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The Accuracy of Detection and Diagnosis of Oral Lesions by Clinical Dental Students

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ORIGINAL ARTICLE

The Accuracy of Detection and Diagnosis of Oral Lesions by Clinical Dental Students

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ABSTRACT

Objective: To determine the accuracy of diagnosing oral lesions through clinical photos taken by clinical dental students (CDS). **Methods**: The observational analytic study was conducted on 100 CDS to evaluate 140 clinical photos of oral lesions. The gold standard was evaluated by three oral medicine specialists. Data analysis will be performed using accuracy and kappa tests. **Results**: The accuracy rate of lesion detection in CDS is high (88.55%) with substantial agreement ($\kappa = 0.66$). However, the accuracy rate of diagnosis is low (38.21%) with no agreement ($\kappa = -0.30$). Participation in the clinical Oral Medicine module positively influenced detection accuracy, with the highest rate among students who had completed the module (96.18%). However, diagnostic accuracy remained low across all groups. **Conclusion**: CDS demonstrates good detection abilities but struggles with accurate diagnosis. Participation in the clinical Oral Medicine module is beneficial for improving detection abilities. Further efforts are needed to enhance diagnostic skills and ensure that CDS are well-prepared for clinical practice.

Keywords: accuracy, dental students, detection, diagnosis, oral lesions

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INTRODUCTION

Oral lesions are alterations or damage to the structure of oral mucosal tissues under abnormal conditions, causing changes in color, consistency, size, texture, pattern, or shape. They include sores, spots, swellings, lumps, ulcers, and abnormal tissue growth and can indicate pathological or abnormal changes in the oral cavity. Oral lesions can appear in various locations, including the lips, palate, gums, tongue, and floor of the mouth. Some of these conditions can be serious, with significant morbidity, potentially affecting patients' quality of life and even posing life-threatening risks. According to the Indonesian Medical Council's Regulation Number 40 of 2015 on the Competency Standards for Indonesian Dentists, dentists must be able to identify normal variants in oral soft tissues, provide treatment for oral lesions (such as traumatic ulcers, aphthous stomatitis, angular cheilitis, etc), and refer patients with systemic-related conditions such as erythema multiforme, herpangina, hand-foot-and-mouth disease, as well as oral potentially malignant diseases (OPMD) and malignancy.[1] A study on the prevalence of oral mucosal lesions found that 53% of the 22 cases involved patients over 60 years old who were predominantly female, with the most frequent condition being oral lichen planus/oral lichenoid reaction.[2] Thus, clinicians must be able to detect and diagnose oral lesions, especially those with the potential to become malignant, such as leukoplakia and erythroplakia.

As of June 2024, the Indonesian Dental Association reported a scarcity of oral medicine specialists in Indonesia, totaling only 219, most of whom were concentrated in major cities such as Jakarta. Meanwhile, many other regions still lack access to this specialization. This limitation makes it difficult for

residents in remote or underserved areas to receive optimal oral healthcare, particularly those with soft tissue conditions. Therefore, oral medicine specialists must rely on general dentists' knowledge and skills in recognizing and identifying changes or signs of diseases in oral soft tissues. In fact, approximately 44.5% of the dentists in a prior study reported that they seldom examined oral soft tissues before performing dental treatments, thereby diminishing their expertise and ability to diagnose and treat oral lesions.[3]

Unfortunately, as future dentists, most dental students focus solely on dental issues, neglecting problems associated with oral soft tissues. Students detect caries lesions more often than oral mucosal lesions.[4] This oversight suggests dental students have a decreased ability to diagnose oral lesions,[5] which can lead to misdiagnosis, improper treatment, and potentially adverse effects on patient health. Previous research shows oral mucosal lesions are the most frequently misdiagnosed condition.[6] Due to the limited number of oral medicine specialists in Indonesia, there is a need for general dentists as practitioners who are often at the forefront of oral health services to handle cases related to oral lesions. They can actively contribute to early detection as a preventive measure, provide treatment, and educate patients about the importance of oral soft tissue health.

Diagnosing oral lesions can be challenging because they have similar clinical presentations, potentially resulting in fatal treatment errors. Dental students should possess sufficient knowledge to accurately diagnose oral lesions so that they can provide appropriate and optimal treatment to patients.[7,8]

Clinical dental students (CDS) are in the final stage of their education and are preparing for clinical practice. Assessing their ability to detect and diagnose oral lesions is crucial for ensuring that they are ready to face clinical challenges. This study aimed to determine the level of accuracy of detection and diagnosis of oral lesions by CDS and to explore how the characteristics of participation in the clinical Oral Medicine module influence their ability to detect and diagnose oral lesions. This research is expected to serve as a reference and reflection tool for these students to learn how to detect and diagnose oral lesions, thereby improving the quality of care they provide as future dentists. Additionally, this study can benefit institutions by evaluating students' capabilities and providing insights into the effectiveness of the curriculum and teaching methods used. By understanding the strengths and weaknesses of students' detection and diagnostic abilities, educational institutions and regulatory bodies can develop assessment standards and strategies to enhance students' future professional competencies. Although previous research suggests that factors, such as experience and interest in a topic, influence diagnostic abilities, further research on other contributing factors is needed.

METHODS

This cross-sectional study was conducted in November 2023. The participants were CDS at the Dental Hospital of the Faculty of Dentistry, Universitas Trisakti. This study was approved by the Ethics Commission of the Faculty of Dentistry, Universitas Trisakti, No. 713/S1/KEPK/FKG/8/2023.

Sample size

The samples used in this study were cases of oral lesions. A minimum sample size of 220 oral lesion cases was required to achieve a medium effect size and 95% power. A total of 100 CDS from different clinical entry years participated in this study by working on five cases of oral lesions each, resulting in a total of 500 samples. The participating CDS were categorized based on their progress in the clinical Oral Medicine module as completed, ongoing, or not yet begun.

Sample selection

The respondents in this study included active CDS at Universitas Trisakti, who indicated their willingness to participate in the study by providing informed consent. Students who were taking leave were excluded from the study.

Participant characteristics

The frequency distribution of the respondents in this study was based on sex, age, educational level at the Clinical Oral Medicine stage, and the grade point average (GPA) based on the curriculum.

