondents (60.8%) assessed a patient's risk to caries before they commenced treatment. With regards to the diagnosis and classification of caries, the majority of respondents (46.2%) selected to use G.V. Black criteria rather than the ICDAS II (4.6%) or ADA (17.7%) classification systems.<sup>10</sup>



**Figure 1:** Distribution of respondents based on years of experience.



**Figure 2:** Distribution of respondents based on Postgraduate degree.

**Table 1: Knowledge of respondents relating to MID in caries management.**

Item	Correct responses	Incorrect responses
CAMBRA (caries management by risk assessment)	40.0%	60.0%
ICCMS (caries management by caries classification and personalized treatment plan)	15.4%	84.8%
Selective caries removal (depending on the depth of the lesion)	20.0%	80.0%
Cavitated carious lesion (presenting with breaks on the surface of the enamel)	23.1%	76.9%
Consistency (hardness) of carious dentin is important in selective caries removal techniques	74.6%	25.4%

**Table 2: Responses of participants to MID statements.**

Statement	Disagree		I don't know (Neutral)		Agree		Weighted mean	Attitude
	n	%	n	%	n	%		
The main factor to prevent recurrent caries is appropriate restorative techniques with the placement of restorative material on a clean caries-free prepared cavity	39	30.0	4	3.1	87	66.9	2.37	Agree
Carious lesion must be completely removed to prevent further progression that may affect the vitality of the pulp	57	43.8	3	2.3	70	53.8	2.10	Neutral
For private practice, a possible disadvantage of applying minimally invasive approaches is that their price is less than the conventional restorative treatments	33	25.4	23	17.7	74	56.9	2.32	Neutral

**Table 3: Relationship between participant responses and demographic and educational factors.**

Item	Years of experience	Postgraduate degree	Location of dental degree (Saudi vs non-Saudis)	Gender	Age
CAMBRA (Caries management by risk assessment)	<b>0.032</b>	0.185	0.827	0.319	0.193
ICCMS (caries management by caries classification and personalized treatment plans)	0.734	0.338	0.538	0.686	0.243
Selective caries removal (depends on the depth of the lesion)	<b>0.001</b>	0.394	<b>0.047</b>	0.534	<b>0.037</b>
Cavitated carious lesion (should present with a broken enamel surface)	<b>0.005</b>	<b>0.001</b>	<b>0.005</b>	0.140	0.149
Consistency (hardness) of carious dentin is important in selective caries removal techniques	<b>0.003</b>	<b>0.097</b>	<b>0.050</b>	0.073	<b>0.018</b>

Significant *P*-values in bold (statistical significance level  $p < 0.05$ ).

With regards to caries removal statements; 66.9% of participants agreed to the statement regarding the main factor to prevent recurrent caries is an appropriate restorative technique on a caries-free cavity. However, 53.8% agreed with the statement of complete carious removal to prevent further caries progression and to protect pulp vitality (Table 2). Similarly, 71.5% agreed to the statement that all active caries lesions should be restored. For private practice, 56.9% of respondents agreed that a possible disadvantage of applying MID approaches is that the financial benefit for dentists is usually less than that of conventional restorative treatment.

With regards to the attitude of dentists towards MID in caries management, 16.2% of the respondents preferred the complete removal of caries and pulp capping for cases with a deep caries lesion and an asymptomatic tooth. However, the majority (68.5%) applied selective caries removal and pulp capping; only and 15.4% of respondents preferred the step-wise removal of caries.

Although our sample size of respondents with over 5 years of experience was relatively small (Figure 1), we still identified a statistically significant relationship between years of experience and most of the knowledge questions. Postgraduate degrees were significantly related with cavitated carious lesions and with the risk assessment of caries prior to commencing treatment. Table 3 presents *P*-values for different factors and the attitudes of respondents with regards to MID caries management.

