Editorial

Oral health Promotion: Are we doing it right?

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Oral health promotion is a key public health action areas that aims increase individuals control over their own oral health. It includes education, training and resources to achieve better outcomes. There are many oral health promotion initiatives across the globe. One of the most famous initiatives is World Oral Health Day organized by the World Federation Dentaire (FDI) on 20 March every year. Over the past few years, many dental organizations and institutions celebrated the world oral health day by launching health education and promotion campaigns targeting schoolchildren. Although the intentions were decent to raise oral health awareness, such activities appeared to have little effect on oral public health in Libya.

First, the campaigns can contribute to widening oral health inequalities among Libyan since most of them targeted private schools. The main reason for this, as mentioned by some organizers, is that it is easy to access private schools. Therefore, these mistargeted oral health campaigns will eventually improve the oral health among affluents (who have better oral health resources) and ignore oral health promotion among their worse off counterparts studying in state-run schools. The social gradient in oral health is well documented globally and locally in several recently published theses and conference presentations.[1-4]

Second, most of campaigns were focusing on dental caries and ignore other oral health problems such dental traumatic injuries, fluorosis, dentine hypersensitivity, dental neglect and Molar-Incisor Hypomineralisation which are relatively prevalent.[5-9] These conditions can have significant impact on the quality of life and should be targeted in the future oral health campaigns. Moreover, the immediate management of conditions such as trauma requires the involvement of those who provides the first aid at the site of injury. Several studies have highlighted the insufficient oral health related knowledge among parents, teachers and sports coaches.[10] Therefore, it is highly recommended that future oral health campaigns expand their target groups to include different age groups, settings and planned in a way that ensures fulfilling the community needs and reducing inequalities in oral health.

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Assessment of Knowledge and Attitude Towards Oral Health and Periodontal Disease in Diabetic Patients among Libyan Physicians

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ABSTRACT

Background: Periodontitis is a chronic inflammatory disease characterized by the destruction of the supporting structures of the teeth. Emerging research suggests a bidirectional link between diabetes mellitus (DM) and periodontal disease (PD). This indicates that DM elevates the risk of developing PD, while periodontal inflammation may contribute to increased blood sugar levels and worsen glycemic control.

Aim: To determine the knowledge and attitude of internal medicine physicians towards oral health and periodontal disease in public and private diabetic clinics within the city of Benghazi, Libya.

Methods: A cross-sectional study among practicing physicians who treat diabetic patients in various clinics within the city limits of Benghazi, Libya. A structured questionnaire consisting of 30 questions was utilized to assess the physicians' demographics, their understanding of periodontal disease, and their attitudes towards the oral health of diabetic patients.

Results: The study findings indicated that a positive attitude was more prevalent among female physicians (75%) than their male counterparts (25%). Conversely, a negative attitude was predominantly observed in senior house officers (93.8%), whereas consultants and physicians with over 10 years of experience demonstrated a positive attitude, accounting for 22.4% and 55.3% respectively. The data also revealed a statistically significant association between the attitude and knowledge level and the basic demographic characteristics of the participants, with a *p*-value < 0.05.

Conclusion: Although most physicians are aware of the impact that PD and DM have on overall patient health, a knowledge deficiency is evident among senior house officers. In contrast, consultants possess the most comprehensive knowledge. The physicians also expressed a willingness to enhance their understanding of PD to improve health outcomes for their diabetic patients.

Keywords: *Periodontitis, Diabetes Mellitus, Oral health, Physician, Knowledge.*

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INTRODUCTION

One of the most common chronic inflammatory non-communicable diseases (NCD) in humans is periodontal disease, according to statistics from the Global Burden of Disease (GBD) database.[1] Periodontitis is a chronic inflammatory disease characterized by the destruction of the teeth-supporting structures which, if left untreated, could lead to tooth loss.[2] The disease affects subjects in all age groups but is more common in adult populations.[3] More than 10% of the adult population worldwide may be affected by severe periodontitis, making it the 11th most prevalent disease globally, more prevalent than cardiovascular disease.[4-6] In addition, male gender, smoking, diet, oral hygiene, diabetes mellitus, and various socioeconomic factors are considered risk factors for periodontal disease.[7, 8]

Periodontal diseases often result from inadequate brushing and flossing habits, allowing bacterial biofilm to accumulate either at the gum margins or within the gingival sulcus.[9] Gingivitis causes inflammation of the gingival tissue without affecting the underlying structure. If left untreated, it can advance into periodontitis. This irreversible disease destroys the supporting structure of the tooth and migration of the junctional epithelium, which may lead to tooth loss.[10]

Periodontitis is also thought to influence systemic health, including the cardiovascular system, respiratory system, low birth weight preterm, and diabetes

mellitus.[11-13] In the early 1990s periodontitis was sometimes referred to as the sixth complication of diabetes,[14] and individuals with diabetes increased their risk of developing periodontal diseases. Furthermore, patients with both diabetes and periodontal diseases develop poor glycemic control, rapid progression of periodontal disease, and tooth loss.[15]

Healthcare professionals play an important role in patient education on the prevention of periodontal disease. In addition, assessing and improving the existing knowledge about periodontal disease and its systemic manifestations among healthcare professionals will be beneficial to society; since healthcare professionals who are knowledgeable and stay up-to-date can effectively prevent and manage periodontal diseases through public awareness, timely treatment interventions or Interdisciplinary collaboration with different health professionals to provide comprehensive patient care. This leads to fewer cases of advanced periodontal diseases, tooth loss, and associated health complications.[8,16]

There is a lack of population-based data on knowledge about periodontal disease in Libya. Also, no study has been done to assess the awareness of periodontal disease and knowledge among medical physicians in our country. Thus, the purpose of the present study was to determine the knowledge and attitude of internal medicine physicians towards oral health and periodontal disease in both public and private diabetic clinics within Benghazi, Libya.

MATERIALS AND METHODS

A cross-sectional study was conducted between December 2022 and August 2023, involving one hundred and twenty-two internal medicine physicians practicing in different areas of the Benghazi district. Most participants were affiliated with the governmental Benghazi Medical Centre (BMC) and Seidi-Hussein Diabetic Center, while the remaining physicians worked in private clinics at Al-Haram, Beirut, and Venezia hospitals, all of which treated diabetic patients in Benghazi, Libya. The study conveniently sampled a group of qualified medical professionals, including senior house officers, specialists, and consultants practicing within the diabetic unit.

All doctors voluntarily entered the study and were informed about the nature and purpose of the study. The knowledge and attitude of the doctors were assessed using the responses to the written questions, either yes or no. The questionnaire was developed based on a previous study that assessed the awareness of medical professionals about the etiology of periodontal diseases in India.[17] The questionnaire included 30 questions with

multiple-choice answers, as depicted in the appendix section. It was divided into three sections; the first section comprised four questions related to socio-demographic personal data. The second included eighteen questions aimed at evaluating knowledge and awareness of periodontal disease. The third section consisted of nine questions exploring physicians' attitudes and behaviors toward oral health care and periodontal disease in their patients.

Statistical Analysis: The sample size was calculated based on a previous study.[18] A minimum sample size of 97 subjects was found to be sufficient for estimating the knowledge and attitude at 0.1 margin of error and 95% confidence level. A typical piece of advice is to reject the null hypothesis H_0 if the corresponding *p*-value is smaller than 0.05.

A pilot sample of 20 subjects was chosen to assess the stability and validity of the questionnaire. The findings from this assessment were as follows:

Table 1: Stability and validity of the questionnaire:

	Cronbach's alpha	Test-retest reliability
Knowledge	0.85	0.792
Attitude	0.861	0.822
Total questionnaire	0.871	0.81

The transcript analysis of our data was fed to the computer and analyzed using IBM SPSS software package version 24. Quantitative data, including basic demographic data, knowledge level and attitude were described using numbers and percentages from the total number "122." Also, about the study the data were presented as the number of cases in each category and the corresponding percent.

The test used in the study of the relationship between each of the two variables was the Chi-square test. This test was used for categorical variables (number and percent). The significance of the obtained results was judged at the 5% level.

RESULTS

All participants completed the questionnaire without any reminders, resulting in a 100% response rate and 122 participants. According to the demographic characteristics shown in **Table 2**, the distribution of subjects participating in this study was a total of 122: 93 females (76.2%), and 29 males (23.8%). The number of participants who were senior house officers SHO 73

(59.8%) and less experienced in their field of work was great compared to specialists 32 (26.2%)

Table 2: Demographic characteristics of the study participants (n=122).

Variable	N (%)
Gender	
Female	93 (76.2)
Male	29 (23.8)
Working units (diabetic center)	
Diabetic unit	77 (63.1)
Other units treat diabetic patients	45 (36.9)
Specialization	
Senior house officer	73 (59.8)
Specialist	32 (26.2)
Consultant	17 (13.9)
Years of experience	
Less than 5 years	41 (33.6)
5-10 years	35 (28.7)
More than 10 years	46 (37.7)
Total	122 (100)

Assessment of knowledge and awareness of periodontal disease among Libyan physicians, as shown in **Table 3** below, showed statistically significant knowledge about gingivitis and periodontitis. Roughly 70 percent of the physicians had heard of the terms gingivitis and periodontitis, while only (30%) could distinguish between the two disease processes. Fifty percent of the participants could define dental plaque, less than (25%) understood that periodontal disease had both a plaque and a hereditary factor associated with it, and an additional (30%) had no idea what causes periodontal disease. However, (70%) of the participants claimed they knew the signs and symptoms of periodontal disease, and at least (90%) of the participants knew periodontitis had underlying causes of smoking and diabetes associated with it, while approximately (90%) understood that the condition could also affect the systemic overall health of the patient.

Table 3: The distribution of participants based on knowledge-related questions.

Questions	Number of (Yes) answers	Percent (%)
Have heard of the terms gingivitis and periodontitis	85	69.7
Difference between them	41	33.6
Specialties in dentistry	89	73.0
Periodontal disease is caused by		
Plaque	42	34.4
Hereditary factor	16	13.1
Both	27	22.1
Definition Dental plaque	60	49.2
Definition Dental calculus	70	57.4
Signs & symptoms of PD	89	73.0
If yes mention		
Bleeding	81	66.4
Redness	13	10.7
Mobility	17	13.9
Bad breath	8	6.6
Change in the contour and size	3	2.5
OH affects the periodontal health	121	99.2
Smoking affects periodontal tissues	118	96.7
PD is more in diabetic patients	112	91.8
DM and PD bidirectional way	99	81.1
Modifiable risk factors for PD		
Diabetes mellitus (DM)	92	75.4
Smoking	17	13.9
Stress	13	10.7
Treatment of PD improves glycemic control	89	73.0
PD associated with some systemic diseases	104	85.2
PD are preventable	114	93.4
Agree oral health is an integral part of general health	120	98.4
Mention six complications of DM		
1-3 (answer not included PD)	55	45.1
4-6 (24 persons only their answer included PD)	67	54.9
Importance of PD and oral	118	96.72
Seen patients with dental	98	80.33
Refer your patient to a dentist	103	84.43
Screen patients for PD	50	40.98
Refer your patient to		
Not refer	4	3.28
General Dentist	100	81.97
Periodontist	18	14.75
Prescribe to your patient a	75	61.48
Prevalence of gum disease-	110	90.16
Agree that treatment of PD	115	94.26
Accept to gain the knowledge regarding PD and implement it in your daily work	111	90.98

Moreover, the third section of our research showed that there was a statistically significant difference in the

distribution of the physicians regarding their knowledge level and attitude. As shown in **Table 4** sixty-seven percent of the physician's overall knowledge was considered adequate or good, while (23.8%) had fair knowledge, and (9%) were considered to have poor knowledge. When assessing physician attitude, 76 had a positive attitude, while (24.6%) had a neutral attitude and (13.1%) had a negative attitude.

Table 4: The distribution of participants categorized by their level of knowledge and attitude

Variable	N (%)
Knowledge level	
Good	82 (67.2)
Faire	29 (23.8)
Poor	11 (9)
Attitude	
Positive	76 (62.3)
Neutral	30 (24.6)
Negative	16 (13.1)

Figure 1 illustrates the association between knowledge level and demographic characteristics among the participants. Specifically, most females demonstrated good knowledge, while males' knowledge was poorly evaluated based on their responses. Additionally, the study assessed physicians' experience levels in terms of knowledge and attitude, revealing that senior house officers had poorer knowledge compared to consultants. Furthermore, individuals with less than 5 years of experience exhibited lower knowledge levels than those with over 10 years of experience. Overall, a statistically significant relationship exists between knowledge level and participant characteristics.
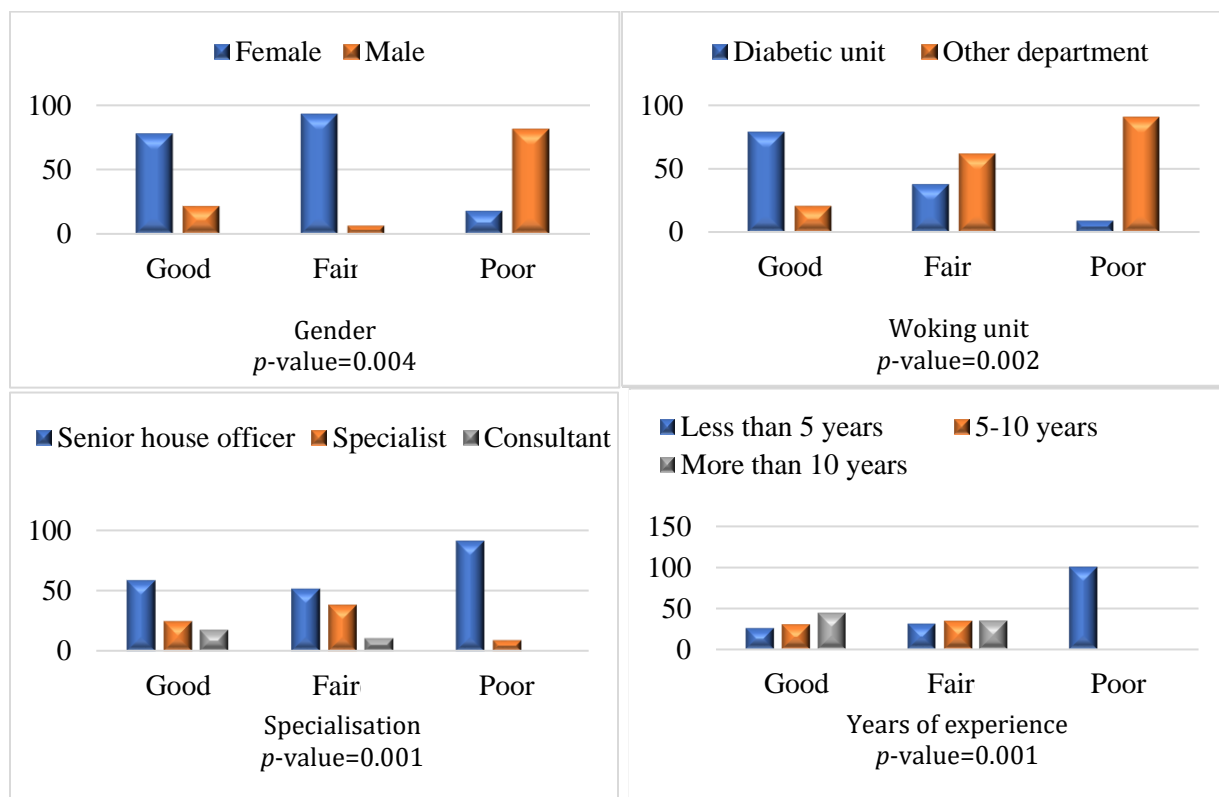

Figure 1: Differences in knowledge level between study participants based on demographic characteristics: gender, working unit, specialization, and year of experience (Chi-square test)

Table 5 shows that positive attitude was higher in females 57(75%) than in males 19(25%). Positive attitudes were higher in diabetic unit staff 60(78.9%) while most of the other units had negative attitudes 14(87.5%).

Negative attitudes in senior house officers were higher (15, 93.8%) while all consultants had positive attitudes (17,22.4%). Most of the cases with more than 10 years of experience had positive attitudes (42, 55.3%), while most cases with less than 5 years had negative attitudes (11, 68.8%).