Clinical pictures

Students were evaluated by questionnaire using 140 clinical photographs covering the entire oral cavity, including the palatal, buccal, lingual, and labial areas. Thirty-seven types of oral lesions were represented, including 18 types of normal variants, two types of hypersensitivity reactions, one type of cyst lesion, six types of infectious lesions, two types of traumatic lesions, one type of nutritional deficiency lesion, two types of inflammatory lesions, three types of OPMD lesions, one type of benign neoplastic lesion, and one type of malignant lesion. The clinical photographs were obtained from the Oral Disease Atlas, combined with documentation of oral lesions from the Dental Hospital of the Faculty of Dentistry, Trisakti University. The photographs were selected by three oral medicine specialists and were chosen based on lesions commonly encountered in clinical practice and in accordance with the Indonesian Dental Competency Standards.

Questionnaires

All participants gathered in a room equipped with individual computers, each separated by partitions.

Before the research commenced, the participants were given a brief explanation of the purpose and objectives of the study as well as the procedures for filling out the questionnaire. They were then asked to complete an informed consent form and a Google Form questionnaire containing case scenarios and oral lesion images within a time range of 30-45 minutes. Participants completed the questionnaire independently and were supervised by the research staff to prevent communication. The descriptive variables provided by the students included their age, sex, stage of training in Oral Medicine at the clinic, Oral Medicine module scores, and GPA. The students were tasked with identifying the presence of lesions, specifying their location, and providing a clinical diagnosis. Figure 1 shows examples of photographs of oral lesions included in the questionnaire. A 4 × 4 grid (dividing the image into 16 quadrants) served as a visual guide, allowing the students to pinpoint the area where the oral lesions were present precisely. By dividing the image into smaller sections, the grid facilitated a systematic approach to lesion examination, ensuring the thoroughness and accuracy of the assessment process. With each quadrant marked, students navigated through the image easily, making observations and evaluations more structured and organized. Lesions that occupied < 10% of the grid were proportionally excluded. This questionnaire was face-validated and tested by three oral medicine specialists and 30 CDS, who assessed if the image quality was good, the selection of images used was relevant and appropriate, the questions represented the research objective, the time to answer the questions was adequate, and the questions were too simple or complex.

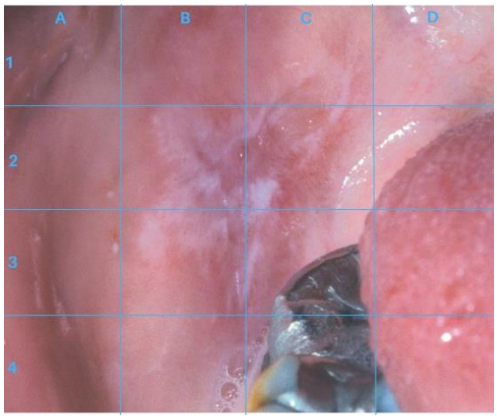

Figure 1. The example photos of oral lesion cases and the accompanying grid used in the questionnaire provide a structured framework for students to analyze and evaluate oral abnormalities.

Statistical analysis

Primary data for this study were obtained directly from the participants. Oral lesion detection and diagnosis accuracy was determined using sensitivity and specificity tests and kappa values. A linear regression test was performed to determine the effect of the Oral Medicine module scores and GPA on the ability to detect and diagnose CDS. Statistical analysis was conducted using IBM SPSS Statistics version 27.

RESULTS

A total of 100 CDS from various stages of clinical education participated in this study. Their demographic characteristics are shown in Table 1. The majority of participants were female, comprising 83 (83%), while 17 (17%) were male. The participants ranged in age from 21 to 26 years, with the majority (79%) between 21 to 23 years. Conversely, those aged 24 to 26 constituted a smaller proportion of the sample, accounting for only 21% of the participants. Most participants (78%) were in the Oral Medicine stage at the clinic. Table 2 describes the oral lesions included in the questionnaire and the ability of the CDS to detect and diagnose oral lesions.

Sensitivity and specificity tests were conducted to measure the accuracy of oral lesion detection and diagnosis by CDS, and kappa values were calculated, as shown in Table 3. The findings indicated that CDS had an accuracy rate of 88.55% in detection. The kappa value of 0.66 reflected a substantial level of agreement. On the other hand, the overall accuracy rate of students in making diagnoses was 38.21%, with a kappa value of -0.30, indicating a low level of agreement.

In this study, the ability of the CDS to accurately detect and diagnose oral lesions was analyzed based on their participation level in the clinical Oral Medicine module (Table 3). In the analysis of oral lesion detection, the highest accuracy rate was observed among students who had passed the Oral Medicine module (96.18%), with a kappa value of 0.72, followed by students currently enrolled in the Oral Medicine module (89.40%), with a kappa value of 0.66, and the lowest among students who had not yet participated in the Oral Medicine module (83.29%), with a kappa value of 0.56. Students who were currently enrolled in or had passed the clinical Oral Medicine module showed substantial agreement, whereas those who did not participate showed moderate agreement.

Table 1. Characteristics of clinical dental students

Variables	n	%
Gender		
Female	83	83
Male	17	17
Age (years)		
21 – 23	79	79
24 – 26	21	21
Participation in the clinical Oral Medicine module		
Not yet	5	5
Currently	78	78
Passed	17	17

Table 2. Clinical dental students' performance in the diagnosis of 37 oral lesions