## Discussion

The purpose of this study was to investigate how dentists in Almadinah Almunawwarah province, KSA, are applying minimally invasive concepts in the management of caries. Our study targeted everyday dental practice and the participants were mainly Saudi general dentists working in private dental clinics; our study cohort featured a similar distribution of males and females. There are no official statistics for dentists in Almadinah Almunawwarah province to compare with our current dataset. However, we consider that our sample is representative of dentists in Almadinah Almunawwarah as a similar distribution was

observed between male and female dentists; furthermore, our analysis featured general practitioners (73%) and specialists and consultants (27%). This is consistent with the distribution of dentists across the KSA according to the latest statistics provided by the Ministry of Health in which 75% of dentists held general roles and 25% were specialists and consultants?<sup>12</sup>

The majority of participants reported that they used the G.V. Black classification (46%) or relied on their experience (28%) when diagnosing dental caries. Furthermore, <5% of our study cohort used the ICDAS II criteria when diagnosing lesions. Similarly, Al Dhubayb et al. (2021) reported that dentists in KSA were unable to adequately detect caries using the ICDAS criteria.<sup>13</sup> This indicates the necessity of appropriate clinical training during dental undergraduate programs, as well as continuous education after graduation; such training improves the early diagnosis of dental caries when applying the ICDAS II criteria. G.V. Black classified carious lesions into five classes based on the concept of “extension for prevention”; however, this concept has largely become obsolete. Almost half of our respondents selected the G.V. Black criteria for diagnosis; this practice may lead to the application of more aggressive treatment approaches. In contrast, the ICDAS II criteria rely on visual and tactile factors to help clinicians to categorize all stages of caries lesions, including early enamel demineralization. In a previous study, Bahadır and Çelik found the use of the ICDAS II criteria by dental practitioners led to standardized diagnostic skills for caries while also improving their decision-making and treatment selection, particularly for early caries lesions.<sup>14</sup> The ADA CCS is a simplified system that is similar to the ICDAS II visual criteria (initial, moderate, advance). These diagnostic systems facilitate the implementation of current conservative restorative and non-restorative treatment modalities as they are more sensitive and more helpful for the detection of carious lesions during their early stages. Caries activity plays a significant role in management and monitoring, particularly for individuals at high risk of caries. For instance, non-cavitated active lesions should be managed non-surgically by remineralization *via* the topical application of fluoride.



With regards to caries risk assessment (CRA), the majority (60.8%) of our respondents agreed that they would assess the risk of a patient before commencing restorative treatment. A previous study, conducted in India, revealed that 81% of general dentists agreed that CRA should be conducted for all patients<sup>15</sup>; these findings concurred with those of our present study. However, only 11.5% of respondents reported that they would start with CRA and non-restorative treatment when a patient attends their first appointment for caries management. This may suggest that participants have the specific knowledge regarding the importance of CRA for treatment planning, but they are not fully implementing this knowledge in their daily practice. A possible barrier for implementation could be the low cost of minimally invasive treatment methods based on CR when compared to traditional restorative and prosthetic approaches, as indicated by the majority of our respondents (56.9%). Moreover, approximately 31% of respondents reported that they would not assess a patient's risk due to the length of time needed to collect an adequate set of data to determine risk. In contrast, Alrasheedi et al.,<sup>16</sup> found that the majority of interns in KSA agreed that they would plan restorative treatment based on a given patient's risk of caries. This controversy could relate to differences in the targeted population; Alrasheedi et al. targeted early graduate interns in an academic environment, whereas our study included only dentists working in private and public hospitals. Nonetheless, assessing the risk of caries is a crucial step in a successful and durable form of management for dental caries. This form of assessment is needed to construct a personalized treatment plan for each individual patient with dental caries because traditional restorative and prosthetic treatment approaches are mainly based on the concept of 'drill and fill'. This approach lacks preventive and non-restorative caries models that may lead to recurrent caries and continuation of a tooth's cycle and, subsequently, extraction. Performing risk assessment for caries allows the analysis and control of risk factors that contribute to the occurrence of caries in a specific patient. Thus, individualized restorative and non-restorative treatment plans for caries can be formulated and ensure appropriate follow-up and maintenance. Several international caries classification and management standards are being widely applied, including Caries Management by Risk Assessment (CAMBRA), American Dental Association (ADA) caries risk assessment, and the Caries Risk Assessment Tool (CAT).<sup>17</sup>