There was a statistically significant relation between attitude and basic demographic characteristics of the studied group (P < 0.05)

Table 5: Association between attitude and demographic characteristics of the studied group

Variable	Attitude						Total	X^2 p-value
	Positive		Neutral		Negative			
	N	%	N	%	N	%		
Gender								
Female	57	75	28	93.3	8	50	93	10.9
Male	19	25	2	6.7	8	50	29	0.004*
Working unit								
Diabetic unit	60	78.9	15	50	2	12.5	77	12.8
Other units	16	21.1	15	50	14	87.5	45	0.002*
Specialization								
Senior house officer	34	44.7	24	80	15	93.8	73	18.2
Specialist	25	32.9	6	20	1	6.3	32	0.001*
Consultant	17	22.4	0	0	0	0	17	
Years of experience								
Less than 5 years	14	18.4	16	53.3	11	68.8	41	16.8
5-10 years	20	26.3	10	33.3	5	31.3	35	0.001*
More than 10 years	42	55.3	4	13.3	0	0	46	
Total	76		30		16		122	

DISCUSSION

It is well known that DM is significantly associated with an increased incidence and severity of PD, which can result in tooth loss. Because primary care physicians and specialists play a crucial role in the management of DM, it is important to assess their knowledge and attitude. Since improving periodontal knowledge can play an important role in the prevention of periodontal diseases.[19] The present study evaluated the knowledge and attitude towards understanding the significance of periodontal disease in primary and specialty clinics in Benghazi, Libya.

Our data shows gaps in physician's knowledge when it comes to understanding the differences between gingivitis and periodontitis. In our current study only (33%) acknowledged knowing the difference between the two. In a recent systematic review by Siddiqi et al. 2020, they showed medical professional knowledge of oral health and periodontal disease was only (55%).[20] In fact, some studies found medical professional knowledge that gingival bleeding was associated with the first signs of the disease process was as low as

(16.5%) Umeizudike et al. 2015,[19] while in other studies it was as high as (87%) Tasdemir and Alkan, 2015.[21]

Because physicians routinely interact with their patients more frequently than patients interact with their dentist, improving the existing knowledge base for periodontal awareness in this group could be a great starting point for re-education to help reduce gingivitis and periodontitis. The physicians in our study were aware (90%) that PD and DM are linked, which is much higher than what is reported in the literature for physicians understanding the interrelationship between the two diseases where it is estimated to be about (50-56%).[20,22-24] In a previous study, (56.7%) of the medical professionals were aware of the bidirectional relationship between systemic and periodontal diseases, while (38.6%) of them were aware of the relationship in one of either direction only.[25]

The awareness of the Libyan physicians' understanding that PD can affect glycemic control was over (70%) and equivalent to what is reported in the literature for other healthcare professionals which ranges between (65-76%).[26-28] In fact, (80%) of the physicians report seeing

patients with dental complaints and 84% refer their patients to dental services, but only (40%) refer to a dental specialist trained to treat PD. This rate of referral was substantially higher than what has been reported in a study by Umeizudike and colleagues.[19] In their study, the medical professionals only referred their patients to the dentist (33%) of the time. Even though the Libyan physicians had a high competence in oral health knowledge and confidence, it was not reflected in their clinical practice, where less than half of the physicians evaluated their patients for PD.

The current study results show a similar trend that has been found by other researchers, where the length of training and specialty have the most knowledge about PD. Researchers reported a higher understanding of senior-level physicians and specialists about the adverse effects of PD on systemic health.[29] The current study also evaluated the knowledge and attitudes of female and male physicians and found female physicians had better knowledge than males. A similar trend was also reported by Taani and colleagues.[30]

Although the current study offers foundational data for future research, it does have certain limitations that warrant discussion. Specifically, relying on a self-reported questionnaire could introduce social desirability and recall bias, despite the respondents' confidentiality assurances and the absence of personal identifiers. Also, the study was conducted in some clinics in the city of Benghazi and hence may not reflect the whole population in Benghazi.

CONCLUSION

This study showed that doctors who had just graduated had inadequate knowledge and attitudes about PD and how it implicated DM. Indeed, very few participants were aware that PD is one of the six problems that diabetic patients encounter. Therefore, we strongly recommend an interdisciplinary approach including dentistry experts, diabetes mellitus care specialists, and health workers to promote the health of diabetic patients.

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APPENDIX

Questionnaire parts:

Section 1: Demographic personal data:
Gender: Female / Male
Working unit: diabetic unit
Specialization: Senior House officer/specialist/consultant.
Years of experience: Less than 5 years / 5-10 years /> 10 years.

Section 2: Knowledge related questions:
Have you heard of the terms gingivitis and periodontitis?
If yes do you know what's the difference between them?
Are you aware of the specialties in dentistry?
Periodontal disease is caused by Plaque/ hereditary factors, both, don't know?
Do you know what dental plaque is?
Do you know what is the dental calculus?
Do you know the most common signs/symptoms of PD?
If yes mention: Bleeding, Redness, Mobility, bad breath and Change in the contour and size.
Do you think bad oral hygiene affects gum health?
10- Does smoking affect periodontal tissues?
11- Do you think periodontal diseases are more prevalent in diabetic patients?
12- Do you know that diabetes and periodontal disease are bidirectional way?
13- Do you think the modifiable risk factors for periodontitis are: diabetes mellitus (DM), smoking and stress?
14-Do you think that treatment of periodontal disease improves glycemic control?
15- Do you know that periodontal diseases have implications for certain systemic diseases/conditions like cardiovascular diseases, Pregnancy, low birth weight babies, and diabetes?
16- Do you think periodontal diseases are preventable?
17- Do you agree that oral health is an integral part of general health?
18- What are the complications of diabetes?

Last section: Attitude related questions:
Do you think it is important to know about periodontal diseases and oral hygiene?
Have you ever seen patients with dental complaints, gum lesions or other conditions?
Do you refer your patients to a dentist according to his/her oral evaluation?
Do you screen your patients for periodontal disease?
Do you refer your patient to a general dentistry practitioner, or to a periodontist?
Do you prescribe to your patient a mouthwash if he/she complains of bleeding or swollen gum?
Do you think lower socioeconomic status causes more prevalence of gum disease?
Do you agree that treatment of gum disease is included as a part of the general health assessment of the patient to improve overall health?
Do you accept to gain knowledge regarding periodontal diseases and implement health education regarding periodontal diseases in your practice and career?

Original article

Perception of Tooth Carving Sessions among Undergraduate Dental Students within the Faculty of Dentistry/University of Benghazi

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ABSTRACT

Background: In most dental schools, dental anatomy is taught in both theoretical and practical sessions during the first years of the Bachelor of Dental Surgery (BDS). This comprehensive course equips students with essential knowledge about dental morphology and occlusion. Furthermore, it serves as the fundamental basis for various clinical disciplines within dentistry, particularly those related to tooth restoration.

Aim: The study aimed to evaluate dental students' response to tooth carving sessions using wax blocks within the BDS curriculum at the Faculty of Dentistry in Benghazi and to assess the benefit of these sessions in improving their knowledge, and understanding of tooth morphology.

Methods: A three-month cross-sectional descriptive study was conducted in 2022 among 474 undergraduate dental students at the Faculty of Dentistry in Benghazi. We employed a convenience sampling approach to collect the data. The questionnaire was prepared using a semi-structured proforma, which included questions about participants' perceptions of tooth carving. Participants received a Google Form link through the telegram channel of the students. Descriptive statistics, including mean, standard deviation, percentage, and frequency were calculated using the SPSS 21.

Results: A total of 474 dental students participated in this study. Among them 94% practiced tooth carving using wax blocks during their practical sessions of dental anatomy. More than 70% of participants agreed that tooth carving enhanced their understanding of precise tooth morphology, dental anatomy, and proper occlusion relationships. Interestingly, 63% of the participants believed that live demonstration assisted with step-by-step video tutorials would be more effective in practicing tooth carving.

Conclusion: Based on the results, it is evident that most students at the Dental Faculty of Benghazi recognize the significant importance of tooth carving in their educational journey as future dental practitioners. This valuable data can inform the development of dental education programs, ensuring continued emphasis on teaching tooth carving during the undergraduate stage. However, as we move forward, exploring innovative approaches becomes essential. Incorporating newer techniques such as computer-aided platforms and video tutorials could enhance student engagement and provide a deeper understanding of tooth morphology and anatomy.

Keywords: *Tooth carving, Dental anatomy, Tooth morphology.*

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INTRODUCTION

Obtaining both foundational theory and practical skills is required for detection, management, and therapy of disorders affecting the oral cavity.[1] Dental anatomy is the study of anatomical and morphological components of human dentition (both permanent and deciduous) in addition to their placement and connection to the related oral structures.[2] Therefore, it is considered a fundamental course for establishing a firm dental background that will be needed in future dental procedures.[3,4]

Dental anatomy is taught in most dental schools around the world in two stages: theory and practical.[5] First, students learn theoretical material through lectures, reading textbooks, looking at models of teeth, and diagrams. Second, students carve a reference model of

various teeth using different materials (wax, soap, or plaster) in order to reinforce their psychomotor skills.[6] Both cognitive and psychomotor skills are involved in the process of learning tooth morphology through carving sessions.[7,8]

There are six surfaces on every tooth in the dental arch, and each surface has special characteristics that set it apart from the others. Learning to mimic the forms, convexities, and concavities particular to the type and location of teeth is the goal of dental wax carving.[9] Dental students can gain experience with hand instrumentation techniques and practice skills like grip, aiming, reaction, and finger dexterity through dental wax carving.[10] These skills are critical for the high level of precision required in the field of dentistry.[11,12]

Tooth carving is a crucial aspect of practicing dental anatomy and represents a substantial challenge for most dental students.[10,13] Different opinions concerning tooth carving exist among dental students who have already completed the tooth carving phase during undergraduate study. The use of this traditional method reveals some weak points that can cause frustration for students. Therefore, this study's goal was to analyze the perceived importance of tooth carving among undergraduate dental students during the preclinical stage.

MATERIALS AND METHODS

A cross-sectional descriptive study was conducted over three months in 2022 amongst undergraduate dental students at the Faculty of Dentistry, Benghazi, Libya using a web-based questionnaire. The ethical approval (APP No: 0173) was obtained from the Scientific Research Ethics Committee (SREC)-Faculty of Dentistry. A semi-structured self-administered questionnaire consisting of 15 open-ended questions related to the perception of tooth carving was prepared based on the literature review.[8] Several questions were included regarding various aspects of tooth carving sessions including the benefits of these sessions on improving the student understanding of tooth morphology. We also asked the students how these sessions enhance their manual dexterity. Several questions were about the suitability of the equipment, the workspace, session time and the carving material. Further inquiries focused on the marking standards and the practicality of life carving demonstrations. Moreover, they have been asked about how helpful the carving session is in fixed and restorative prosthodontic sessions. Finally, they have been asked if they have any other comments or suggestions for future improvement. The questionnaire was set using Google Forms via docs.google.com/forms and the link

was sent to the enrolled participants through the telegram channel of the department. The participants were selected to be from the second year, who had already completed their preclinical tooth carving stage in the first academic year of BDS. No personal information was collected, and the participation was totally voluntary. The filled questionnaires were removed from Google Forms and exported to Microsoft Excel 2019. Only completely filled Questionnaires were included in the study. Descriptive statistics, mean, standard deviation, frequency and percentage were calculated using IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA).

RESULTS

The Google link to the questionnaire was shared with 474 students, and 271 of them responded, contributing to the final analysis. This resulted in a response rate of 57.17%. Among the participants, 207 (76%) were female, while 64 (24%) were male students enrolled in the second year at the Dental Faculty of Benghazi University.

Of the total number of participants only 86 (31.7%) carved a full set of permanent teeth while the majority of the students have carved only a few permanent teeth 185 (86.2%). More than half of the student believed that the crown is the most important part of the tooth 146 (53.8%) while the other thought that both the crown and root are very important. About two-thirds 205 (75.6%) agreed that tooth carving enhanced their understanding of tooth morphology **(figure 1)**. Moreover, (67.5%) of participants found carving sessions very helpful in understanding occlusion.

When they were asked if the tooth carving was helpful in restorative and prosthodontics lab sessions in the second year 108 (39.8%) answered yes to this question. About 156 (57.5%) of dental students agreed that the total time allowed for the course per year is relevant, while 124 (45.7%) assumed that the time allowed for each carving session wasn't enough for them to finish the tasks **(figure 2)**. More than half of the participants 169 (62.3%) believed that tooth carving shouldn't be continued as an assessment parameter for first-year dental students, and about the same percentage (63%) thought that using video demonstration instead would be more helpful.

Regarding comments and feedback from the students, most comments were focused on criticizing the smaller number of tutors in contrast to the number of students in each carving session. A few of them came up with different ideas like teaching the carving as step-by-step videos which could be delivered to the students to use for continuous practicing at home.
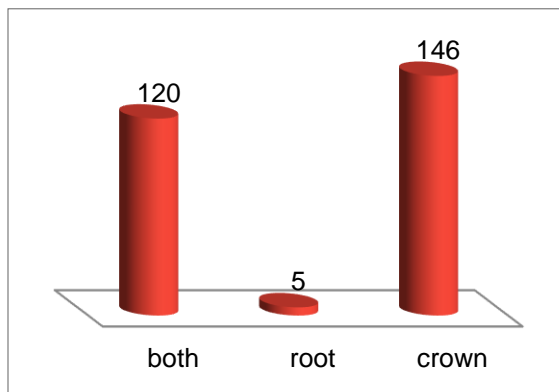
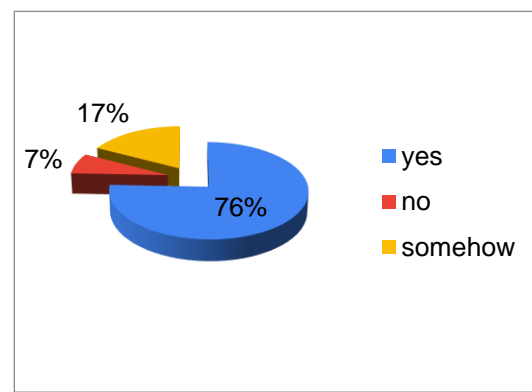**Figure 1:** The most important part in the tooth: participants insights

Figure 2: Tooth carving helped in better understating of tooth morphology: participants insights
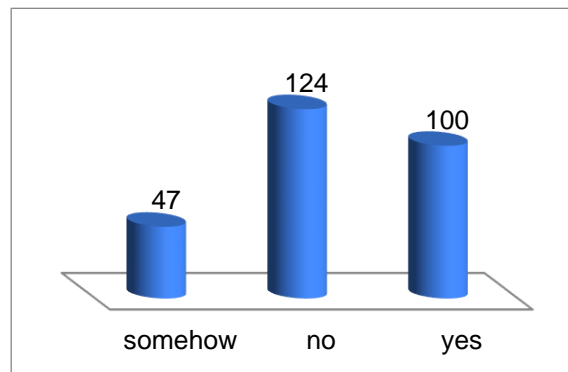

Figure 3: Participants response about time sufficiency of tooth carving sessions

DISCUSSION

Within the context of dental education, it is conventionally expected that dental students acquire a comprehensive understanding of scientific principles and develop exceptional skills related to tooth morphology. These competencies are crucial for dentists, as they enable precise restoration of lost tooth structures, particularly in the fields of operative dentistry and prosthodontics.[14] Comprehending tooth morphology plays a pivotal role in various aspects of dentistry, including endodontic therapy, forensic investigations, anthropological research, and the prevention of dental diseases.[15,16] This makes dental anatomy a fundamental course that fosters the seamless integration of these diverse specialties.