Diagnosis of oral lesions	Number of images	Dental students		
		Correct diagnosis n (%)	Not detected n (%)	Incorrect diagnosis n (%)
Normal variant				
Amalgam tattoo	1	35 (70)	5 (10)	10 (20)
Black hairy tongue	1	47 (94)	-	3 (6)
Coated tongue	2	24 (24)	9 (9)	67 (67)
Crenated tongue	2	28 (28)	5 (5)	67 (67)
Erythema migrans	2	25 (25)	1 (1)	74 (74)
Fissure tongue	1	47 (94)	1 (2)	2 (4)
Fordyce spot	5	180 (72)	11 (4.4)	59 (23.6)
Frictional keratosis	6	10 (3.3)	212 (70.7)	78 (26)
Geographic tongue	2	74 (74)	2 (2)	24 (24)
Leukoedema	4	102 (51)	8 (4)	90 (45)
Linea alba	4	184 (92)	2 (1)	14 (7)
Median rhomboid glossitis	1	38 (76)	3 (6)	9 (18)
Morsicatio buccarum/labiorum	1	12 (24)	6 (12)	32 (64)
Papilla circumvallate	1	29 (58)	7 (14)	14 (28)
Physiologic pigmentation	6	280 (93.3)	9 (3)	11 (3.7)
Sublingual varicosis	10	196 (39.2)	197 (39.4)	107 (21.4)
Torus palatinus/mandibularis	4	192 (96)	4 (2)	4 (2)
Hypersensitivity reaction				
Angioedema	1	27 (54)	17 (34)	6 (12)
Lichenoid reaction	1	13 (26)	-	37 (74)
Cyst				
Mucocele	1	13 (26)	8 (16)	29 (58)
Infection				
Angular cheilitis	1	46 (92)	3 (6)	1 (2)
Denture sore mouth	1	22 (44)	5 (10)	13 (26)
Herpes labialis	1	46 (92)	-	4 (8)
Herpes zoster	1	26 (52)	-	24 (48)
Oral hairy leukoplakia	2	20 (20)	16 (16)	64 (64)
Oral thrush	1	28 (56)	-	22 (44)
Trauma lesion				
Chemical burn	1	14 (28)	-	36 (72)
Nicotina stomatitis	2	76 (76)	3 (3)	21 (21)
Nutritional deficiencies				
Glossitis	1	30 (60)	7 (14)	13 (26)
Inflammatory				
Recurrent aphthous stomatitis	3	142 (94.7)	5 (3.3)	3 (2)
Pyogenic granuloma	1	12 (24)	3 (6)	35 (70)
OPMD				
Erythroplakia	1	9 (18)	9 (18)	22 (44)
Leukoplakia	1	13 (26)	1 (2)	36 (72)
Lichen planus	2	54 (54)	-	46 (46)
Benign neoplastic				
Fibroma	1	13 (26)	1 (2)	36 (72)
Malignant lesion				
Oral Squamous cell carcinoma	1	17 (34)	-	33 (66)

The diagnostic accuracy results among the three groups were similar. Students who had completed the clinical Oral Medicine module had the highest accuracy rate (38.97%), with a kappa value of -0.27, followed by those currently enrolled in the Oral Medicine module (38.94%), with a kappa value of -0.28, and the lowest among students who had not yet participated in the Oral Medicine module (36.25%), with a kappa value of -0.28. All three groups showed no agreement.

As shown in Table 4, the students' grades in the Oral Medicine module significantly affected their ability to detect oral lesions, with a p-value of 0.035. Similarly, GPA significantly influenced the students' ability to diagnose oral lesions ($p = 0.025$).

DISCUSSION

This study used clinical images to detect and diagnose oral lesions instead of direct visual examinations of patients. The students' responses in detection and

Table 3. Accuracy of detection and diagnosis of clinical dental students

	All		Oral Medicine Module					
			Have Not Taken		Currently Taking		Has Taken	
	Detection	Diagnosis	Detection	Diagnosis	Detection	Diagnosis	Detection	Diagnosis
Sensitivity (95% CI)	88.74 (88.29 – 89.18)	45.85 (45.50 – 46.19)	93.37 (91.55 – 94.90)	40.3 (38.77 – 41.84)	87.83 (87.30 – 88.34)	46.25 (45.86 – 46.64)	91.47 (90.50 – 92.37)	45.59 (44.77 – 46.41)
Specificity (95% CI)	88.51 (88.30 – 88.72)	17.60 (17.18 – 18.04)	82.53 (81.42 – 83.61)	28.63 (26.71 – 30.60)	89.71 (89.50 – 89.93)	19.64 (19.14 – 20.15)	96.49 (96.33 – 96.64)	20.89 (19.79 – 22.02)
PPV (95% CI)	62.17 (61.74 – 62.61)	60.02 (59.80 – 60.24)	50.75 (49.14 – 52.36)	51.57 (50.41 – 52.73)	62.96 (62.45 – 63.46)	60.31 (60.06 – 60.56)	62.64 (61.58 – 63.69)	61.15 (60.61 – 61.69)
NPV (95% CI)	97.37 (97.26 – 97.46)	10.75 (10.51 – 11.00)	98.48 (98.06 – 98.80)	20.27 (19.13 – 21.45)	97.37 (97.26 – 97.48)	12.15 (11.87 – 12.44)	99.43 (99.37 – 99.49)	12.32 (11.74 – 12.93)
LR+ (95% CI)	7.72 (7.58 – 7.87)	0.56 (0.55 – 0.56)	5.35 (5.01 – 5.70)	0.56 (0.54 – 0.59)	8.54 (8.35 – 8.73)	0.58 (0.57 – 0.58)	26.04 (24.89 – 27.24)	0.58 (0.56 – 0.59)
LR- (95% CI)	0.13 (0.12 – 0.13)	3.08 (3.00 – 3.15)	0.08 (0.06 – 0.10)	2.09 (1.94 – 2.24)	0.14 (0.13 – 0.14)	2.74 (2.67 – 2.81)	0.09 (0.08 – 0.10)	2.60 (2.47 – 2.75)
Accuracy (95% CI)	88.55 (88.36 – 88.74)	38.21 (37.92 – 38.49)	84.29 (83.31 – 85.23)	36.25 (35.05 – 37.47)	89.40 (89.20 – 89.60)	38.94 (38.62 – 39.27)	96.18 (96.03 – 96.34)	38.97 (38.28 – 39.66)
AUC (95% CI)	0.86 (0.845 – 0.874)	0.95 (0.943 – 0.961)	0.52 (0.493 – 0.553)	0.88 (0.862 – 0.901)	0.82 (0.805 – 0.837)	0.89 (0.883 – 0.909)	0.69 (0.676 – 0.715)	0.87 (0.860 – 0.888)
κ	0.66	-0.30	0.56	-0.28	0.66	-0,28	0,72	-0,27

κ: Kappa value, PPV: Positive Predictive Value, NPV: Negative Predictive Value, LR+: Likelihood Ratio Positive, LR-: Likelihood Ratio Negative, CI: Confidence Interval

Table 4. Linear regression analysis of Oral Medicine module grades and GPA on detection and diagnosis abilities of CDS

Variable	Estimate (SE)	R^2 adj	95% CI	p
Oral Medicine Module				
Detection	9.30 (4.34)	0.035	0.68 – 17.9	0.035*
Diagnosis	8.39 (5.72)	0.012	-2.96 – 19.7	0.146
GPA score				
Detection	37.1 (18.9)	0.028	-0.40 – 74.7	0.052
Diagnosis	55.7 (24.5)	0.040	7.11 – 104	0.025*

*p < 0.05, SE: Standard Error, CI: Confidence Interval

diagnosis were compared with the answers confirmed by the three oral medicine specialists. Normal variant lesions were the most common cases in the questionnaire due to their frequent occurrence in clinical practice.[9] According to the Indonesian Dentist Competency Standards, a general dentist must have the skills to identify normal variants in oral soft tissues.[1] Moreover, several images depicting lesion-free conditions served as controls for assessing the student's ability to identify whether a condition is normal or pathological.