Most participants agreed that complete caries removal prevents recurrent caries and prevents the further progression of caries. Our results concur with a previous study that reported that the majority of dentists believe that complete caries removal is important for the success of treatment.<sup>8</sup> However, there is overwhelming evidence to support the fact that the complete removal of caries is not needed for the management of carious lesions and may jeopardize pulp health.<sup>18</sup> A range of different factors play key roles in the occurrence of recurrent caries, including the risk of caries, the type of restorative material, and the presence of tooth/restoration gaps.<sup>19</sup> Therefore, recurrent caries prevention can be achieved by applying an appropriate marginal seal for the restoration and by controlling the

risk factors of caries by performing caries-risk assessment and personalized treatment planning. Similarly, arresting existing carious lesions, preventing the formation of new lesions, and preventing progression can be achieved *via* the management of caries based on the risk of caries in individual patients.

For deep carious lesions, most respondents (68.5%) preferred a more conservative approach by performing selective caries removal and pulp capping. However, in lesions with a moderate depth, the respondents tended to be less conservative as complete caries removal was the preferred treatment for 71.5% of participants. This observation may indicate that new generations of dentists are well trained with regards to the concept of selective caries removal in deep lesions to protect tooth vitality by leaving carious dentin in proximity of the pulp and by preserving the dentin bridge. In contrast, Schwendicke et al. found that the majority of French and German dentists would perform complete excavation even for deep lesions in the belief that this would prevent the progression of caries.<sup>7</sup> On the other hand, when considering lesions of moderate depth, it appears that there is still some resistance to implement selective caries removal as the main technique for caries excavation. This finding was not consistent with a previous study conducted in KSA (the Riyadh province) in which general practitioners tended to be more conservative in their initial strategy for the management of caries.<sup>20</sup> This could be attributed to their dental education as several dental schools in KSA have incorporated preventive and minimally invasive strategies for caries management into their undergraduate dental curriculum.

Our analysis also revealed that dentists with 20 or more years of experience had lower levels of knowledge with regards to contemporary minimally invasive methods. This difference may be due to variations in dental education, as older dentists may show some resistance to new concepts and methods, particularly those related to the management of caries. However, this observation should be considered with caution due to the small sample size in this sample (10 participants with >20 years of experience). However, other factors, including age, gender, working facility, and nationality, did not differ significantly in most of the questions relating to the level of knowledge and attitude towards MID among Our analysis shed significant new light on the attitude of dentists towards essential current concepts related to MID, including selective caries removal, visual caries detection criteria (ICDAS II) and CRA. Moreover, our analysis emphasized the need for more effective continuous educational programs, including workshops and meetings in Almadinah Almunawwarah province to help dentists update their knowledge and encourage them to implement the current clinical recommendations for caries management in their clinical practice.

One of the limitations of this study is that it was confined to the Almadinah Almunawwarah province. To better represent dentists in KSA, other regions of the country should be considered in future research. In addition, our questionnaire did not cover some concepts related to MID in the management of caries, such as MID treatment planning, awareness of the minimally invasive diagnostic tools, as well as MID non-restorative treatment options. Including clinical cases with specific questions relating to the diagnosis and

management of caries lesions should also be considered in future to obtain a more comprehensive understanding about the attitude and practice of dentists towards MID. Furthermore, open-ended questions should be included in future survey tools measuring MID awareness. This will provide better insight relating to the potential barriers that hinder dentists from implementing MID in the management of caries.

## Conclusion

Our analysis demonstrated that dentists in Almadinah Almunawwarah province seemed to have some awareness of the importance of MID in the management of caries. However, our respondents do not fully implement MID concepts into their everyday clinical practice, including caries risk assessment, the ICDAS II diagnostic criteria, and selective caries.

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## Conflict of interest

None of the authors have any conflicts of interest to declare.

## Ethical approval

This research was ethically approved by Taibah University College of Dentistry Research Ethics Committee (Reference number: TUCDREC/20200327/RMAIWesaidi).

## Authors' contribution

AAA: conceptualization, methodology, validation, writing (original draft preparation, reviewing and editing). RMA: methodology, validation, data curation and manuscript drafting. RSA: methodology, validation, data curation and manuscript drafting. NAA: data curation and manuscript drafting. SFA: Data curation and manuscript drafting. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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