At the faculty of Dentistry, Benghazi, students learn about tooth anatomy through lectures and by carving a tooth-sized wax block following a tutor's demonstration. To make improvements, we wanted to know how students felt about the carving exercise and how helpful it was for them in their practice. More than half of the students believed that the crown is the most important part of the tooth 146 (53.8%) which is contrary to the Kathmandu study, [17] where dental students carved only the crown (16.2%) while (82.7%) of respondents carved both the crown and the root. However, the majority of students felt that the carving of the tooth's crown and root was equally significant.[17]

In the current study, fewer than half of the students (39.8%) said that carving sessions were useful in the restorative and prosthodontics lab sessions. This percentage was less than that of studies conducted in Kathmandu and West India by Chaulagain et al, and Nayak et al, (73.1% - 62.6%) respectively.[8,18] More than half of the participant 169 (62.3%) in our study have agreed that carving sessions were useful in all. These findings align with a study conducted at Baqai Dental College in Karachi, where approximately 66% of students reported the benefits of carving sessions.[19]

Furthermore, another study revealed that around 75% of students found practicing tooth carving valuable for distinguishing between normal and anomalous teeth, as well as replicating tooth morphology in a laboratory setting. These results challenge the assertions made by some authors who advocate for the removal of tooth carving from undergraduate dental curricula, citing it as a waste of time, effort, and resources.[21]

Among the students in this study, a significant percentage (63%) thought that watching a step-by-step video demonstration of tooth carving would be more helpful as it can be repeated when needed. A similar result was found in another study conducted by Yara Oweis et al., where a large number of students agreed that combining live carving with video demonstrations of tooth carving would be highly beneficial.[22-24] This finding may reflect the fact that the students at the Faculty of Dentistry in Benghazi perceive inadequate training and a need for additional repetition. The underlying reasons may include a scarcity of teaching staff for laboratory training, limited facilities, and the overwhelming number of dental students on the faculty (over 300 in a building designed for a maximum of 50). Consequently, educational quality and training have been compromised.[25-27]

Two-thirds of participants in the current study agreed that the carving session enhanced their conception of tooth morphology and occlusion relationship. Similar findings were reported in Moretto et al, study.[28] The current study emphasized that carving exercises should remain as part of the dental anatomy course, but some new methods, such as video-based carving tutorials, and computer-assisted learning programs should also be introduced.

LIMITATIONS

As with any other questionnaire-based studies, using questionnaires offers ease of use and access to substantial data, they can raise some challenges relating to sampling, instrument design, low response rates, biased self-selection and over-claims on data from a small sample.[29] Also, the use of Google Form questionnaires may significantly affect the response rate. Another limitation of the study was its focus solely on Benghazi dental faculty students, which prevents the generalization of the findings beyond this specific group.

CONCLUSION

This study highlights the students' inclination toward tooth-carving exercises. Among the primary objectives of these exercises, students acknowledged their role in enhancing manual dexterity, deepening tooth identification knowledge, and refining clinical skills. The effective teaching of dental anatomy through this carving module appears to benefit dental students significantly.

However, there is a need for improvement in the BDS curriculum at the Faculty of Dentistry in Benghazi. It is recommended to explore innovative approaches, such as computer-aided platforms and video tutorials, to enhance student engagement. Continuously introducing fresh ideas and teaching strategies will foster a more dynamic and effective learning environment for aspiring dentists.

ACKNOWLEDGMENT

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Periodontal Health Knowledge Levels among Libyan Adult Patients Attending Public and Private Dental Clinics: A Comparative Study

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ABSTRACT:

Background: Periodontal diseases can result in premature tooth loss; However, early detection, adherence to oral hygiene practices, and regular prophylaxis can help prevent or minimize the severity of periodontal diseases. Additionally, increased awareness and knowledge about periodontal health can positively influence behaviors related to oral health.

Objectives: This study aimed to assess and compare the level of knowledge about periodontal oral health among patients attending public and private dental clinics and to investigate the relationship of their knowledge with Socio-demographic factors.

Methods: A cross-sectional study was conducted to assess periodontal health knowledge among Libyan adults. Researchers interviewed 180 adults aged 18 years and older face-to-face. The study focused on demographic factors such as age, gender, education level, occupation, and clinic type. Additionally, a chi-square test was used to explore differences in periodontal health knowledge between patients attending public and private dental clinics, considering age, gender, education, and occupation

Results: Socioeconomic status correlates with knowledge about periodontal signs, symptoms, etiology, and prevention. Females, those with higher education, and better economic status had significantly higher periodontal health knowledge. Knowledge increased with occupation level. The 41-60 age group and university-educated individuals demonstrated higher periodontal health knowledge. Females in public clinics were more aware of etiology than males. In private clinics, both genders showed an inverse association regarding the same question, with higher periodontal knowledge found among males.

Conclusion: The study showed differences in periodontal knowledge among patients attending different types of dental clinics, with variations based on age, gender, education, and occupation. Better socio-economic status is associated with better knowledge.

Key Words*: Periodontal health, knowledge, Awareness, Periodontal disease, Public dental clinic, Private dental clinic, Plaque control.*

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INTRODUCTION

Periodontal diseases affect people of all races and socioeconomic levels and age groups.[1,2] Periodontal disorders are mainly caused by dental plaque and can eventually lead to tooth loss due to damaging supporting periodontal tissues. Adequate oral hygiene motivation and regular prophylaxis can prevent or lessen the severity of periodontal diseases.[3] Furthermore, increased periodontal health awareness and knowledge have been shown to positively impact periodontal health practices and behaviors. Likewise, as good periodontal outcomes are dependent on patient knowledge and attitude toward dentistry in general, and periodontal health in particular, it is imperative to understand the public's attitude and knowledge toward keeping a disease-free oral cavity.[4] In short, people's periodontal health knowledge reflects their comprehension of its relevance, affecting their periodontal health management. Worldwide studies have been conducted

to assess diverse populations' knowledge and practice of periodontal health.[5]

Several research have linked university education, and higher socioeconomic status to better periodontal health knowledge.[6, 7] Plaque-induced periodontal diseases are prevalent, even though they can be easily prevented and treated by removing microbial plaque.[8] Untreated periodontitis leads to tooth loss in many patients who might lack an understanding of the causes and prevention of periodontal disease.

Libya's oral health care system includes both public and private dentists.[9] In contrast to public dental clinics, private dental clinics provide all dental services. In Libya, little research was conducted to explore the knowledge and awareness of dental patients about periodontal health, and no studies compared periodontal knowledge levels between public and private clinic patients. Given the fact that more than half of the Libyan population needs attention to their oral health care,[9-13] this study aimed to assess patients' knowledge of periodontal health in public and private dental clinics and to investigate the possible relationship between knowledge and socio-demographic characteristics.

MATERIALS AND METHODS

Study design
This cross-sectional study was conducted in Benghazi from June 1 to August 30, 2020. The questionnaire was applied face-to-face by three well-trained interviewers. Two of them were hygienists and one was a dentist. The survey used structured questions. The questions were close-ended. A minimum sample size of 97 participants was considered appropriate for this cross-sectional investigation to estimate the proportion having appropriate knowledge at 0.05 precision. This number was doubled to compensate for the sample non-response, The participants were selected from patients who sought dental care at both public and private clinics using a convenience sampling approach from randomly selected clinics. The inclusion criteria encompassed all patients aged 18 years and older who attended both public and private dental clinics during the study period and consented to be interviewed. At the end of the questionnaire, respondents had the opportunity to add comments. The researcher distributed the surveys to patients in their wards, and the investigator collected and filled them for subsequent analysis. This cross-sectional study took place in Benghazi, Libya's second-largest city, at both public and private dental clinics, which collectively receive approximately ten new patients daily. The outcome variables were derived from self-reported questions related to periodontal health knowledge, considering factors such as age, gender, education, and occupation

Study instrument
This study included twenty-four questions. Twelve of them investigated periodontal disease, including its origin, signs, symptoms, risk factors, health problems, and bleeding during brushing. Socioeconomic indicators considered were education level (high, low, or never educated) and occupational classification (professional, intermediate, manual, or never worked) based on the National Statistics Socio-economic Classification (NS-SEC 3).[15] Other variables included age groups (18-40, 41-60, and over 60), gender, and types of dental clinics (private or public). A group of specialists reviewed the questionnaire for clarity, simplicity, relevance, and necessity. With input from five clinicians, the final instrument was refined, rectified, or removed. The second draft was then tested on 15 dental clinic patients.

Statistical analysis
Statistical Package for Social Sciences (SPSS 22) was used to compute the statistics. Descriptive statistics were conducted for all variables in the analysis. The knowledge of periodontal health was analyzed within socioeconomic status and patient profile. The Chi-Square test was performed to compare periodontal knowledge between patients from public and private dental clinics based on age, gender, education, and occupation. All statistical tests were performed at P<0.05.

RESULTS
Data collection involved 180 patients, and their responses to the periodontal health knowledge questionnaire were tabulated and graphed.

Table 1: Demographic characteristics of the study participants (n=180).

Variables	Classification	N (%)
Gender	Male	69 (38.3)
	Female	111 (62.7)
Age	18-40 years	100 (55.6)
	41-60 years	67 (37.2)
	More than 60 years	13 (7.2)
Occupation	Unemployment	81 (45)
	Profession employment	22 (12.2)
	Intermediate employment	66 (36.7)
	Manual employment	11 (6.1)
Education degree	No Education	42 (23)
	Lower education	77 (43)
	Higher education	61 (34)
Dental clinic type	Public clinic	90 (50)
	Private clinic	90 (50)
	Total	180 (100)

The study analyzed flossing habits among participants. Dental floss was used twice daily by 2.3% of individuals, once daily by 14.4%, and not at all by 83.3% **(Figure 1)**. In **Figure 2**, while brushing was the most common cleaning method, 61.1% of subjects brushed their teeth twice daily, 28.9% brushed once daily, and 10% did not use it.
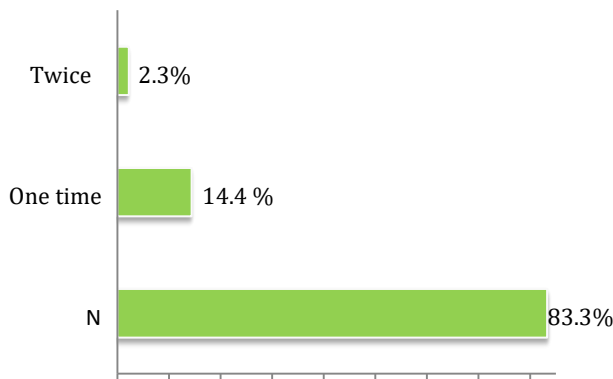
Figure 1: Distribution of use of dental floss
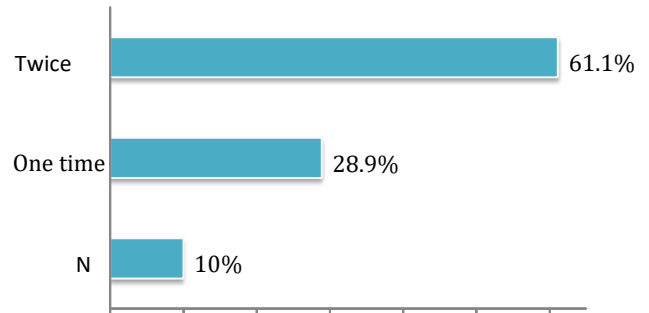
Figure 2: Distribution of use of toothbrush

In the study, a statistically significant difference between genders was observed. Females attending public clinics demonstrated greater awareness of issue 6: 'Do you think that the initiating factor of periodontal disease is a dental calculus?' (p=0.001) and question 5: 'Do you think that the initiating factor of periodontal disease is a bacterial plaque?' (p=0.014). However, no significant gender differences were detected in private clinics for the same questions. Male patients in private practice had better knowledge of the correct answer to question 4: 'Do you think that dry mouth can cause bad breath?' compared to female patients. On the other hand, female patients attending public practice were more aware of the same question than male patients. Additionally, the reasons for tooth loss significantly differed between male and female patients, particularly in cases of periodontal disease (as shown in **Table 2**)

Table 2: Responses to periodontal health knowledge questions among different sex groups based on clinic type

Sr.	Questions	Clinic	Gender	Response				p-value
				Yes		No		
				N	%	N	%	
1.	Is there any relation between periodontal health and general health?	Public	Female	27	45.8%	32	54.2%	0.216
			Male	10	32.3%	21	67.7%	
		Private	Female	41	78.8%	11	21.2%	
			Male	25	65.8%	13	34.2%	
2.	Is there any relation between periodontal disease and diabetes?	Public	Female	24	40.7%	35	59.3%	0.908
			Male	13	41.9%	18	58.1%	
		Private	Female	33	63.5%	19	36.5%	
			Male	25	65.8%	13	34.2%	
3.	Is there any relation between periodontal disease and heart disease?	Public	Female	18	30.5%	41	59.5%	0.137
			Male	5	24.2%	26	75.6%	
		Private	Female	18	34.6%	34	65.4%	
			Male	17	44.7%	21	55.3%	
4.	Do you think that dry mouth can cause bad breath?	Public	Female	34	57.6%	25	42.4%	0.046
			Male	11	35.5%	20	64.5%	
		Private	Female	34	65.4%	18	34.6%	
			Male	32	84.2%	6	15.8%	
5.	Do you think that the initiating factor of periodontal disease is a bacterial plaque?	Public	Female	36	61%	23	39%	0.014
			Male	8	25.8%	23	74.2%	
		Private	Female	43	82.7%	9	17.3%	
			Male	31	81.6%	7	14.4%	
6.	Do you think that the initiating factor of periodontal disease is a dental calculus?	Public	Female	36	61%	23	39%	0.001
			Male	8	25.8%	23	74.2%	
		Private	Female	43	82.7%	9	17.3%	
			Male	31	81.6%	7	18.4%	
7.	Do you think that the most indicating sign of periodontal disease is gingival bleeding?	Public	Female	38	64.4%	21	35.6%	0.079
			Male	14	45.2%	17	54.8%	
		Private	Female	46	88.5%	6	11.5%	
			Male	30	78.9%	8	21.1%	
8.	Do you think that use of toothbrush and dental floss can prevent periodontal disease?	Public	Female	29	49.2%	30	50.8%	0.608
			Male	17	54.8%	14	45.2%	
		Private	Female	39	75%	13	25%	
			Male	32	84.2%	6	15.8%	
9.	Do you think that a mouthwash from the pharmacy can play an important role in reducing periodontal disease?	Public	Female	26	44.1%	33	55.9%	0.331
			Male	17	54.8%	14	45.2%	
		Private	Female	45	86.5%	7	13.5%	
			Male	34	89.5%	4	10.5%	
10.	Do you think that regular visits to the dentist at least every six months can reduce periodontal disease?	Public	Female	40	67.8%	19	32.2%	0.008
			Male	12	38.7%	19	61.3%	
		Private	Female	48	92.3%	4	7.7%	
			Male	36	94.7%	2	5.3%	
11.	Do you think that the main causes of tooth lose are periodontal diseases?	Public	Female	34	57.6%	25	42.4%	0.046
			Male	11	35.5%	20	64.5%	
		Private	Female	46	88.5%	6	11.5%	
			Male	31	81.6%	7	18.4%	
12.	Do you think that the initiating symptom of periodontal disease is pain?	Public	Female	40	67.8%	19	32.2%	0.037
			Male	14	45.2%	17	54.8%	
		Private	Female	82.7	82.7%	17.3	17.3%	
			Male	30	78.9%	8	21.1%	

p-value<0.05=Significant

Table 3 compares participants' ages and knowledge levels among clinics. Those aged 41-60 at a private clinic replied yes to question 3 more than those aged 18-40 and over 60. In the public clinic, persons aged 41-60 years old replied yes to question 3 more than those of other ages (*p*-value=0.04). Patients with greater education in the private sector were substantially more likely to answer questions about risk factors and plaque control than patients with lower education or illiteracy.

Table 3 also shows that intermediate personnel in both clinics were more conscious of answering multiple questions. In other words, they replied yes to questions 7, 9 and 10, while the public answered properly to question 4. This finding shows that most intermediate employees are aware of the signs and symptoms of periodontal disease. The 2-test findings show that the differences found in both clinics by occupation level are statistically significant (*p*-value 0.05).