In this study, CDS detected oral lesions with an accuracy rate of 88.55% and diagnosed with an accuracy rate of 38.21%, indicating that they find it easier to detect than to diagnose. This finding is similar to that of the Amtha *et al*. study in Bangka Belitung, which showed that clinical students were better at detecting than accurately diagnosing oral mucosal lesions.[5] The difficulty in diagnosing oral lesions may be due to inadequate educational systems, limited experience in dealing with oral lesion cases, and students' lack of interest in Oral Medicine.[10]

However, the results of the present study contradict those of Ali *et al*., who showed that students in Kuwait had more difficulty detecting than diagnosing lesions.[4] It is a major challenge for dentists to accurately detect and diagnose oral lesions because of the similarity of symptoms and physical appearance among several lesion types. Some lesions may be difficult to distinguish because of their similar colors, shapes, or textures. In this study, the students' memorization capabilities seem to influence the low accuracy rate of diagnosis. Although many students correctly referred to the diagnosis, they made mistakes because they forgot the names of certain conditions or lesions. This highlights the importance of understanding concepts and remembering detailed information to achieve diagnostic accuracy. The ability to diagnose oral lesions is often closely related to a student's experience level; hence, lack of experience can be a determining factor, as students need at least five years of clinical experience to enhance their understanding and diagnostic skills.[6,11]

Analysis of the three groups, categorized based on their participation in the clinical Oral Medicine module, showed high detection accuracy. A significant difference was observed in detection among the groups that had not undergone, were currently undergoing, or had completed the Oral Medicine stage in the clinic. CDS who have completed the Oral Medicine stage may have broader clinical

experience and have become accustomed to patient conditions. This may have enhanced the accuracy of oral lesion detection, as reflected by the highest accuracy rate among the groups. Having opportunities to observe and participate in diverse cases during the clinical phase may be crucial. Meanwhile, the CDS currently participating in the Oral Medicine stage also exhibited a high level of detection accuracy, even if it was slightly lower than that of the completed group. CDS in this stage may still be in the learning and skill development process; hence, their accuracy level may reflect ongoing learning.[12] The group of CDS that have not yet participated in the Oral Medicine stage in the clinic showed a lower level of detection accuracy. This may be due to their limited clinical experience.[13,14]

However, the accuracy of diagnosis among the three groups was not significantly different, as evidenced by the relatively similar results. All three groups had low diagnostic ability. This indicates that participation in the clinical Oral Medicine module does not significantly influence the ability of CDS to diagnose oral lesions. These findings provide insight into the challenges CDS faces in integrating this knowledge into clinical practice. The connection to this condition is closely related to the need to reinforce Oral Medicine education in clinics. Their participation in the Oral Medicine clinic is undoubtedly beneficial, but they are perceived as not addressing all the knowledge gaps. Students require more training in diagnosing oral lesions to obtain an adequate understanding.[15,16] Exposure or experience related to oral lesions may impact diagnostic accuracy.[17,18]

This study concluded that the grades of the CDS in the Oral Medicine module influenced the ability to detect oral lesions. This module plays an important role in providing the information, concepts, and skills required to understand and identify oral lesions. The Oral Medicine module is a learning program encompassing theory and practice, providing an understanding of history-taking, lesion identification, etiology and pathogenesis of lesions, clinical and diagnostic examination, management, and treatment, as well as prevention and patient education related to oral lesions. Essential and relevant learning in detecting oral lesions is provided by this module to prepare students for clinical situations.[19]

GPA is a simple numerical index that summarizes students' academic performance during dental education. The results of this study indicate that the GPA affects the ability of CDS to diagnose oral lesions. This is supported by the study by Sandra *et al*., which found a significant correlation between the performance of junior doctors and their academic performance, as measured by GPA.[20] This indicates that overall, the GPA of Dental Bachelor's students can reflect academic achievements and a deep understanding of various learning materials.[21] Students with a high GPA tend to have a stronger knowledge base and better academic abilities, which can be crucial for applying diagnostic concepts in clinical practice.[22]

Subjective, objective, and additional examinations (if needed) are necessary to establish the diagnosis of oral lesions. Adequate knowledge of the clinical signs of a lesion, such as its location, size, color, and morphology, can greatly assist in identifying oral lesions. This is because each oral lesion has distinct clinical features. By understanding these clinical characteristics, clinicians can more accurately differentiate between the various types of oral lesions, ultimately supporting a more precise and effective diagnostic process. In this study, each clinical case of oral lesion was accompanied by additional scenarios to help students assess and make accurate decisions regarding the diagnosis. The use of clinical images in this study allowed researchers to provide a more varied range of oral lesion cases than would be encountered in direct patient examinations. This study can be considered a preliminary step for subsequent research, which should involve the direct examination of patients to provide a more comprehensive clinical assessment of CDS abilities.

One limitation of this study was the imbalance in the number of CDS participating in the Oral Medicine stage in the clinic. The majority of respondents in this study were CDS who are currently undergoing the Oral Medicine stage, possibly biasing the results because they may more accurately reflect this group's experiences and abilities than those who have not completed or have already completed the Oral Medicine stage. Therefore, further research involving an equal number of CDS participating in Oral Medicine in the clinic is necessary and would better represent the variability among the three groups in the detection and diagnosis of oral lesions. The diagnostic method in this study was limited to an objective examination using clinical images; therefore, future research may consider using a more comprehensive diagnostic method. This study did not determine which types of oral lesions were the easiest and most difficult for CDS to detect and diagnose because of the uneven distribution of images in each lesion category. This imbalance could potentially introduce bias into the interpretation of the results. Other variables, such as interest in specific dental fields, sex, and age, should be further investigated.

The findings of this study are expected to serve as a scientific foundation for establishing and developing learning standards for the detection and diagnosis of oral lesions. One implication is the need for educators to provide periodic education to enhance students' understanding of oral lesions. This will ensure that future dental professionals are equipped with the knowledge and skills to accurately detect and diagnose

oral lesions, enhancing the overall quality of dental and oral healthcare services.

CONCLUSION

In this study, clinical dental students demonstrated good detection abilities but poor diagnostic skills. They tended to make less accurate diagnoses after detection. Students' participation in the clinical Oral Medicine module influenced their ability to detect oral lesions. The value of the Oral Medicine module affected the students' ability to detect oral lesions, whereas their GPA affected their ability to diagnose oral lesions. Developing effective and efficient Oral Medicine teaching strategies is necessary to enhance students' clinical competency in oral lesions and may be accomplished by increasing the presentation of lesions with low detection and diagnosis rates to students.