Table 3: Distribution of significance responses to periodontal health knowledge questions within occupation groups, age groups and education groups based on clinic type

Questions	Variables	Clinics	Classification	Response Yes N	Yes %	No N	No %	*p*-value
Q4. Do you think that dry mouth can cause bad breath?	Occupation groups	Public	Unemployment	21	45.7%	25	54.3%	0.013
			Professional	4	57.1%	3	42.9%	
			Intermediate	20	66.7%	10	33.3%	
			Manual	0	50%	7	50%	
		Private	Unemployment	26	74.3%	9	25.7%	
			Professional	13	86.7%	2	13.3%	
			Intermediate	23	63.9%	13	36.1%	
			Manual	4	100%	0	0%	
Q7. Do you think that the most indicating sign of periodontal disease is gingival bleeding?	Occupation groups	Public	Unemployment	27	58.7%	19	41.3%	0.006
			Professional	3	42.9%	4	57.1%	
			Intermediate	19	63.3%	11	36.7%	
			Manual	3	42.9%	4	57.1%	
		Private	Unemployment	30	85.7%	5	14.3%	
			Professional	12	80%	3	20%	
			Intermediate	33	9.7%	3	8.3%	
			Manual	1	25%	3	75%	
Q10. Do you think that regular visits to the dentist at least every 6 months can reduce periodontal disease?	Occupation groups	Public	Unemployment	26	56.5%	20	43.5%	0.003
			Professional	3	42.9%	4	57.1%	
			Intermediate	21	70%	9	30%	
			Manual	2	28.6	5	71.4	
		Private	Unemployment	32	91.4%	3	8.6%	
			Professional	15	100%	0	0%	
			Intermediate	35	97.2%	1	2.8%	
			Manual	2	50%	2	50%	
Q3. Is there any relation between periodontal disease and heart disease?	Age groups	Public	18-40 years	9	22%	32	78%	0.007
			41-60 years	12	29.3%	29	70.7%	
			More than 60	2	25%	6	75%	
		Private	18-40 years	16	27.1%	43	72.9%	
			41-60 years	16	61.5%	10	38.5%	
			More than 60	3	60%	2	40%	
Q10. Do you think that regular visits to the dentist at least every 6 months can reduce periodontal disease?	Age groups	Public	18-40 years	23	56.1%	18	43.9%	0.001
			41-60 years	29	70.7%	12	29.3%	
			More than 60	0	0%	8	100%	
		Private	18-40 years	55	93.2%	4	6.8%	
			41-60 years	24	92.3%	2	7.7%	
			More than 60	5	100%	0	0%	
			No Education	1	11.1%	8	88.9%	

Q2. Is there any relation between periodontal disease and diabetes?	Education groups	Public	Low education	19	42.2%	26	57.8%	0.008
			High education	17	47.2%	19	52.8%	
		Private	No Education	0	0%	3	100%	
			Low education	17	53.1%	15	46.9%	
			High education	41	74.5%	14	25.5%	
Q9. Do you think that a mouthwash from the pharmacy can play an important role in reducing periodontal disease?	Education groups	Public	No Education	5	55.6%	4	44.4%	0.022
			Low education	20	44.4%	25	55.6%	
			High education	18	50%	18	50%	
		Private	No Education	3	100%	0	0%	
			Low education	24	75%	25	7.7%	
			High education	52	94.5%	3	5.5%	

p-value<0.05=Significant

DISCUSSION

To the best of our knowledge, no previous studies have examined the level of knowledge of gingival and periodontal diseases among patients of both public and private dental clinics. This study presents the first comparison of patient's knowledge in this regard.

The findings of this research reveal differences in periodontal knowledge among patients attending different types of dental clinics, with variations based on age, gender, education, and occupation. While most individuals recognized the importance of using a toothbrush to prevent periodontal disease, more than two-thirds of the participants were unaware that dental floss also plays a crucial role in preventing such diseases. This result highlights the need to improve knowledge about dental floss and promote its usage.

Our hypothesis suggests that patients attending private dental clinics possess greater knowledge about periodontal health compared to those attending public dental clinics, likely due to the higher socioeconomic status (SES) of private patients. Interestingly, both higher and lower educated patients attending private clinics demonstrated better knowledge about periodontal health, which supports our hypothesis. However, it's worth noting that despite this knowledge, only 2% of individuals reported using dental floss. This finding contrasts with the high rate of dental floss usage (44%) reported in developed countries such as Canada.[16] This may be attributed to the educational programs implemented in Canada, which our society lacks. Thus, public education and motivation are urgently required to adopt this effective oral healthcare strategy.

Previous research has shown that poor income, ethnicity, and education play a role in periodontal disease development.[17] We are unaware of any research on the importance of periodontal health knowledge. Our study had a flaw: there is no international consensus on periodontal health knowledge assessment. Our study used straightforward, easy-to-understand questions to define periodontal health knowledge. No open-ended questions were asked. To reduce the chance of misinterpretation, the questions were answered as yes or no.

Comparing periodontal knowledge levels among different occupational categories, professionals and intermediate employees had higher levels, while jobless had lower levels. Graduates have a stronger awareness and knowledge of periodontal disease than illiterates. Our study observed a higher prevalence of periodontitis among individuals with lower levels of education, income, and occupation, which aligns with findings from other studies.[18] Furthermore, our research revealed that patients with low socioeconomic status and education may not be aware of the importance of oral health education, which may be explained by their inability to afford oral hygiene products.[19] Additionally, this study revealed that well-educated professionals who will build our modern civilization are no better than the general population in terms of educational knowledge. overall, the level of awareness and knowledge about oral health and diseases remains suboptimal.

In a South Australian study, 96% of respondents believed that frequent teeth brushing helps prevent gum disease.[20] Brushing and flossing were rated as the best approach to avoid gum infections by 65% of our respondents. Apart from media knowledge, most of them acquired basic dental instruction during early school life which emphasizes brushing. However, just half of the responders recognized that brushing their teeth before bedtime is useful. This means further education is needed.

The study found that age is associated with periodontal knowledge, which aligns with similar findings by Diofode and colleagues.[21] Contrary to findings in Jordan [6] and Sweden [22], there was no clear association between periodontal knowledge level and age.

In our study, women in public clinics had higher periodontal knowledge about how dry mouth can lead to bad breath, and they understood that bacterial plaque

and dental calculus play a crucial role in initiating periodontal disease. Additionally, these women were aware that periodontal diseases are the primary cause of tooth loss. A similar observations among Japanese teenagers[23] which implies that women prioritize dental health more than males, and are more open to receiving pertinent information.[24]

Overall, we found a notable discrepancy in periodontal knowledge based on educational levels, with higher education being positively associated with greater knowledge. This highlights the crucial role of oral health education. A study by Khanal et al. also emphasized how education level impacts oral hygiene awareness.[27] Furthermore, our research aligns with a Swedish study that demonstrated higher education levels correlate with increased knowledge about oral health among adults.[25]

Conclusion

The study showed differences in periodontal knowledge among patients attending different types of dental clinics, with variations based on age, gender, education, and occupation. Better socio-economic status is associated with better knowledge.

Practice implications

Long-term awareness programs are needed to improve the knowledge, attitudes,and behaviors among patients with different socioeconomic levels toward periodontal health and disease. Health education programs should place moreemphasis on the causes and manifestations of periodontal disease. All target groups must be educated to avoid any variation between different social class levels.

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Age Estimation in Libyan Children Based on Dental Panoramic Radiography

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ABSTRACT

Background: Age estimation plays a key role in the human identification process, and in guiding police investigations. Tooth development is widely used in determining age and state of maturity. Dental age (DA) is of high importance in forensic and pediatric dentistry and also orthodontic treatment planning.

Objective: The aim of this study was to assess the accuracy of the Cameriere method in estimating chronological age (CA) of a Libyan sample of 6-year-old up to 13-year-old children through analysis of panoramic radiographs on teeth, considering the relationship between age and measurements of open apices teeth.

Materials and methods: Orthopantomographic images of 156 radiographs were selected for the study of which 76 belonged to boys and 80 girls children. The dental age of the subjects was determined through the Cameriere method. Differences and correlations between chronological and dental ages were assessed by paired t-tests and Pearson's correlation analysis, respectively. Multiple regression analysis was used to predict chronologic age in Libyan from 6-13 years children population.

Results: A high positive correlation was found between chronologic age and dental age (as assessed by Cameriere's formula) with r values 0.882, 0.975, and 0.758 for the total, girls and boys study population, respectively. The mean dental age assessed by Cameriere's method was significantly lower than the chronologic age in the Libyan population with boys and the total study population ($p < 0.05$). Six out of nine parameters were significantly associated with chronologic age ($R2=0.996$, $F (6,155)= 2792.023$, $p<0.01$).

Conclusion: Our findings demonstrate that Cameriere's method is a robust tool for age estimation. These results underscore the high accuracy and importance of assessing dental development for precise age estimation. Based on this research, we can conclude that Cameriere's method is suitable for dental age estimation in Libyan children.

Keywords: *Age estimation, Panoramic X-ray, Cameriere formula*

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INTRODUCTION

The most prevalent measure of the aging process is typically determined by chronological age, which may not always be ascertainable or subject to manipulation. The identification of deceased individuals holds significant importance within the legal context, yet it can present a formidable challenge due to the multitude of potential circumstances.[1-4] Age estimation plays a key role in the human identification process and guides police investigations. Due to the growing incidence of natural disasters, the accurate age estimation narrows the search within the possible victims.[1] Age also plays a crucial role in pediatric dentistry, as well as in the process of treatment plans for orthodontic patients and performing surgeries. Evaluation of skeletal age using radiological techniques is a suitable criterion for assessing individual biological maturation and is normally applied to answer forensic, pediatric, and orthodontic questions.[2, 3] Although skeletal maturation can play an important part in determining age as an orderly process, teeth and hand-wrist areas are the most common indicators of age in growing children.[4]

Several studies have highlighted that mineralization serves as the main tool to determine the correspondence between biological age and

chronological age. Since 1950, many researchers have been induced to concentrate on mineralization due to the routine use of X-rays.[5] Many authors have developed scoring methods in order to assess dental age using dental calcification stages of permanent teeth.[6-9]

Demirjian and his colleagues studied one method of age estimation. Their original sample comprised 1,446 boys and 1,482 girls of French–Canadian origin, and their data were later compared with other sample groups from several nationalities.[5] Most of the results revealed the fact that the standards of dental maturation described by Demirjian et al. (1973) are not always suitable for these countries.[5] More recently, in 2006, Cameriere et al.[2] presented a method for assessing chronological age in children based on the relationship between age and measurement of open apices in teeth, which gave reliable estimates of the ages of 455 Italian-Caucasian children. In the same year, the same authors also published a paper with additional samples from Kosovo and Slovenia, for a total number of 1,100 children.[10]

In recent times, accurately estimating the age of living individuals has become increasingly relevant. This is particularly crucial for those lacking legal documentation of birth, especially when they are suspected of committing crimes and their age needs to be assessed to determine importability. In Libya, there is scarce information about age estimation using Cameriere's method except for one study.[11] Those studies have only examined the third molars based on Cameriere's role in determining if a subject is an adult or not in the Libyan population. There is a lack of information on the validity of Cameriere's method in the Libyan population. Hence, this study aimed to assess the reliability of the Cameriere method in determining the chronological age of a sample of Libyan children. Additionally, if the method proves inaccurate, the study seeks to develop a new algorithm specifically tailored for estimating the chronological age of Libyan children.

MATERIALS AND METHODS

Study sample

The present cross-sectional study used prospective evaluation of orthopantomographs of children who attended private dental clinics from different Libyan cities named Benghazi, Tripoli, Tobruk and Albyida. All patients' digital radiographs were obtained by a digital orthopantamograph (Planmeca® ProOne X-ray unit, Planmeca Oy, Asentajankatu 6, FIN-00880, Helsinki, Finland). The same brand Planmeca® ProOne X-ray unit is consistently used in all the cities included in this research. All the digital X-ray images were viewed and calibrated using a computer with Planmeca Romexis 22 imaging software revision 2.3.0. Provided with the Planmica digital X-ray **(Figure 1)**.

The orthopantomographs of 156 healthy Libyan children (76 boys, 80 girls) aged between 6 and 13 years old were analyzed. Only radiographs that satisfied the inclusion criteria were included in the study. All collected orthopantomographs were analyzed to correlate chronologic age with dental age as estimated by Cameriere's method in the Libyan population. Here is a variable equal to 1 for boys and 0 for girls, N0 is the number of teeth with closed apices, x1 is the ratio of apex width and tooth length of lower left central incisor and so on till x7 for the second permanent molar, s is the summation of all teeth ratio (x1, x2 …. x7). The A/L ratio for each tooth (x1 to x7): the ratio of open apex width to crown length, which is used to correct potential errors in magnification and angulation.

Data collection

The personal information obtained from the case records included the patient's gender, date of birth and the date the radiograph was taken. The date of birth was recorded based on information provided by the parents. The difference in time between the radiograph date and the date of birth was used to determine the patient's chronological age. The chronological age at the time of the radiographic examination was recorded in completed years and months. If the difference in days was more than 15, it was rounded up to the nearest month. All patients' radiographs were taken using a digital orthopantomograph machine. The digital X-ray images were viewed and calibrated using computer software provided by the X-ray unit. The measurements on the panoramic radiograph were focused on the lower teeth, as measuring the upper teeth can be challenging due to overlapping roots or other structures. Since the growth pattern is usually symmetrical, measurements were taken from only one quadrant (lower left). An example radiograph displayed measurements for reference **(Figure 1).**
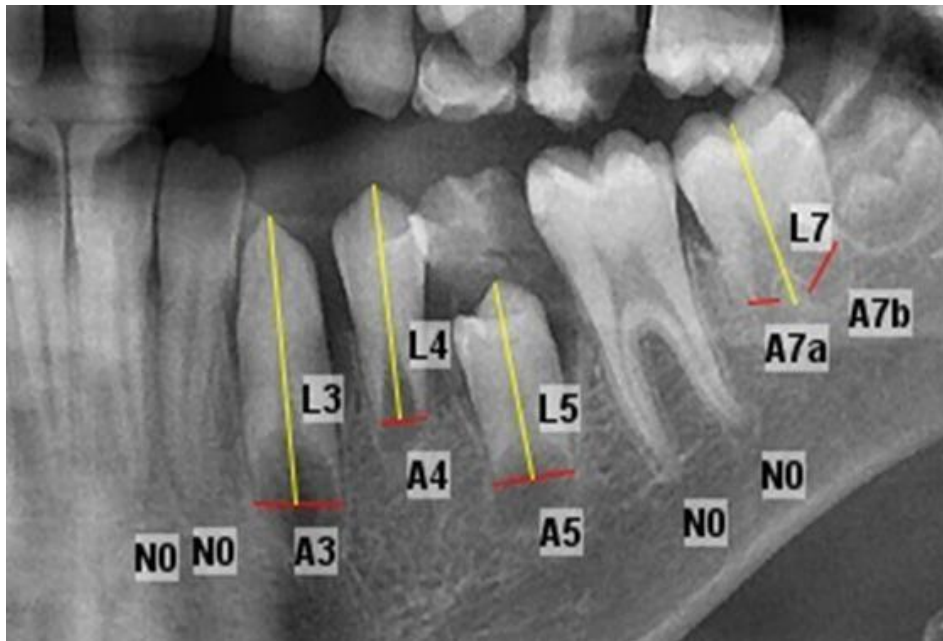
 Figure (1): A panoramic image demonstrating the measurements for the Cameriere's formula. The measurement of tooth apices A1 to A5 is the distance between the inner sides of single-rooted teeth. For teeth with two roots, measure the sum of distances (A6a + A6b) between the inner sides of the two open apices. L1 to L7 represent the tooth length measurements.

Inclusion Criteria
The study included Libyan patients aged between 6 and 13 years old who had undergone a panoramic radiograph investigation. Only children without any medical conditions were considered for inclusion.

Exclusion Criteria
Patients who did not hold Libyan nationality, those above the age of 13 or below the age of 6 were excluded from the study. Additionally, individuals with incomplete medical or dental histories, documented tooth extraction or agenesis (particularly in the left lower quadrant), distorted radiographs, unclear radiographs, or radiographs showing evidence of periapical lesions, carious teeth, fractured teeth, or internal tooth resorption were excluded. Patients with systemic diseases or congenital anomalies were also excluded. Premature birth and hypodontia of permanent teeth (excluding third molars) or hypertonia, as well as those with a history of orthodontic treatment, were excluded. Incorrect neck position and anteroposterior error (chin tipped down) radiographs were excluded. Prior to accessing the patient data, permission was obtained, and all personal details were de-identified.

Statistical analysis
For this study, 20 radiographs were randomly selected and measured by two independent observers. After two weeks, the same radiographs were re-examined to assess measurement consistency. The correlation coefficient between the two observers for open apices measurements was 0.96, and within each observer independently was 0.99 ($p < 0.05$). The data was analyzed using SPSS version 23 software. Pearson's correlation analysis examined the relationship between study variables and chronologic age. A paired t-test compared chronologic age with dental age using the Cameriere method. Multiple regression analysis determined statistically significant variables in the mixed model. Step-wise regression analysis was conducted to create a more precise equation for predicting chronologic age ($p < 0.05$).

To assess inter-observer error, a new random sample of 50 individuals was re-examined after three weeks by a second examiner. This subsample was also measured by a third observer with no prior experience. The inter-observer reliability of the sum of normalized open apices [1] was studied using the concordance correlation coefficient, and the inter-observer reliability of the number of the seven left permanent mandibular teeth with complete root development (N0) was measured using Cohen's Kappa coefficient (values range from 0 to 1, with 0 indicating chance agreement and 1 indicating perfect agreement).

RESULTS
The study analyzed a total of 156 radiographs, with 76 from male children and 80 from female children. The objectives of the study focused on the correlation between chronologic age and dental age determined by Cameriere's formula. The results revealed a significant positive correlation between the two. For girls, the correlation coefficient was 0.975, for boys, it was 0.758, and for the overall study population, it was 0.882. These findings are summarized in **Table 1**.

Table 1: Comparison of Chronologic and Dental Age by Cameriere formula.

Age	N	Mean	SD	Mean Diff.	SD Diff.	Paired t	p-value	R
CA-Total	156	9.025	2.160	0.256	1.050	3.039	0.003**	0.882
DA-Total	156	8.769	2.159					
CA-Girls	80	9.053	2.273	0.107	0.521	1.840	0.070	0.975
DA-Girls	80	8.946	2.343					
CA-Boys	76	8.995	2.050	0.412	1.395	2.573	0.012*	0.758
DA- Boys	76	8.583	1.947					

*Statistically significant at 5%, **statistically significant at 1% levels of significance.

There was a significant correlation between all radiographic parameters (x1 to x7) and chronological age, as determined through statistical analysis ($p < 0.05$). Surprisingly, no significant correlation between gender and chronological age was observed ($p > 0.05$). as indicated in **Table 2**.

Table 2: Correlation between chronological age with radiographic measurements.

Variables	Correlation between chronological age with		
	r-value	t-value	p-value
Gender	-0.084	-1.046	0.295
N_0	0.900	25.623	0.000**
x_1	-0.373	-4.989	0.000**
x_2	-0.525	-7.655	0.000**
x_3	-0.909	-27.066	0.000**
x_4	-0.836	-18.906	0.000**
x_5	-0.871	-22.001	0.000**
x_6	-0.660	-10.902	0.000**
x_7	-0.929	-31.152	0.000**

*Statistically significant at 5%, **statistically significant at 1% levels of significance.

A multiple regression analysis was conducted to forecast age utilizing parameters (N0, x1 to x7) as independent variables and chronological age as the dependent variable. This analysis uncovered a highly significant relationship (R= 0.996, R^2= 0.992, p($F_{(9,155)}$=1893.491) < 0.01). Suggesting that these predictors accounted for the variability observed in age. However, it is worth noting that x1, x5, and x6 did not exhibit statistical significance as indicated in **Table 3**.

Table 3: Multiple regression analysis of radiographic measurements on chronological age.

Independent variables	Unstandardized Coefficients	SE of Reg. coefficient	Standardized Coefficients	*t*-value	*p*-value
Intercept	9.370	0.099	-	94.666	0.000**
N₀	0.560	0.020	0.436	28.384	0.000**
x₁	0.402	0.524	0.011	0.767	0.444
x₂	3.609	0.409	0.121	8.816	0.000**
x₃	-2.004	0.192	-0.226	-10.455	0.000**
x₄	-1.237	0.118	-0.141	-10.516	0.000**
x₅	0.309	0.176	0.043	1.757	0.081
x₆	-0.309	0.244	-0.016	-1.265	0.208
x₇	-1.560	0.090	-0.405	-17.416	0.000**

R= 0.996, R^2=0 .992, p($F_{(9,155)}$=1893.491) < 0.01, Std. Error of Estimate= 0.2051

*Statistically significant at 5%, **statistically significant at 1% levels of significance.

Hence, the Cameriere's equation for the regression model is Age = 9.370 + 0.328(gender) + 0.560N0 + 0.402x1 + 3.609x2 - 2.004x3 - 1.237x4 - 0.309x5 - 0.309x6 - 1.560x7. however, the utilization of stepwise multiple regression unveiled a significant correlation between chronological age and six parameters out of the nine considered (R2 = 0.996, F(6,155) = 2792.023, p < 0.05) as displayed in **Table 4**. Therefore, the obtained linear regression equation will be as follows: Age = 9.357 + 0.335*(gender) + 0.565*N0 + 3.880*x2 - 1.281*x3 - 1.848*x4 - 1.474*x7.

Table 4: Stepwise multiple regression analysis of radiographic measurements on chronological age.

Independent variables	Unstandardized coefficients	SE of Reg. coefficient	Standardized Coefficients	*t*-value	*p*-value
Intercept	9.357	0.093	-	100.803	0.000**
Gender	0.335	0.035	0.078	9.504	0.000**
N₀	0.565	0.018	0.440	31.735	0.000**
x₂	3.880	0.301	0.130	12.879	0.000**
x₃	-1.281	0.116	-0.147	-11.067	0.000**
x₄	-1.878	0.159	-0.212	-11.805	0.000**
x₇	-1.474	0.071	-0.383	-20.735	0.000**

R= 0.996, R^2= 0.991, p($F_{(6,155)}$=2792.023) < 0.01, Std. Error of Estimate= 0.2068

*Statistically significant at 5%, **statistically significant at 1% levels of significance.

The plot displaying the comparison between observed and predicted values exhibits a symmetrical distribution with a propensity to converge towards the center **(Figure 2)**.

Similarly, the plot illustrating the residuals plotted against the fitted values, created using the regression model, does not reveal any discernible pattern, apart from a few outliers **(Figure 3)**.

These findings from both plots provide support for the application of our regression model in estimating chronological age. Notably, when applying the regression equation to 166 children within the Libyan population, no statistically significant variation was observed between the predicted and actual chronological ages.
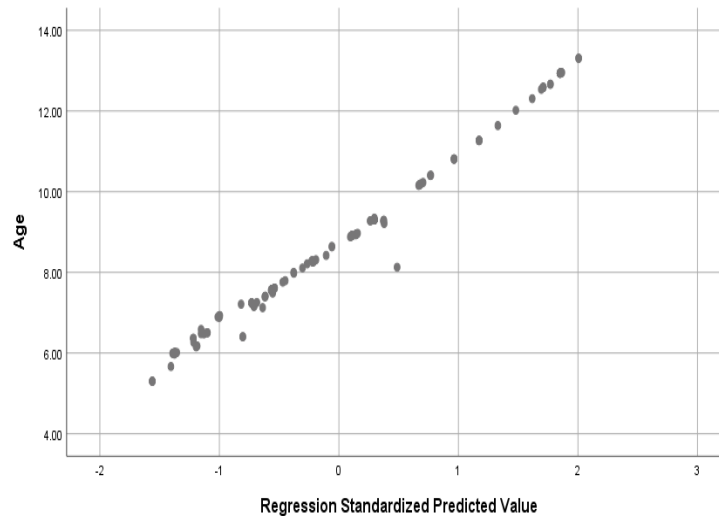
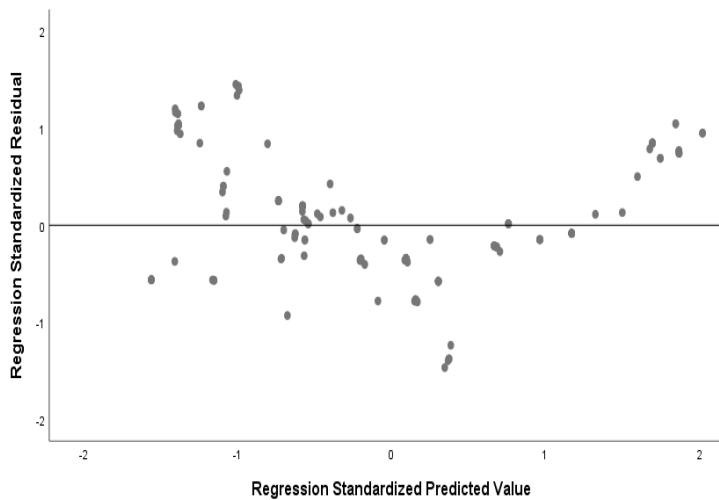**Figure (2):** Scatterplot, showing the dependent variable (age) against predicted value.

Figure (3): Scatterplot showing Regression residual against predicted value.

DISCUSSION

Though chronological age is essential in many situations, undocumented or missing birth data alerts the need to estimate the age of an individual. Age estimation plays an increasingly important role in forensic science, archaeology, pediatric dentistry and clinical aspects.[10] In forensic contexts, particularly concerning unidentified deceased individuals, age estimation is crucial for creating biological profiles. However, the need to determine an age also arises for living children of unknown identity. According to scholarly literature, there are instances in which a child may encounter legal complications due to being either the target of a criminal act, considered a suspect in a criminal case, or classified as a refugee of indeterminate age.[4, 12-15]

To determine the age of such individuals, various morphological techniques have been devised. However, the efficacy of these methods hinges on their capacity to yield an estimate that closely aligns with the individual's chronological age, within acceptable error limits.[16, 17] In legal cases, it is also necessary to use non-invasive methods which are more precise and in compliance with legal requirements.[2] Among various methods, Cameriere's method of age estimation has been shown to be more reliable and accurate, as it relates closely with chronological age than any other maturity indicators and is the least variable method compared to others.[4]

In the field of dental age assessment, two main concepts can be identified. One is by assessing the age of tooth eruption in the oral cavity, and the other is by recording the stages of root and crown mineralization in primary and permanent dentition. The former possesses the disadvantage of being affected by local factors during the process of tooth eruption. Such as premature deciduous tooth loss, ankyloses, and others. While the latter is a progressive phenomenon and easily definable by the staging of calcification and therefore is the most reliable dental indicator.[16]

In the current study, all variables played an essential role in determining the dental age except x1, x5 and x6, which were not statistically significant (p>0.05). This is in agreement with Cameriere et al (2006) study [10] but in contrast to AlShahrani et al (2019) study[12] where all variables were at a lower level of significance. As regards repeatability, there were no statistically significant inter-observer differences between the paired sets of measurements carried out on the re-examined orthopantomographs. This emphasizes the fact that, although this technique involves more steps during calculation, it is faster and easier than other quantitative methods. As noted by Cunha et al. (2009) [4], the best method is sometimes the one that has been tested by many researchers on several different populations, and which is also suitable for a specific forensic context, practical, quick and inexpensive. Cameriere et al. (2006) showed that the relationship between chronological and estimated dental ages was evaluated for each gender and age group, as well as for the total sample by analysis of means and standard deviation.[9]

The mean prediction error (Mean differences)[2] (standard deviation) (SD) was 0.63 years for girls and 0.52 years for boys.[18] Cameriere et al (2008) [18] also compared the mean for three methods, those of Willems et al (2001)[1], Cameriere et al (2006) [10] and Demirjian et al (1973)[5] Cameriere's method provided 0.48 years for girls and 0.50 years for boys, which are close to the results in the current study and with the European formula in Mexican children. Using Cameriere's method, Galic´ et al (2011) [19] found mean of 0.53 years for girls and 0.55 years for boys. In the Mexican sample, Cameriere's method yielded a mean overestimation of 0.10 for girls and a correct mean estimation for boys. The estimation of DA was found to be overestimated, as evidenced by mean errors [5] of 0.58 and 0.65 observed in the spanning 5-6 and 6-7 years respectively. It was also underestimated by MEs of 1.06 for girls in the age group 14-15 years. In addition, although a different trend was observed in boys, slight MEs of 0.02 and 0.27 were shown in older individuals in the age groups of 13-14 and 14-15 years.[20]

The results in this study match those of many previous studies examining the applicability of Cameriere's method on various subjects from Europe and children from India and Egypt. [21, 22] The other researchers studied a sample of 1089 Bosnian–Herzegovian children aged between 6 and 13 years. For girls, the mean DA was overestimated by 0.10 years according to Cameriere's method by the range of differences of - 0.80 to 0.60 years for all age groups. For boys, the mean DA was underestimated for -0.02 according to Cameriere's method by the mean of differences of -0.60 to 0.09 years for the 10-, 11-, 12- and 13-year-old groups, whereas it was 47 overestimated by the mean of differences of 0.09 to 0.45 years for the 6-, 7-, 8- and 9-year-old groups. In Egyptian children, Cameriere's method showed an average underestimation of -0.29 ±1.04 years for the total sample, -0.26 ± 1.21 years for girls and -0.49 ± 1.03 years for boys. According to Cameriere, [21] when

employing his method to the Indian sample of 480 children between 3 and 15 years, a mean overestimation of 0.05 years for boys and 0.04 years for girls was observed. This trend may be attributed to a combination of factors including inter and intra-population variations, discrepancies among observers and specific techniques used.

Precision is mainly related to factors influenced by chance, as in random errors.[23] Frequently, as well as slightly noticeable methodological errors, biological variation should also be considered.[24] It has been reported that the growth of a child may be influenced by several factors including genetic, nutritional, racial, hormonal, climatic, social, and others. Among the several maturity bio-indicators usually examined, teeth are least influenced by all these factors. It is to be counted that various dental age estimation methods recommended in the past did not provide a common formula for the population of the whole world.[25]

These methods also differed in their accuracy when different populations were considered. Hence this study focuses on the improvement of the method developed by Cameriere et al. (2006) to suit the Libyan children. This highlights the fact that Cameriere's technique is very accurate and represents a useful technique for age assessment in children of this age group (5– 15 years). The accuracy of age estimation indicates how well chronological age can be predicted, and greater accuracy can be obtained by choosing the method that shows the least variability with age.[26]

CONCLUSION

Cameriere's formula, as validated in a study conducted on children in Libya, has been proven to be a robust tool for estimating the chronological age of both male and female individuals. In order to enhance the accuracy of age assessment in Libyan children, it is recommended to develop a prediction formula based on Cameriere's method specifically tailored for this population. To further explore the reliability of dental age assessment using the new formula, future research should involve larger sample sizes and should aim to investigate the potential impact of regional background, nutritional factors, and the distribution of chronological age among Libyan children.

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A Questionnaire-based Study on Impression Materials and Techniques for Complete Denture Construction among Dentists Practicing in Central/Western Regions of Libya

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ABSTRACT

Background: The success of complete dentures mainly depends on impression-making accuracy; thus, dentists need to select the proper impression materials and techniques to achieve optimal outcomes.

Objective: To determine the favoured impression materials and techniques used for complete denture construction among dentists practicing in the Central/Western regions of Libya.

Materials and Methods: This study was conducted between July 2023 and September 2023. The questionnaire was comprised of 30 questions, which were divided into two parts including; 11 questions for demographic and professional attitude and 19 questions focused on professional steps of complete denture fabrication for edentulous patients.

Results: The response rate for this questionnaire was (66%). It was revealed that (96.1%) of respondents used only irreversible hydrocolloid (alginate) as an ideal option for primary impressions. In response to the same question for final impressions, (45.8%) of participants exhibited that polyvinylsiloxane was the favourite choice. Regarding custom trays, (41.7%) of practitioners preferred using light-cured acrylic resin as a custom tray to take definitive impressions. (87.4%) of prosthodontists border molded the custom tray in sections by (81.9%), using modelling plastic impression compound by (92.1%). The most used philosophy for final impression making was the mucostatic impression technique by (50.4%), while (37.0%) used selective pressure and (12.6%) selected muco-compressive. Implant-supported overdenture was discussed as an alternative treatment by (65.4%). The obtained data was statistically analyzed using SPSS 28.

Conclusion: This study reflects a diversity of opinion among Libyan dentists during the construction of complete dentures. The most commonly used material for primary impression was irreversible hydrocolloid (alginate) and for final impression was polyvinylsiloxane, which coincides with professional practices worldwide. Modelling plastic impression compound was the most preferred material for border molding. The mucostatic technique was the predominantly used impression philosophy for final impression making.