CONFLICT OF INTEREST

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ORIGINAL ARTICLE

The Accuracy of Detection and Diagnosis of Oral Lesions by Clinical Dental Students

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ABSTRACT

Objective: To determine the accuracy of diagnosing oral lesions through clinical photos taken by clinical dental students (CDS). **Methods**: The observational analytic study was conducted on 100 CDS to evaluate 140 clinical photos of oral lesions. The gold standard was evaluated by three oral medicine specialists. Data analysis will be performed using accuracy and kappa tests. **Results**: The accuracy rate of lesion detection in CDS is high (88.55%) with substantial agreement ($\kappa = 0.66$). However, the accuracy rate of diagnosis is low (38.21%) with no agreement ($\kappa = -0.30$). Participation in the clinical Oral Medicine module positively influenced detection accuracy, with the highest rate among students who had completed the module (96.18%). However, diagnostic accuracy remained low across all groups. **Conclusion**: CDS demonstrates good detection abilities but struggles with accurate diagnosis. Participation in the clinical Oral Medicine module is beneficial for improving detection abilities. Further efforts are needed to enhance diagnostic skills and ensure that CDS are well-prepared for clinical practice.

Keywords: accuracy, dental students, detection, diagnosis, oral lesions

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INTRODUCTION

Oral lesions are alterations or damage to the structure of oral mucosal tissues under abnormal conditions, causing changes in color, consistency, size, texture, pattern, or shape. They include sores, spots, swellings, lumps, ulcers, and abnormal tissue growth and can indicate pathological or abnormal changes in the oral cavity. Oral lesions can appear in various locations, including the lips, palate, gums, tongue, and floor of the mouth. Some of these conditions can be serious, with significant morbidity, potentially affecting patients' quality of life and even posing life-threatening risks. According to the Indonesian Medical Council's Regulation Number 40 of 2015 on the Competency Standards for Indonesian Dentists, dentists must be able to identify normal variants in oral soft tissues, provide treatment for oral lesions (such as traumatic ulcers, aphthous stomatitis, angular cheilitis, etc), and refer patients with systemic-related conditions such as erythema multiforme, herpangina, hand-foot-and-mouth disease, as well as oral potentially malignant diseases (OPMD) and malignancy.[1] A study on the prevalence of oral mucosal lesions found that 53% of the 22 cases involved patients over 60 years old who were predominantly female, with the most frequent condition being oral lichen planus/oral lichenoid reaction.[2] Thus, clinicians must be able to detect and diagnose oral lesions, especially those with the potential to become malignant, such as leukoplakia and erythroplakia.

As of June 2024, the Indonesian Dental Association reported a scarcity of oral medicine specialists in Indonesia, totaling only 219, most of whom were concentrated in major cities such as Jakarta. Meanwhile, many other regions still lack access to this specialization. This limitation makes it difficult for

residents in remote or underserved areas to receive optimal oral healthcare, particularly those with soft tissue conditions. Therefore, oral medicine specialists must rely on general dentists' knowledge and skills in recognizing and identifying changes or signs of diseases in oral soft tissues. In fact, approximately 44.5% of the dentists in a prior study reported that they seldom examined oral soft tissues before performing dental treatments, thereby diminishing their expertise and ability to diagnose and treat oral lesions.[3]

Unfortunately, as future dentists, most dental students focus solely on dental issues, neglecting problems associated with oral soft tissues. Students detect caries lesions more often than oral mucosal lesions.[4] This oversight suggests dental students have a decreased ability to diagnose oral lesions,[5] which can lead to misdiagnosis, improper treatment, and potentially adverse effects on patient health. Previous research shows oral mucosal lesions are the most frequently misdiagnosed condition.[6] Due to the limited number of oral medicine specialists in Indonesia, there is a need for general dentists as practitioners who are often at the forefront of oral health services to handle cases related to oral lesions. They can actively contribute to early detection as a preventive measure, provide treatment, and educate patients about the importance of oral soft tissue health.

Diagnosing oral lesions can be challenging because they have similar clinical presentations, potentially resulting in fatal treatment errors. Dental students should possess sufficient knowledge to accurately diagnose oral lesions so that they can provide appropriate and optimal treatment to patients.[7,8]

Clinical dental students (CDS) are in the final stage of their education and are preparing for clinical practice. Assessing their ability to detect and diagnose oral lesions is crucial for ensuring that they are ready to face clinical challenges. This study aimed to determine the level of accuracy of detection and diagnosis of oral lesions by CDS and to explore how the characteristics of participation in the clinical Oral Medicine module influence their ability to detect and diagnose oral lesions. This research is expected to serve as a reference and reflection tool for these students to learn how to detect and diagnose oral lesions, thereby improving the quality of care they provide as future dentists. Additionally, this study can benefit institutions by evaluating students' capabilities and providing insights into the effectiveness of the curriculum and teaching methods used. By understanding the strengths and weaknesses of students' detection and diagnostic abilities, educational institutions and regulatory bodies can develop assessment standards and strategies to enhance students' future professional competencies. Although previous research suggests that factors, such as experience and interest in a topic, influence diagnostic abilities, further research on other contributing factors is needed.

METHODS

This cross-sectional study was conducted in November 2023. The participants were CDS at the Dental Hospital of the Faculty of Dentistry, Universitas Trisakti. This study was approved by the Ethics Commission of the Faculty of Dentistry, Universitas Trisakti, No. 713/S1/KEPK/FKG/8/2023.

Sample size

The samples used in this study were cases of oral lesions. A minimum sample size of 220 oral lesion cases was required to achieve a medium effect size and 95% power. A total of 100 CDS from different clinical entry years participated in this study by working on five cases of oral lesions each, resulting in a total of 500 samples. The participating CDS were categorized based on their progress in the clinical Oral Medicine module as completed, ongoing, or not yet begun.

Sample selection

The respondents in this study included active CDS at Universitas Trisakti, who indicated their willingness to participate in the study by providing informed consent. Students who were taking leave were excluded from the study.

Participant characteristics

The frequency distribution of the respondents in this study was based on sex, age, educational level at the Clinical Oral Medicine stage, and the grade point average (GPA) based on the curriculum.

Clinical pictures

Students were evaluated by questionnaire using 140 clinical photographs covering the entire oral cavity, including the palatal, buccal, lingual, and labial areas. Thirty-seven types of oral lesions were represented, including 18 types of normal variants, two types of hypersensitivity reactions, one type of cyst lesion, six types of infectious lesions, two types of traumatic lesions, one type of nutritional deficiency lesion, two types of inflammatory lesions, three types of OPMD lesions, one type of benign neoplastic lesion, and one type of malignant lesion. The clinical photographs were obtained from the Oral Disease Atlas, combined with documentation of oral lesions from the Dental Hospital of the Faculty of Dentistry, Trisakti University. The photographs were selected by three oral medicine specialists and were chosen based on lesions commonly encountered in clinical practice and in accordance with the Indonesian Dental Competency Standards.

Questionnaires

All participants gathered in a room equipped with individual computers, each separated by partitions.

Before the research commenced, the participants were given a brief explanation of the purpose and objectives of the study as well as the procedures for filling out the questionnaire. They were then asked to complete an informed consent form and a Google Form questionnaire containing case scenarios and oral lesion images within a time range of 30-45 minutes. Participants completed the questionnaire independently and were supervised by the research staff to prevent communication. The descriptive variables provided by the students included their age, sex, stage of training in Oral Medicine at the clinic, Oral Medicine module scores, and GPA. The students were tasked with identifying the presence of lesions, specifying their location, and providing a clinical diagnosis. Figure 1 shows examples of photographs of oral lesions included in the questionnaire. A 4 × 4 grid (dividing the image into 16 quadrants) served as a visual guide, allowing the students to pinpoint the area where the oral lesions were present precisely. By dividing the image into smaller sections, the grid facilitated a systematic approach to lesion examination, ensuring the thoroughness and accuracy of the assessment process. With each quadrant marked, students navigated through the image easily, making observations and evaluations more structured and organized. Lesions that occupied < 10% of the grid were proportionally excluded. This questionnaire was face-validated and tested by three oral medicine specialists and 30 CDS, who assessed if the image quality was good, the selection of images used was relevant and appropriate, the questions represented the research objective, the time to answer the questions was adequate, and the questions were too simple or complex.

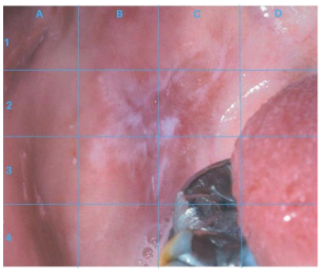

Figure 1. The example photos of oral lesion cases and the accompanying grid used in the questionnaire provide a structured framework for students to analyze and evaluate oral abnormalities.

Statistical analysis

Primary data for this study were obtained directly from the participants. Oral lesion detection and diagnosis accuracy was determined using sensitivity and specificity tests and kappa values. A linear regression test was performed to determine the effect of the Oral Medicine module scores and GPA on the ability to detect and diagnose CDS. Statistical analysis was conducted using IBM SPSS Statistics version 27.

RESULTS

A total of 100 CDS from various stages of clinical education participated in this study. Their demographic characteristics are shown in Table 1. The majority of participants were female, comprising 83 (83%), while 17 (17%) were male. The participants ranged in age from 21 to 26 years, with the majority (79%) between 21 to 23 years. Conversely, those aged 24 to 26 constituted a smaller proportion of the sample, accounting for only 21% of the participants. Most participants (78%) were in the Oral Medicine stage at the clinic. Table 2 describes the oral lesions included in the questionnaire and the ability of the CDS to detect and diagnose oral lesions.

Sensitivity and specificity tests were conducted to measure the accuracy of oral lesion detection and diagnosis by CDS, and kappa values were calculated, as shown in Table 3. The findings indicated that CDS had an accuracy rate of 88.55% in detection. The kappa value of 0.66 reflected a substantial level of agreement. On the other hand, the overall accuracy rate of students in making diagnoses was 38.21%, with a kappa value of -0.30, indicating a low level of agreement.

In this study, the ability of the CDS to accurately detect and diagnose oral lesions was analyzed based on their participation level in the clinical Oral Medicine module (Table 3). In the analysis of oral lesion detection, the highest accuracy rate was observed among students who had passed the Oral Medicine module (96.18%), with a kappa value of 0.72, followed by students currently enrolled in the Oral Medicine module (89.40%), with a kappa value of 0.66, and the lowest among students who had not yet participated in the Oral Medicine module (83.29%), with a kappa value of 0.56. Students who were currently enrolled in or had passed the clinical Oral Medicine module showed substantial agreement, whereas those who did not participate showed moderate agreement.

Table 1. Characteristics of clinical dental students

Variables	n	%
Gender		
Female	83	83
Male	17	17
Age (years)		
21 – 23	79	79
24 – 26	21	21
Participation in the clinical Oral Medicine module		
Not yet	5	5
Currently	78	78
Passed	17	17

Table 2. Clinical dental students' performance in the diagnosis of 37 oral lesions

Diagnosis of oral lesions	Number of images	Dental students		
		Correct diagnosis n (%)	Not detected n (%)	Incorrect diagnosis n (%)
Normal variant				
Amalgam tattoo	1	35 (70)	5 (10)	10 (20)
Black hairy tongue	1	47 (94)	-	3 (6)
Coated tongue	2	24 (24)	9 (9)	67 (67)
Crenated tongue	2	28 (28)	5 (5)	67 (67)
Erythema migrans	2	25 (25)	1 (1)	74 (74)
Fissure tongue	1	47 (94)	1 (2)	2 (4)
Fordyce spot	5	180 (72)	11 (4.4)	59 (23.6)
Frictional keratosis	6	10 (3.3)	212 (70.7)	78 (26)
Geographic tongue	2	74 (74)	2 (2)	24 (24)
Leukoedema	4	102 (51)	8 (4)	90 (45)
Linea alba	4	184 (92)	2 (1)	14 (7)
Median rhomboid glossitis	1	38 (76)	3 (6)	9 (18)
Morsicatio buccarum/labiorum	1	12 (24)	6 (12)	32 (64)
Papilla circumvallate	1	29 (58)	7 (14)	14 (28)
Physiologic pigmentation	6	280 (93.3)	9 (3)	11 (3.7)
Sublingual varicosis	10	196 (39.2)	197 (39.4)	107 (21.4)
Torus palatinus/mandibularis	4	192 (96)	4 (2)	4 (2)
Hypersensitivity reaction				
Angioedema	1	27 (54)	17 (34)	6 (12)
Lichenoid reaction	1	13 (26)	-	37 (74)
Cyst				
Mucocele	1	13 (26)	8 (16)	29 (58)
Infection				
Angular cheilitis	1	46 (92)	3 (6)	1 (2)
Denture sore mouth	1	22 (44)	5 (10)	13 (26)
Herpes labialis	1	46 (92)	-	4 (8)
Herpes zoster	1	26 (52)	-	24 (48)
Oral hairy leukoplakia	2	20 (20)	16 (16)	64 (64)
Oral thrush	1	28 (56)	-	22 (44)
Trauma lesion				
Chemical burn	1	14 (28)	-	36 (72)
Nicotina stomatitis	2	76 (76)	3 (3)	21 (21)
Nutritional deficiencies				
Glossitis	1	30 (60)	7 (14)	13 (26)
Inflammatory				
Recurrent aphthous stomatitis	3	142 (94.7)	5 (3.3)	3 (2)
Pyogenic granuloma	1	12 (24)	3 (6)	35 (70)
OPMD				
Erythroplakia	1	9 (18)	9 (18)	22 (44)
Leukoplakia	1	13 (26)	1 (2)	36 (72)
Lichen planus	2	54 (54)	-	46 (46)
Benign neoplastic				
Fibroma	1	13 (26)	1 (2)	36 (72)
Malignant lesion				
Oral Squamous cell carcinoma	1	17 (34)	-	33 (66)