Keywords: *Impression materials, Impression techniques, Complete dentures, Edentulous patients, Prosthodontics.*

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INTRODUCTION

Edentulism is a major problem in elderly people due to chronic oral diseases, including dental caries and/or periodontal problems.[1] Providing edentulous patients with complete denture (CD) is an essential treatment option in order to re-establish the patient's quality of life (function & aesthetic).[2, 3] Moreover, impression-making is a critical step in determining the success or failure of CD, thus several contributing factors affect the construction procedures of impressions, such as; selecting a suitable tray, the used technique, the type of the material and the patient's intra-oral condition.[4] However, impression-making is still a widely debatable area for CD fabrication.[5, 6]

The impression is a negative likeness (replica) of oral tissues, it is made by placing an impression material into the mouth using an impression tray.[7] This replica should include all the landmarks of the edentulous mouth (entire denture bearing area & border seal area of maxillary/mandibular arches) to achieve the maximum degree of retention, stability and support for CD.[7, 8] As stated in textbooks and literature, there is a variety of impression materials which available for impression making and they are mainly classified into

elastic and non-elastic (rigid) types, according to their behaviour after setting.[7, 9] The non-elastic impression materials include all; impression plaster, impression compound, zinc oxide eugenol (ZOE) impression paste and impression wax. On the other hand, the elastic impression materials comprise; hydrocolloids and elastomers. The hydrocolloids group includes; agar-agar (reversible type) and alginate (irreversible type), whereas the elastomers include; polysulfide, additional and condensational silicones (polyvinylsiloxane) and polyether.[7, 8, 10]

Nowadays, highly viscous alginate (irreversible, elastic, hydrocolloid impression material) is the most widely used material for recording the primary impression when fabricating a CD.[11] On the other hand, impression compound is a non-elastic (rigid), thermo-plastic (reversible) and muco-compressive impression material, which is classified into two types according to ADA (low fusing & high fusing material).[7, 12] This material now is used relatively little as a primary impression compared to other impression materials, which can be used with low viscosity impression materials such as; ZOE as impression tray.[13] It cannot be used in the presence of undercuts because distortion occurs when the replica is removed from the mouth.[7, 12, 13]

Well known that elastomeric impression materials are rubber-like polymers with a hydrophobic property, commonly used for recording the final impression.[7, 14] They are supplied in different viscosity's ranging from low to high viscosity associated with an elastic behavior at the time of loading.[12, 15] These materials have two advantages over the elastic, hydrophilic impression materials (hydrocolloids): (1) good tear resistance, and (2) dimensional stability.[7] In contrast, ZOE impression paste is an irreversible, non-elastic and mucostatic impression material.[12] It is sufficiently fluid to record all fine surface details in the mouth, but cannot be used in undercut regions for edentulous patients.[12]

Many studies proved that several techniques/philosophies used to make dental impressions for edentulous patients have been affected by the clinical situations of maxillary/mandibular arches, these techniques are divided into three groups; mucostatic (minimal pressure or passive), muco-compressive (definite pressure or functional) and selective pressure techniques.[16, 17] The choice of which impression materials and techniques to use in each edentulous case not only depends on understanding of anatomy, physiology of oral structures and properties of selected materials but also on the individual's oral condition.[18]

Several questionnaires have been conducted in different parts of the world to study the preference of impression materials/techniques that used during CD fabrication, whereas there is no published information among Libyan dentists. Therefore, the purpose of this study was to assess the favoured impression materials and impression recording techniques used for CD construction by dentists working in the Central/Western regions of Libya.

MATERIALS AND METHODS

This cross-sectional study was conducted between July 2023 and September 2023 through self-administered questionnaires. A purposive sampling technique was used to choose 190 participants (general dentists and prosthodontists), they were selected based on providing CD prostheses in their routine dental clinical work, and also according to the place of practice which is in Central/Western regions of Libya. Both paper-based and/or online (google form) questionnaires were used for the participants.

This questionnaire was constructed depending on the ideal academic and clinical requirements of CD construction (clinical and laboratory). It was sent to seven specialists in Prosthodontics affiliated with the dental schools, in order to assess the clarity, importance and logical order of the questionnaire's questions. Based on their feedback, the final version of the questionnaire was written and confirmed; as shown in the Appendix (supplement data). The research approval was obtained via the Bioethics Committee at the Biotechnology Research Center, Tripoli-Libya, under Reference Number [NBC: 001. H. 23. 15].

The questionnaire comprised of 30 questions in total, was divided into two parts including; 11 questions for demographic and professional attitude and 19 questions regarding the straightforward CD construction for the cases with no bony undercuts or flabby edentulous ridges. The information was tested in Part 1, demographic information; such as gender, age, working (sector, position, region), years of experience, frequency of providing CD, alternative treatment plan for edentulous patients, asking not to wear the exciting CD for 24-48 hrs prior impression making, selection of impression technique according to individual's intra-oral condition and contributing factors that may affect the selection of impression materials.

Furthermore, Part 2 involved information regarding the professional steps for CD construction (impression materials and their techniques used for fabrication of CD); such as history-taking methods, type of tray used for taking primary impression, using utility wax for tray periphery, type of materials used for primary impression, waiting time until pouring the recorded impression, materials used for custom tray fabrication, use of wax spacer, stoppers and relief holes during fabrication of custom tray, handle shape of custom tray, border molding favoured materials and techniques,

type of materials used for final impression, final impression techniques, recording techniques for posterior palatal seal (PPS), correction of minor deficits for final impression and materials used for disinfection of impression.

Statistical Analysis: The collected data were subjected to a statistical analysis using SPSS (Statistical Package for Social Sciences) software package version 28.

RESULTS

Out of 190 questionnaires distributed among practitioners, 127 responded, ensuring a total response rate of (66.0%). The highest response rate was from the central regions of Libya (56.7%). The majority of respondents were male (56.7%) and the other participants were female (43.3%). (79.5%) of contributors were general practitioners, while (20.5%) of them were specialists (Prosthodontists). (43.3%) of dentists were working in both sectors (public and private sectors). A sizable number of dentists had practiced dentistry for the duration of 11-20 years (35.4%), the data is summarised in **Table 1.**

Table 1: Distribution of Participants according to region, gender, working as, working in and working experience

Percent Distribution of Participants			
According to the Region:			
Central Region		Western Region	
56.7%		43.3%	
According to the Gender:			
Male		Female	
56.7%		43.3%	
Working as:			
General Practitioners		Specialists	
79.5%		20.5%	
Working in:			
Public Sector	Private Sector		Both
14.2%	42.5%		43.3%
Working experience:			
< 5 years	5-10 year	11-20 years	> 20 years
21.3%	32.3%	35.4%	11.0%

The CD was routinely provided by (66.1%) of participants in their clinics. (65.4%) of practitioners offered an implant-supported overdenture as an alternative treatment for edentulous patients. (59.8%) of dentists instructed their patients to discontinue wearing the existing CD for 24-48 hrs prior to impression making. Further, (73.2%) of contributors evaluated the patient's intra-oral condition in order to select the correct impression technique during CD construction. The distribution of dentists according to the contributing factors that affecting selection of impression materials is presented in **Table 2**.

Table 2: Contributing factors affecting the selection of impression materials

Contributing Factors	Percentage (%)
Availability of the material	22.8
Cost	1.6
Ease of use	0.8
Degree of accuracy	9.4
Status of the ridge	6.3
All of the above	46.4
Availability of the material + Cost	1.6
Availability of the material + Ease of use	2.4
Availability of the material + Degree of accuracy	0.8
Availability of the material + Cost + Ease of use	1.6
Availability of the material + Ease of use + Degree of accuracy	0.8
Cost + Status of the ridge	0.8
Cost + Ease of use + Status of the ridge	0.8
Ease of use + Degree of accuracy + Status of the ridge	0.8
Degree of accuracy + Status of the ridge	3.1

This study revealed that the majority of respondents (90.6%) took the patient's medical/dental history orally, while (9.4%) through written format and none of them approved using the electronic format. (15.0%) of practitioners favoured using metallic trays for recording the primary impression, (32.3%) preferred using plastic trays and (52.8%) of them used both types. (66.9%) of respondents favoured adjusting the tray periphery using utility wax, while the remainder did not approve this step. It was observed that (96.1%) of dentists routinely used irreversible hydrocolloid (alginate) impression material for recording the primary impression, (3.1%) used impression compound and only one practitioner favoured using a putty material; as seen in **Figure 1**.
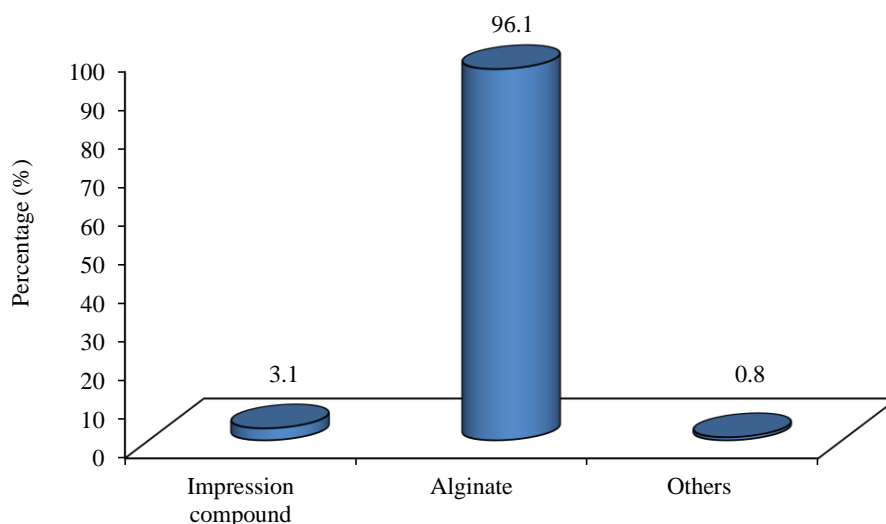

Figure 1: Percent distribution of the materials used as primary impressions.

It was exhibited that (16.5%) of this study respondents poured the primary impression immediately, while (27.6%) within 15-30 min, (36.2%) after 1 hr and (19.7%) postponed this step after 24 hrs. Subsequently, the custom tray was fabricated for final impression making and (33.1%) of dentists selected shellac

material as a material of choice, (25.2%) preferred using self-cured acrylic resin and the majority of (41.7%) favoured light-cured acrylic resin; as shown in **Figure 2**. In addition, (67.7%) of practitioners performed a wax spacer during the designing of a special tray, (65.4%) preferred to add stoppers and (66.9%) favoured the incorporation relief holes. Majority of contributors desired L-shaped handle for the custom tray (91.3%), whereas (7.9%) chosen a stub-shaped handle and only one participant preferred the construction the custom tray without a handle.
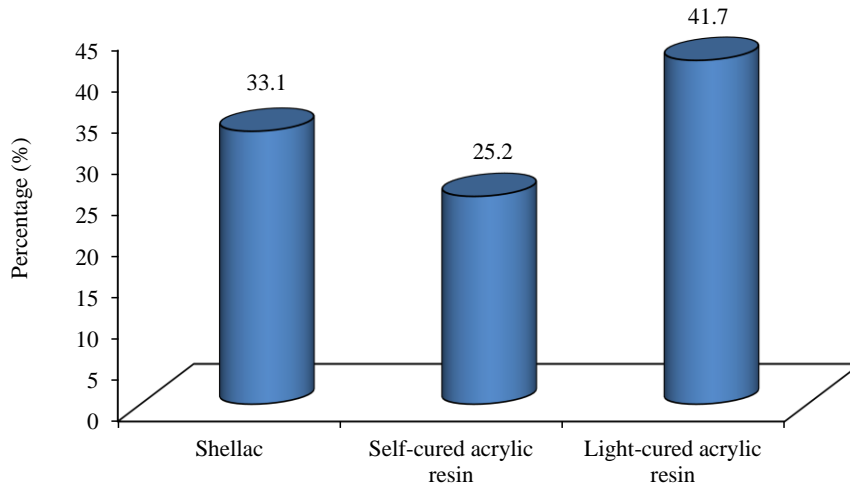

Figure 2: Percent distribution of the materials used for custom tray fabrication.

Regarding the border molding procedure, (87.4%) of dentists favoured to make it. Modelling plastic impression compound was used by (92.1%), while (7.9%) preferred using heavy-body elastomers. Further, about (81.9%) selected the sectional technique and others chose the one-step method. It was revealed that (45.8%) of practitioners preferred using polyvinylsiloxane for recording the final impression.

Other materials were selected as options for final impressions; ZOE impression paste (34.6%), alginate (9.4%), polysulfide (7.1%) and polyether (3.1%); as illustrated in **Figure 3**. For impression techniques, (50.4%) of contributors favoured using the mucostastic technique, though muco-compressive and selective pressure techniques were chosen by (12.6%) and (37.0%) respectively; as presented in **Figure 4**.
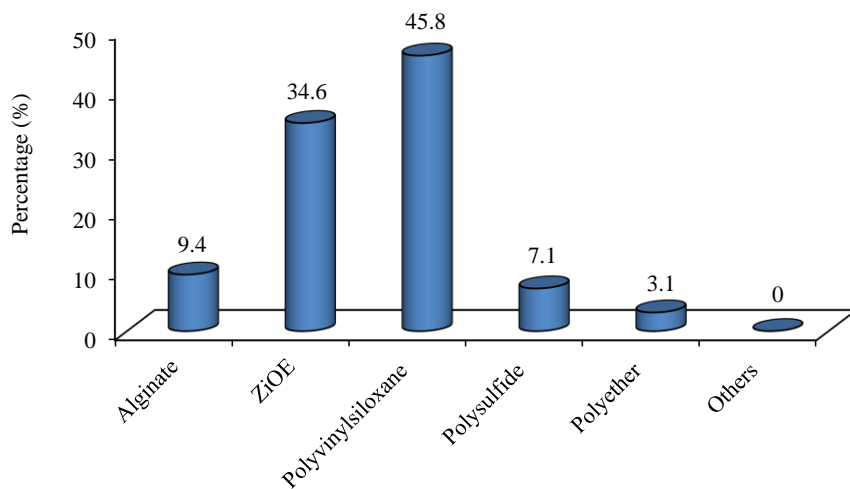

Figure 3: Percent distribution of the materials used as secondary impressions.
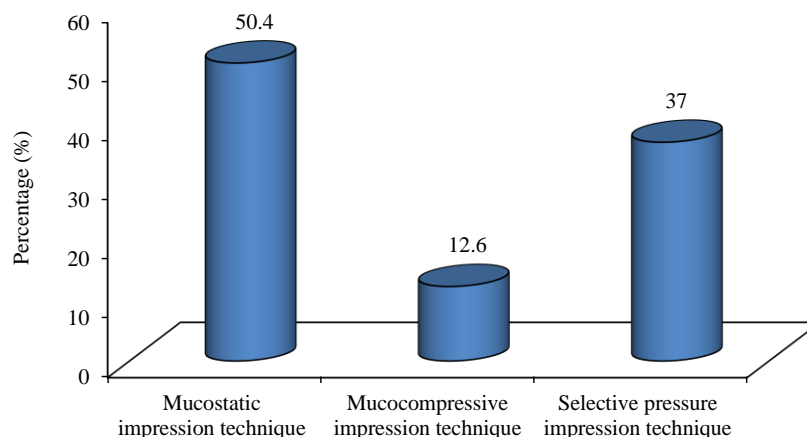
Figure 4: Percent distribution of the techniques used during impression making.

The data showed that (83.5%) of contributors recorded PPS and the majority (76.4%) used conventional technique for PPS, while (7.9%) used fluid wax technique and (15.7%) used arbitrary scraping method. (68.5%) of dentists performed correction of the minor deficits in the final impression, (31.5%) did not approve this step. Regarding disinfection of impressions, most of the practitioners (55.1%) rinsed the impression under tap water only and others chose different materials; as tabulated in **Table 3**.

Table 3: Materials that used for disinfection of impressions

Disinfectant	Percentage (%)
Tap water	55.1
Sodium hypochlorite	17.3
Glutaraldahyde	4.7
Chlorhexidine	8.6
Tap water + Sodium hypochlorite	4.7
Tap water + Glutaraldahyde	2.4
Tap water + Chlorhexidine	2.4
Sodium hypochlorite + Chlorhexidine	2.4
Others	2.4

DISCUSSION

It is well known that recording the anatomical landmarks of edentulous patients via impression-making is the key in the success/failure of CD.[19] The main focus of this study was to evaluate the clinical practice concerning impression materials and techniques used for CD fabrication by general dentists and specialists in the Central/Western regions of Libya. The accuracy of impression-making is achieved by following the manufacturing instructions for each impression material. This could also be attributed to the contributing factors that affect the selection of impression materials. Accordingly, the results of this study revealed that most dentists considered all the factors including; availability of the material, cost, ease of use, degree of accuracy and status of the ridge.