The diagnostic accuracy results among the three groups were similar. Students who had completed the clinical Oral Medicine module had the highest accuracy rate (38.97%), with a kappa value of -0.27, followed by those currently enrolled in the Oral Medicine module (38.94%), with a kappa value of -0.28, and the lowest among students who had not yet participated in the Oral Medicine module (36.25%), with a kappa value of -0.28. All three groups showed no agreement.

As shown in Table 4, the students' grades in the Oral Medicine module significantly affected their ability to detect oral lesions, with a p-value of 0.035. Similarly, GPA significantly influenced the students' ability to diagnose oral lesions (p = 0.025).

DISCUSSION

This study used clinical images to detect and diagnose oral lesions instead of direct visual examinations of patients. The students' responses in detection and

Table 3. Accuracy of detection and diagnosis of clinical dental students

	All		Oral Medicine Module					
			Have Not Taken		Currently Taking		Has Taken	
	Detection	Diagnosis	Detection	Diagnosis	Detection	Diagnosis	Detection	Diagnosis
Sensitivity (95% CI)	88.74 (88.29 – 89.18)	45.85 (45.50 – 46.19)	93.37 (91.55 – 94.90)	40.3 (38.77 – 41.84)	87.83 (87.30 – 88.34)	46.25 (45.86 – 46.64)	91.47 (90.50 – 92.37)	45.59 (44.77 – 46.41)
Specificity (95% CI)	88.51 (88.30 – 88.72)	17.60 (17.18 – 18.04)	82.53 (81.42 – 83.61)	28.63 (26.71 – 30.60)	89.71 (89.50 – 89.93)	19.64 (19.14 – 20.15)	96.49 (96.33 – 96.64)	20.89 (19.79 – 22.02)
PPV (95% CI)	62.17 (61.74 – 62.61)	60.02 (59.80 – 60.24)	50.75 (49.14 – 52.36)	51.57 (50.41 – 52.73)	62.96 (62.45 – 63.46)	60.31 (60.06 – 60.56)	62.64 (61.58 – 63.69)	61.15 (60.61 – 61.69)
NPV (95% CI)	97.37 (97.26 – 97.46)	10.75 (10.51 – 11.00)	98.48 (98.06 – 98.80)	20.27 (19.13 – 21.45)	97.37 (97.26 – 97.48)	12.15 (11.87 – 12.44)	99.43 (99.37 – 99.49)	12.32 (11.74 – 12.93)
LR+ (95% CI)	7.72 (7.58 – 7.87)	0.56 (0.55 – 0.56)	5.35 (5.01 – 5.70)	0.56 (0.54 – 0.59)	8.54 (8.35 – 8.73)	0.58 (0.57 – 0.58)	26.04 (24.89 – 27.24)	0.58 (0.56 – 0.59)
LR- (95% CI)	0.13 (0.12 – 0.13)	3.08 (3.00 – 3.15)	0.08 (0.06 – 0.10)	2.09 (1.94 – 2.24)	0.14 (0.13 – 0.14)	2.74 (2.67 – 2.81)	0.09 (0.08 – 0.10)	2.60 (2.47 – 2.75)
Accuracy (95% CI)	88.55 (88.36 – 88.74)	38.21 (37.92 – 38.49)	84.29 (83.31 – 85.23)	36.25 (35.05 – 37.47)	89.40 (89.20 – 89.60)	38.94 (38.62 – 39.27)	96.18 (96.03 – 96.34)	38.97 (38.28 – 39.66)
AUC (95% CI)	0.86 (0.845 – 0.874)	0.95 (0.943 – 0.961)	0.52 (0.493 – 0.553)	0.88 (0.862 – 0.901)	0.82 (0.805 – 0.837)	0.89 (0.883 – 0.909)	0.69 (0.676 – 0.715)	0.87 (0.860 – 0.888)
κ	0.66	-0.30	0.56	-0.28	0.66	-0.28	0.72	-0.27

κ: Kappa value, PPV: Positive Predictive Value, NPV: Negative Predictive Value, LR+: Likelihood Ratio Positive, LR-: Likelihood Ratio Negative, CI: Confidence Interval

Table 4. Linear regression analysis of Oral Medicine module grades and GPA on detection and diagnosis abilities of CDS

Variable	Estimate (SE)	R^2 adj	95% CI	p
Oral Medicine Module				
Detection	9.30 (4.34)	0.035	0.68 – 17.9	0.035*
Diagnosis	8.39 (5.72)	0.012	-2.96 – 19.7	0.146
GPA score				
Detection	37.1 (18.9)	0.028	-0.40 – 74.7	0.052
Diagnosis	55.7 (24.5)	0.040	7.11 – 104	0.025*

*p < 0.05, SE: Standard Error, CI: Confidence Interval

diagnosis were compared with the answers confirmed by the three oral medicine specialists. Normal variant lesions were the most common cases in the questionnaire due to their frequent occurrence in clinical practice.[9] According to the Indonesian Dentist Competency Standards, a general dentist must have the skills to identify normal variants in oral soft tissues.[1] Moreover, several images depicting lesion-free conditions served as controls for assessing the student's ability to identify whether a condition is normal or pathological.