The obtained results from this study exhibited that (96.1%) of respondents favoured using irreversible hydrocolloid (alginate) for making the primary impression. This could be explained by the low cost of material, ease of manipulation, fast setting time, adequate shelf-life and also pleasant for the patients. Our findings are in excellent agreement with the previous studies conducted all over the world. [2, 20, 21] (88.0%) of dental graduates in the UK and (87.0%) of dental undergraduates in the US schools preferred to use alginate as a primary impression material.[20, 21] In another study conducted in Saudi Arabia, (91.7%) of participants used alginate to make primary impressions.[2] In contrast, other studies reported that (93.0%) of Pakistani dental students and (78.0%) of Indian practitioners preferred to use impression compound as a material of choice for making a primary replica[4, 6] This might be due to the differences in teaching and training programs of dental schools. It is also probably because of the low cost of impression compound compared to other impression materials.

Based on the responses in the current research, the material of choice for custom tray fabrication was light-cured acrylic resin (41.7%). The main advantages of this material are high strength and rigidity, good handling properties and polymerize with no residual monomer.[22] This finding coincides with the results of previous studies, which showed that the use of a

custom tray for the final impression is a vital step in CD construction, which occurs by choosing light-cured acrylic resin as a favorite material.[21, 23] This is in contrast to the achieved results of the questionnaire-based studies in Pakistan, in which (92.0%) of respondents used self-cured (chemical-cured) acrylic resin for custom tray making.[6, 17] The main limitation behind using self-cured acrylic resin is polymerization shrinkage and stress relaxation during the construction procedure of the custom tray, leading to distortion of the final impression and inaccuracy of the final prosthesis.[24]

In the present study, (87.4%) of prosthodontists border molded the custom tray and (81.9%) of them recorded the border in sections prior to the final impression procedure. Further, modelling plastic impression compound was the preferred material by (92.1%) and some used heavy body elastomeric materials (7.9%). Border molding is a major procedure in order to duplicate the contour/size of the buccal, labial and lingual vestibules, thus the borders of impression will be in harmony with the physiologic action of limiting structures. Our findings are in agreement with earlier studies.[17, 23, 25, 26]

This research exhibited that the majority of participants (45.6%) preferred to use polyvinylsiloxane as a material of choice for the final impression, followed by ZOE impression paste (34.6%) as a second option. It is obvious that there is an increase in the popularity of using elastomeric (non-aqueous) materials. This is owing to the superior degree of reproducibility, dimensional stability of the material, proper working/setting time, ease of handling, multiple casts can be produced from the same impression and also the continuous improvement in the physical/mechanical properties of elastomers.[23, 27, 28] In Saudi Arabia, (52.4%) of dentists preferred to use polyvinylsiloxane as a final impression material, followed by using ZOE impression paste (20.0%).[2] This result is in good agreement with our data. Further, another study conducted for US postdoctoral prosthodontic programs showed that the most commonly used impression material for the final impressions was polyvinylsiloxane (42.0%) and the second option was polysulfide (32.0%), followed by alginate (13.0%), ZOE impression paste (8.0%), polyether (3.0%) and impression plaster (2.0%) respectively.[23]

In comparison with other questionnaire-based studies conducted in Pakistan, (97.0%) and (89.0%) of dental practitioners favoured to use ZOE impression paste to record the final impressions.[6, 17] Another work conducted in India also displayed that (73.0%) of respondents used ZOE impression paste for making the final impressions.[4] In Nepal, (73.3%) of dentists favoured using ZOE impression paste, followed by polyvinylsiloxane (11.7%), polyether (11.7%), and polysulfide (3.3%) respectively.[26] One of the major drawbacks of ZOE impression material is the rigidity after setting, which cannot be able to use for recording the undercuts.

It was found that the most used impression philosophy in the current study was mucostatic technique (50.4%), which was followed by selective pressure (37.1%) and muco-compressive techniques (13.2%). The mucostatic philosophy (minimal pressure) provides a large amount of space between the tray and the soft tissues of the basal seat. In contrast to our findings, many research indicated that the most approved philosophy for impression making was selective pressure, followed by muco-compressive and mucostatic technique.[2, 29, 30] The selective pressure technique is based on selectively loading on the primary stress-bearing areas and relieving secondary stress-bearing areas.[31] The variation in the selection of proper technique/philosophy for making a CD is multifactorial. It basically depends on the clinical situation, materials availability and clinician's knowledge, experience and performance.

In this study, (55.1%) of dentists disinfected the obtained impressions under running water only, while (17.3%) used sodium hypochlorite and (8.6%) used chlorhexidine as a disinfectant agent. It is more likely due to the dentist's attitude towards the infection control is poor. Consequently, disinfection of dental impressions should be considered as a routine procedure in both dental clinics and laboratories in order to avoid transmission of infection from the patient to the dental staff.[32] However, many studies emphasized that the disinfection of impressions could affect the dimensional accuracy, stability and wettability of the impression materials.[33, 34]

Regarding implant-supported overdenture, this option was discussed as an alternative treatment rather than conventional CD by (65.4%) in the present research. Many studies proved that the patients who are treated with implant-supported overdenture have a higher quality of life in terms of functions and aesthetics rather than the patients who wear conventional CD.[35, 36, 37] Although, the overdenture treatment needs precise surgical techniques, which requires skills of surgeons, corporation of patients, additional time and cost.[38]

This research was limited to the specific regions in Libya as well as was focused on the traditional impression recording techniques that are used during CD making. Thus, further broadening studies are required to be done in order to discuss the popularity of digital impression techniques and also to evaluate the recent advancement in the discipline of prosthodontics.

CONCLUSION

This study indicates that the clinician's knowledge, experience and performance have an essential influence on the procedures of CD construction. Within the limitation of this questionnaire-base study; it can be concluded that:

I.   Most commonly used material for the primary impression was irreversible

II.   colloid (alginate) and for the final impression was polyvinylsiloxane (PVS).

III. Most of practitioners preferred to use light-cured acrylic resin for custom tray fabrication in order to carry the final impression.

IV.   Modelling plastic impression compound was favoured by most participants to border mold the custom trays in sections.

V.   Mucostatic impression technique was the predominantly used impression philosophy for final impression making.

VI.   Implant-supported overdenture will be the most approved treatment plan for edentulous patients in the coming decades.

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Causes and Patterns of Dental Extraction in Dental College of Sebha University

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ABSTRACT

Objectives: This study aimed to identify the primary cause of permanent teeth extraction among patients attending the Oral and Maxillofacial Surgery (OMFS) department of dental college, Sebha University, and its correlation with age, gender, and tooth type.

Methods: A cross-sectional study was conducted over ten months; and included 509 patients aged 16-90 years, who underwent tooth extraction. Variables studied were the patient's age, gender, tooth type, and extraction cause. SPSS was used for data analysis, and Chi-Square and ANOVA tests were used to evaluate variables associated with the cause of tooth loss. A *p*-value of less than 0.05 was considered statistically significant.

Results: Overall, 509 permanent teeth were extracted, males (62.1%) and females (37.9%). The primary reasons for tooth extraction were dental caries (76.62%), mobility (10.80%), prosthodontics (6.86%), orthodontics, and impaction (2.95%). The most common age group was 36-45 years (24.36%) and 26-35 years (23.38%). The highest percentage of tooth extraction was in the third and first molars (29.1% and 24.4%, respectively), and the lateral incisor (1.77%) was the lowest. There was an insignificant association between the cause of extraction and gender; a significant association between the cause of extraction and age *p*<0.001; and a significant association between (gender and age) with tooth type *p*< 0.001.

Conclusion: dental caries was the main reason for tooth extraction in OMFS department, dental college, Sabha University.

Keywords: *Tooth extraction, Dental caries, Mobility, Impaction, Sebha University*.

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INTRODUCTION

Tooth extraction is one of the most performed dental treatments worldwide. Due to the advancements in conservative, preventive and cosmetic dentistry, the teeth loss percentage has decreased. However, there are still various causes that lead to the extraction of teeth. These causes may be dental caries and its sequel as pulpitis and periapical infections, periodontal disease, orthodontic treatment, endodontic failures, prosthetic procedures, and trauma.[1,2] Early tooth loss has various harmful effects on an individual, such as impairment of masticatory function, unpleasant aesthetics, temporomandibular joint dysfunctions, psychological issues, social withdrawal, and decrease in self-confidence.[3]

Identifying the causes of tooth extraction is the first step in assessing the health needs to inform dental health policies. So, several studies have been carried out worldwide to determine the reason for tooth extraction.[4,5,6] Consequently, the leading cause of permanent tooth extraction in many countries was dental caries, followed by periodontal disease.[7, 8, 9,10] However, different contextual factors can affect the provision and uptake of oral health services.[11] Libya is a country that endures several political, economic and armed conflicts which appear to have impacts on oral health.[12,13] In addition, just two studies have been published that evaluated the reason and pattern of tooth loss and both of them were conducted in the east of Libya.[14,15] Hence, the data on this topic is not enough in Libya, and more information is strongly required about the southern province. Therefore, this study aimed to assess the cause and pattern of tooth extraction in permanent teeth among the Libyan population.

MATERIALS AND METHODS

This cross-sectional study was carried out at the Department of OMFS of Dental College, Sebha University. The outpatients undergoing extraction at the surgical department were included from March

2021 to December 2021, where a total of 509 extractions were performed. Participation was voluntary and all patients were asked for their consent by signing a permission sheet to be included in the study. Internship students filled record sheets, and all procedures were done under the supervision and control of a surgeon specialist. Dentists were asked to explain the information sheet to the patients and record the code of tooth type and the leading cause for each tooth extraction. The following variables were recorded and evaluated for the study population: age, gender, tooth type, and reason for extraction. For accuracy, every reason for tooth extraction recorded in the sheet was defined as; (1) Caries: caries or its sequels, remaining root, and tooth fracture by caries. (2) Mobility: due to periodontal disease, periodontal abscess, and loss of tooth function. (3) Prosthodontic reason: to make denture removable or fixed functionally fitting. (4) Orthodontic reason: correction or prevention of malocclusion. (5) Impaction: tooth unerupted complete, or partial. The sampling technique was non-probability convenient sampling. All extractions carried out with full details, age above 16 years, permanent teeth, and all procedures done under supervision were included. Patients with incomplete details, ages below 16 years, medically compromised patients, and deciduous or supernumerary teeth were excluded.

The data were entered and analyzed using the SPSS software (version 16). The Chi-Square test was performed on the association between gender, cause of extraction, and type of tooth. Pearson chi-square and p-value (<0.05) were calculated to assess group associations. The ANOVA test evaluated the relationships between age groups, cause of extraction, and type of tooth extracted. The mean difference and p-value were recorded.

RESULTS
Out of 190 questionnaires distributed among A total of 509 dental extractions were included in this study (316 males and 193 females). Among the study population, most tooth extractions were 36-45 years (24.36%) and 26-35 years (23.38%). The participants aged from 16 to 90 years, with a mean of 41.35 (14.17); 38.1% were males at a mean of 43.85 (14.76), and 61.9% were female at a mean of 39.81 (13.59) **(Table 1)**.
The third molar noted the highest percentage of tooth extraction, then the first molar (29.1% and 24.4%, respectively), and the lateral incisor (1.77%) was the lowest. Dental caries was the primary cause of tooth extraction (76.62%), while tooth mobility was responsible for only (10.80%), followed by orthodontic and impaction purposes of extraction 2.9% for each cause **(Table 1)**.

Table 1: Distribution of patients who undergone extractions according to age, gender, causes, and tooth type.

Variable	Frequency	Percentage	Age (Mean±SD)
Age			
< 20	73	14.43 %	
20-29	119	23.38 %	
30-39	124	24.36 %	
40-49	111	21.80 %	41.35± 1.41
50-59	49	9.62 %	
> 60	33	6.8 %	
Gender			
Male	316	62.1 %	43.85±14.76
Female	193	37.9 %	39.81±13.59
Causes of extraction			
Mobility/ Periodontal disease	55	10.80 %	
Caries	390	76.62 %	
Ortho	15	2.95 %	
Prosthodontics	34	6.68 %	
Impaction	15	2.95 %	
Tooth type			
Central incisor	12	2.36 %	
Lateral incisor	9	1.77 %	
Canine	21	4.12 %	
First pre-molar	57	11.20 %	
Second pre-molar	56	11 %	
First molar	124	24.36 %	
Second molar	82	16. 11 %	
Third molar	148	29. 08 %	
Total	509	100 %	

Association between gender and cause of extraction
A Chi-Square test was conducted to analyze the association between the extraction cause and gender. There is an insignificant association between gender and the cause of extraction (*p*- value=0.069) **(Table 2)**. Dental caries was the main reason for tooth extraction in females (65.2%), while in males was 34.8%. However, the male patients had more tooth extraction due to severe mobility and prosthodontics (51.9% and 50.0%) respectively. On the other hand, the impaction reason for tooth extraction was higher in females (60%) than males (40%), while the prosthodontics cause was equal in males and females (50%) **(Table 2)**.

Table 2: Distribution of extraction cause according to gender

Cause of extraction	Gender		Chi-square	*p*-value
	Male N (%)	Female N (%)		
Caries	136 (34.8%)	255 (65.2%)	8.685	0.069
Mobility	28 (51.9%)	26 (48.1%)		
Orthodontics	7 (46.7%)	8 (53.3%)		
Prosthodontics	17 (50%)	17 (50%)		
Impaction	6 (40%)	9 (60%)		

p-value level <0.05

Association between age and cause of tooth extraction
The extraction due to dental caries was at a mean age of 38.7±11.97, while the mobility cause was at a mean age of 56.03±9.45. Additionally, the extraction for the orthodontics and the prosthodontics were at a mean age of 20.66±4.06, and 61.02±11.32 respectively.

Table 3: The mean age and relationships with cause of extraction

Cause of extraction	N	Age= Mean ±SD
Caries	391	38.75± 11.97
Mobility	54	56.03± 9.46
Orthodontic	15	20.66 ±4.06
Prosthodontics	34	61.02 ±11.33
Impaction	15	32.20± 11.37

Furthermore, the mean age of impaction reason for extraction was 32.20±11.36. The result indicated that the extraction for mobility and prosthodontics was more common among older participants (56 and 61 years, respectively). In comparison, dental caries and orthodontics cause were among young participants (38 and 20 years, respectively) **(Table 3)**.

Relation between the type of extracted tooth and gender
Chi-square statistics were used to analyze the association between gender and the number of extracted teeth. There is a significant association between gender and type of extracted tooth (*p*-value<0.001). The third molar was the most commonly extracted tooth among males (90.5%), followed by the second premolar tooth (58.6%). At the same time, in females, data showed a distinct difference from males as the central incisor and the first molar was only extracted (100%). In addition, extraction of canine and first premolar was higher in females than in males (95.2% and 96.2%, respectively) **(Table 4)**.

Table 4: Distribution and association between tooth type and gender

Tooth type	Gender		Total	Pearson Chi-square	p-value
	Male	Female			
Central incisor	0%	100%	100%	3.107	0.000
Lateral incisor	22.2%	77.8%	100%		
Canine	4.8%	95.2%	100%		
First premolar	3.5%	96.5%	100%		
Second premolar	58.9%	41.1%	100%		
First molar	0%	100%	100%		
Second molar	26.8%	73.2%	100%		
Third molar	90.5%	9.5%	100%		

p-value level < 0.05

Relation between extracted tooth type and age

The relationship between age and type of extracted tooth was measured by Univariate analysis of variances (ANOVA test). The results show a significant association between age and type of extracted tooth (p-value<0.001). The anterior tooth was extracted most commonly among young participants (central incisor 33 years, lateral incisor 35 years, and canine 36 years of age). In comparison, the premolars were frequently extracted among middle-aged participants (first premolar 44 years and second premolar 45 years of age). The first molar was extracted mainly among young participants (34 years). The second and third molars were extracted frequently at age 43 and 44, respectively **(Table 5)**.

Table 5: The mean age and relation with tooth extracted type

Extracted tooth type	N	Age= Mean± SD	ANOVA test F	p-value
Central incisor	12	33.00± 9.98	7.992	0.000
lateral incisor	9	35.22± 12.42		
Canine	21	36.28± 17.02		
first premolar	57	44.19 ±12.81		
second premolar	56	45.96± 16.81		
first molar	124	34.95 ±8.65		
second molar	82	43.51 ±13.73		
third molar	148	44.45 ±15.27		

p-value level <0.05

The causes of tooth extractions among individual tooth type

Descriptive analysis was conducted to examine the reason for extraction for each tooth type individually. The result indicated that the participants only extracted the central incisor, lateral incisor, canine, first premolar, and first molar due to dental caries. The second molar was frequently extracted because of

dental caries (72.0%), then mobility as the second common cause (14.6%). In addition, dental caries was the leading cause of extraction of the second premolar (48.2%), followed by mobility (35.7%). Finally, dental caries accounted for 55% of the extracted third molar

and approximately 15% for mobility and prosthodontics reasons. Overall, the result observed that dental caries was the most common cause of tooth extraction, whereas mobility was considered the second reason among the participants **(Table 6)**.