In this study, CDS detected oral lesions with an accuracy rate of 88.55% and diagnosed with an accuracy rate of 38.21%, indicating that they find it easier to detect than to diagnose. This finding is similar to that of the Amtha *et al*. study in Bangka Belitung, which showed that clinical students were better at detecting than accurately diagnosing oral mucosal lesions.[5] The difficulty in diagnosing oral lesions may be due to inadequate educational systems, limited experience in dealing with oral lesion cases, and students' lack of interest in Oral Medicine.[10]

However, the results of the present study contradict those of Ali *et al*., who showed that students in Kuwait had more difficulty detecting than diagnosing lesions.[4] It is a major challenge for dentists to accurately detect and diagnose oral lesions because of the similarity of symptoms and physical appearance among several lesion types. Some lesions may be difficult to distinguish because of their similar colors, shapes, or textures. In this study, the students' memorization capabilities seem to influence the low accuracy rate of diagnosis. Although many students correctly referred to the diagnosis, they made mistakes because they forgot the names of certain conditions or lesions. This highlights the importance of understanding concepts and remembering detailed information to achieve diagnostic accuracy. The ability to diagnose oral lesions is often closely related to a student's experience level; hence, lack of experience can be a determining factor, as students need at least five years of clinical experience to enhance their understanding and diagnostic skills.[6,11]

Analysis of the three groups, categorized based on their participation in the clinical Oral Medicine module, showed high detection accuracy. A significant difference was observed in detection among the groups that had not undergone, were currently undergoing, or had completed the Oral Medicine stage in the clinic. CDS who have completed the Oral Medicine stage may have broader clinical

experience and have become accustomed to patient conditions. This may have enhanced the accuracy of oral lesion detection, as reflected by the highest accuracy rate among the groups. Having opportunities to observe and participate in diverse cases during the clinical phase may be crucial. Meanwhile, the CDS currently participating in the Oral Medicine stage also exhibited a high level of detection accuracy, even if it was slightly lower than that of the completed group. CDS in this stage may still be in the learning and skill development process; hence, their accuracy level may reflect ongoing learning.[12] The group of CDS that have not yet participated in the Oral Medicine stage in the clinic showed a lower level of detection accuracy. This may be due to their limited clinical experience.[13,14]

However, the accuracy of diagnosis among the three groups was not significantly different, as evidenced by the relatively similar results. All three groups had low diagnostic ability. This indicates that participation in the clinical Oral Medicine module does not significantly influence the ability of CDS to diagnose oral lesions. These findings provide insight into the challenges CDS faces in integrating this knowledge into clinical practice. The connection to this condition is closely related to the need to reinforce Oral Medicine education in clinics. Their participation in the Oral Medicine clinic is undoubtedly beneficial, but they are perceived as not addressing all the knowledge gaps. Students require more training in diagnosing oral lesions to obtain an adequate understanding.[15,16] Exposure or experience related to oral lesions may impact diagnostic accuracy.[17,18]

This study concluded that the grades of the CDS in the Oral Medicine module influenced the ability to detect oral lesions. This module plays an important role in providing the information, concepts, and skills required to understand and identify oral lesions. The Oral Medicine module is a learning program encompassing theory and practice, providing an understanding of history-taking, lesion identification, etiology and pathogenesis of lesions, clinical and diagnostic examination, management, and treatment, as well as prevention and patient education related to oral lesions. Essential and relevant learning in detecting oral lesions is provided by this module to prepare students for clinical situations.[19]

GPA is a simple numerical index that summarizes students' academic performance during dental education. The results of this study indicate that the GPA affects the ability of CDS to diagnose oral lesions. This is supported by the study by Sandra *et al*., which found a significant correlation between the performance of junior doctors and their academic performance, as measured by GPA.[20] This indicates that overall, the GPA of Dental Bachelor's students can reflect academic achievements and a deep understanding of various learning materials.[21] Students with a high GPA tend to have a stronger knowledge base and better academic abilities, which can be crucial for applying diagnostic concepts in clinical practice.[22]

Subjective, objective, and additional examinations (if needed) are necessary to establish the diagnosis of oral lesions. Adequate knowledge of the clinical signs of a lesion, such as its location, size, color, and morphology, can greatly assist in identifying oral lesions. This is because each oral lesion has distinct clinical features. By understanding these clinical characteristics, clinicians can more accurately differentiate between the various types of oral lesions, ultimately supporting a more precise and effective diagnostic process. In this study, each clinical case of oral lesion was accompanied by additional scenarios to help students assess and make accurate decisions regarding the diagnosis. The use of clinical images in this study allowed researchers to provide a more varied range of oral lesion cases than would be encountered in direct patient examinations. This study can be considered a preliminary step for subsequent research, which should involve the direct examination of patients to provide a more comprehensive clinical assessment of CDS abilities.

One limitation of this study was the imbalance in the number of CDS participating in the Oral Medicine stage in the clinic. The majority of respondents in this study were CDS who are currently undergoing the Oral Medicine stage, possibly biasing the results because they may more accurately reflect this group's experiences and abilities than those who have not completed or have already completed the Oral Medicine stage. Therefore, further research involving an equal number of CDS participating in Oral Medicine in the clinic is necessary and would better represent the variability among the three groups in the detection and diagnosis of oral lesions. The diagnostic method in this study was limited to an objective examination using clinical images; therefore, future research may consider using a more comprehensive diagnostic method. This study did not determine which types of oral lesions were the easiest and most difficult for CDS to detect and diagnose because of the uneven distribution of images in each lesion category. This imbalance could potentially introduce bias into the interpretation of the results. Other variables, such as interest in specific dental fields, sex, and age, should be further investigated.

The findings of this study are expected to serve as a scientific foundation for establishing and developing learning standards for the detection and diagnosis of oral lesions. One implication is the need for educators to provide periodic education to enhance students' understanding of oral lesions. This will ensure that future dental professionals are equipped with the knowledge and skills to accurately detect and diagnose

oral lesions, enhancing the overall quality of dental and oral healthcare services.

CONCLUSION

In this study, clinical dental students demonstrated good detection abilities but poor diagnostic skills. They tended to make less accurate diagnoses after detection. Students' participation in the clinical Oral Medicine module influenced their ability to detect oral lesions. The value of the Oral Medicine module affected the students' ability to detect oral lesions, whereas their GPA affected their ability to diagnose oral lesions. Developing effective and efficient Oral Medicine teaching strategies is necessary to enhance students' clinical competency in oral lesions and may be accomplished by increasing the presentation of lesions with low detection and diagnosis rates to students.

CONFLICT OF INTEREST

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