Table 6: Distribution of tooth types with cause of extraction

Tooth	Cause of extraction					Total
	Caries	Mobility	Orthodontic	Prosthodontics	Impaction	
Central incisor	100%	.0%	.0%	.0%	.0%	100%
Lateral incisor	100%	.0%	.0%	.0%	.0%	100%
Canine	100%	.0%	.0%	.0%	.0%	100%
First premolar	100%	.0%	.0%	.0%	.0%	100%
Second premolar	48.2%	35.7%	5.4%	10.7%	.0%	100%
First molar	100%	.0%	.0%	.0%	.0%	100%
Second molar	72.0%	14.6%	6.1%	7.3%	.0%	100%
Third molar	55.4%	14.9%	4.7%	14.9%	10.1%	100%

DISCUSSION

The result of our study indicated that dental caries and its sequelae were the first common cause of tooth extraction (76.62%). Mobility was the second most common cause of tooth loss (10.80%). The current finding that caries was the leading cause agrees with previous Libyan studies[14,15] and several studies conducted worldwide.[16,17,18] On the other hand, the present study findings differ from reports of other studies, which showed that dental caries and periodontal diseases were almost the leading cause of tooth extraction.[19,20] On the contrary, some studies in Japan, Singapore, and Canada mentioned that periodontal disease was the principal reason for tooth extraction.[20,21,22] These differences may be associated with socioeconomic factors and level of dental awareness, such as fluoride use in these countries.[21,20] In addition, our study noted that tooth extraction due to dental caries was higher among females (76.62%) than males (34.8%), which was in accordance with the previous studies conducted in South Africa, Nigeria, and Saudi Arabia.[23,24,25] Interestingly, the high incidence of dental caries in females more than in males may reflect that females are more likely to excessively use sugary foods, which is the primary reason for dental caries. Furthermore, lack of dental health education and limited dental care access in some regions can be another reason for rising dental caries

prevalence. However, this suggestion requires further assessment and more study in the Libyan context.

Other findings in the present study agreed with various studies' results that the impaction and orthodontic reasons were rare conditions as the cause of tooth extractions.[26,27,28] Most tooth extraction for impaction reasons was carried out in this study at ages 20-29. It was similar to the study result conducted by Sahibzada.[7] It could be the case that the current study was conducted in educational institutions and hence the patients prefer to go to specialists for such procedures. Further research is needed to clearly understand this observation.

Our study demonstrated that dental caries and orthodontic factors are the principal cause of tooth extraction in young patients 20-38 years, while mobility and prosthodontics factors were more in older patients 50-70 years. Thomas and Al-Maqdassy also presented the same findings.[27] Nevertheless, the current result in our study and the previously mentioned study is inconsistent with many studies that reported periodontal disease was the leading cause of tooth loss in patients over 40 years.[20,21,28,29] In other words, if more teeth are conservative and restored instead of extracted, the extraction will be delayed to an older age group, this may reflect the extraction reduction due to dental caries, and most teeth are extracted for the periodontal cause.

In the current study, the most regularly extracted teeth were the third molar and first molar (29.1%, and 24.4%, respectively); this result was consistent with studies conducted by Thomas and Al-Maqdassy and Marcus et al. in the USA, third molars were the most frequently extracted teeth.[27,30] Surprisingly, dental caries in anterior teeth, first premolar, and first molar were the principal reasons for tooth extraction (100%) in all participants. The possible causes of early extraction of anterior teeth and first premolar and molar could be due to lack of prophylactic measures such as fissure sealants to protect the tooth from caries, poor eating habits such as excessive intake of sweets and candies, improper brushing techniques, lack of dental visits and poor oral hygiene. However, the results are inconsistent with other studies that mentioned that periodontal factors and prosthodontics were the leading cause of loss of anterior teeth.[24,26,31,32] The possible reason for the high periodontal extraction in anterior teeth is that this tooth is less susceptible to caries and preserved longer in the mouth by restoration.[24]

The present study could be affected by some limitations such as the short duration and the type of study design that included one institution. However, it gives an idea of the reasons for tooth extraction in the Libyan south. According to our surprising result in this study, it is recommended that should be needed for the actual implementation of preventive oral health care programs. An increase in public awareness about dental health will decrease the high-frequency incidence of dental caries among the Libyan population and retain the tooth in the oral cavity for a long time. Additionally, further study will provide enough information to plan an adequate strategy to reduce early tooth loss due to dental caries and changes in harmful dietary habits of the individuals and negatively affect the general health, oral health, and their related quality of life.

CONCLUSION
In conclusion, the main cause of teeth extraction among dental college patients remains dental caries in both young and old individuals. There is no difference in the cause of extraction between genders, whereas the type of extraction was different between males and females. Females are more prone to anterior extraction than males. Age is another factor associated with the type of tooth extraction and cause of extraction, which shows young individuals are subjected to more anterior extraction and commonly related dental caries. Therefore, dental caries is still the main reason for tooth extraction among the Libyan population, despite the evolution in technology used in dentistry and the

increased number of dental clinics and practitioners in Sabha city in Libya.

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Original article

Infection Control Attitude, Knowledge and Awareness Level Among Dental Students and Interns in the Removable Prosthodontic Department at the Faculty of Dentistry, University of Benghazi, Libya

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ABSTRACT

Background: Dental students have increased patient contact during their education and clinical practice, putting them, their patient population and Dental Health Care Workers (DHCW) at high risk of cross-infection. Awareness of infection control principles may help in preventing disease transmission; therefore, the purpose of this study was to evaluate the level of infection control knowledge, attitude, and practice among dental students and interns in a removable prosthodontic department at the Faculty of Dentistry, University of Benghazi, Libya.

Materials and Methods: In May 2023, we distributed questionnaires containing 33 items to interns, 3rd-year, and 4th-year dental students at the faculty. The questions covered topics such as hepatitis B vaccination, use of personal protective barriers, knowledge of infection control protocols, and practice in the removable prosthodontic department of the faculty. Descriptive statistics were recorded using frequency and percentages. Differences in proportions were assessed using the Chi-square and Fisher exact test. All statistical analyses were performed at a *p*-value less than 0.05.

Results: A total of four hundred and ten (410) participants responded to the questionnaire. Around 21.5% of the students had completed their hepatitis B vaccination, while 41.2% had never been vaccinated. Regarding the self-reported use of protective barriers, intern students showed a significantly higher score than did other study groups (P <0.001). Moreover, the vast majority of 3rd year students reported never wearing eyewear, a face shield, or the head cap (73.2%), (81.1%), or (70.1%), respectively. About two-thirds of intern students (69.4%) showed positive attitudes toward the treatment of patients with infectious diseases.

Conclusion: This study showed moderate compliance to infection control procedures among the participants, they have limited orientation and knowledge of the infection control guidelines and policies. Despite a positive attitude toward infection control measures, proper infection control practices were not consistently followed. Consequently, it is essential to take action to ensure that students understand the critical importance of practicing cross-infection control. Higher education institutions should implement effective solutions to address this issue.

Key Words: *Dental students, Infection control, Prosthodontics, Cross infection.*

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INTRODUCTION

Infection control and prevention of cross-contamination in the dental field are essential to providing a proper environment for patients and DHCW. Transmission of infection during dental treatment includes direct contact with saliva, oral fluids, blood, airborne droplets containing infective agents, or indirect contact via contaminated objects such as instruments, equipment, or environmental surfaces.[1] Several healthcare agencies and dental associations, like the Centers for Disease Control and Prevention in the United States of America (CDC), the Occupational Safety and Health Administration (OSHA), the American Dental Association (ADA), and others, updated their roles on infection control in dental clinics,[2,3] which include several precautions including hand washing, proper injection practice, clean and sterile instruments and devices, clean and properly disinfected environmental surfaces, and the use of personal protective equipment.[4]

Despite the protocols that were placed to make the DHCW aware of recommended practices to control the transmission of infection in dental offices, the percentage of DHCW who followed those practices was

low.[5-7] Dental students worldwide are at high risk of exposure to cross-infection with pathogens and need high-level knowledge and clinical skills in infection control.[8] Dental schools play a crucial role in providing an appropriate educational program to train students, fostering an adequate attitude toward infection control measures for protecting themselves and patients.[9,10] Although dental schools are the fundamental source of infection control education and responsible for providing proper training in infection control measures for future dental practitioners, research in Middle Eastern countries revealed low knowledge of infection control among dental students and some educating staff.[11-13]

Prosthodontic clinics and laboratories need high attention regarding infection control measures. Dental impressions, record blocks, trials, and permanent dentures are subjected to contamination and can spread infectious agents to dental students, clinicians, other patients, and technicians.[14] The objective of the present study was to investigate knowledge, attitudes and practices relative to infection control measures among dental students and interns.

MATERIALS AND METHODS
This questionnaire-based study was conducted among dental students (3rd and 4th year) and interns at the faculty in May 2023. The authors formed the questionnaire with input from field experts. The questionnaire was pretested on a random sample of 30 dental students, including all academic years, to evaluate and assess responses' practicability, readability, clarity, validity, and interpretation. The students involved in the pilot study were excluded from the final sample. The sample consisted of 410 subjects: 164 3rd -year dental students, 148 4th -year dental students, and 98 interns. The questionnaire was reviewed, and the study was ethically approved by the Ethics Committee of the Dental Faculty, Benghazi University. Additionally, approval was obtained from the head of the prosthodontic department. The participant's agreement to answer the questionnaire and return it was considered informed consent. Personal information was eliminated from the questionnaire to provide anonymity. The constructed questionnaire consisted of questions including different aspects of infection control practices:

- Demographic and academic background represents the distribution of students according to their gender and academic year.
- Level of implementation of basic infection control measures by dental students.

- Level of knowledge, attitude, and practice of infection control measures among dental students.
- Response of students toward infection control in the prosthodontic department.

Statistical analysis
The data was analyzed using Statistical Package for Social Science software (IBM SPSS ver. 24). Descriptive statistics were recorded using frequency and percentages. Differences in proportions were assessed using the Chi-square and Fisher exact test. All statistical analyses were performed at p-value less than 0.05.

RESULTS
A total of 410 completed questionnaires were received, of which the majority (72%) of the participants were females. The highest proportion of students was third-year (40%), followed by fourth-year students (36.1%) and interns (23.9%). Only one-fifth (21.5%) of students completed their hepatitis B vaccination, compared to two-fifths (41.2%) who had never been vaccinated and (37.3%) who had received an incomplete HBV vaccination course. (**Table 1** and **Figure 1**). One-third (33.9%) of males completed their hepatitis B vaccination, and nearly half (48.1%) of females had never been vaccinated, the difference was statistically highly significant $(p<0.001$, as shown in **Figure 2**).

Table 1: Distribution of the study participants

Variable	N (%)
Gender	
Male	115 (28.0%)
Female	295 (72.0%)
Year of Study	
Third-year	164 (40.0%)
Fourth-year	148 (36.1%)
Interns	98 (23.9%)
Hepatitis B Vaccination	
Completed (3 doses)	88 (21.5%)
Partial (1-2 doses)	153 (37.3%)
None	169 (41.2%)
Total	410 (100%)
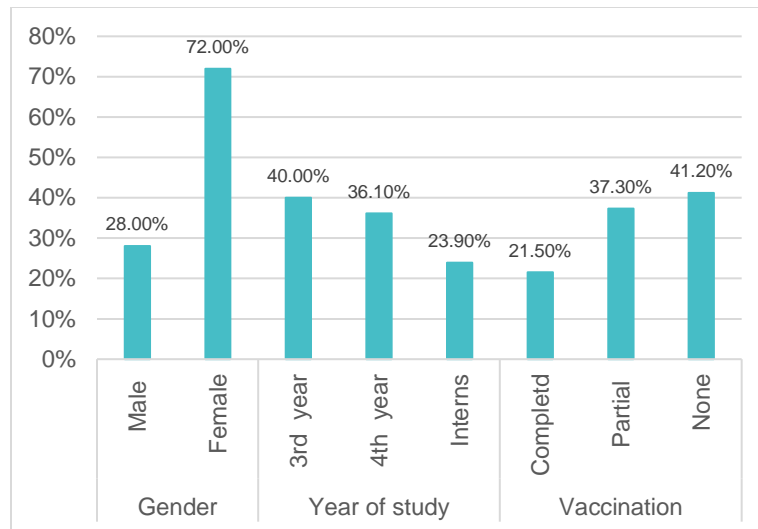
Figure 1: Distribution of the study participants
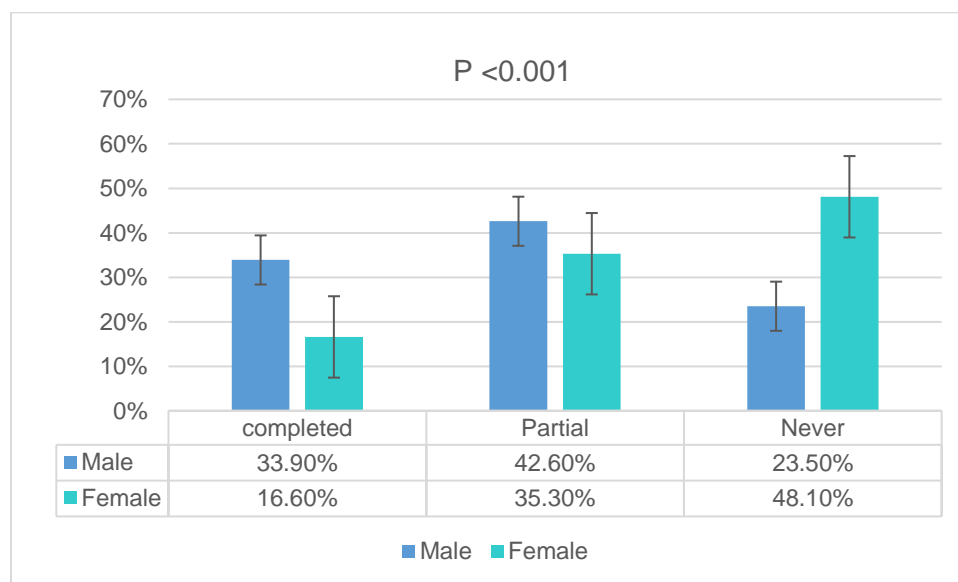
Figure 2: Comparison of vaccination status based on gender

Table 2 depicts the distributions of students based on their willingness to treat patients with infectious diseases. A significantly higher percentage of intern students (69.4%) reported their willingness to treat patients with infectious diseases, as compared to 47.0%, and 45.9 of the third-year and fourth-year students, respectively who did not mind treating patients with infectious diseases ($p<0.01$). The percentage of female students showed a positive attitude toward the treatment of patients with infectious diseases (71%) in comparison with male students (28.2%) However, no gender significant differences were found (p= 0.531).

Table 2: Willingness of dental students to treat patients with infectious diseases

Willingness to treat patients with infectious disease	Year of Study N (%)			p-value	Gender N (%)		p-value
	Third-year	Fourth-year	Interns		Male	Female	
No	7 (4.3)	15 (10.1)	2 (2)		5(20.8)	19(79.2)	
Yes	77(47)	68 (45.9)	68 (69.4)	0.001	60(28.2)	153(71.8)	0.531
Not sure	62 (37)	50(33.8)	23(23.5)		36(26.7)	99(73.3)	

The proportion of students' self-reported use of protective barriers based on the year of study and gender is presented in **Table 3**. A significantly higher percentage (98%) of intern students reported consistently wearing gloves and masks for all dental procedures (p <0.001). The vast majority of 3rd-year students reported never wearing eyewear, a face shield, or the head cap, while only 47.6% reported wearing the protective gown at all times, with no significant differences according to year of study or gender (P > 0.05).

Table 3: Use of protective barriers among dental students

		Year of Study N (%)			p-value	Gender N (%)		p-value
		Third-year	Fourth-year	Interns		Male	Female	
Gloves	Always	116 (70.7)	137 (92.6)	96 (98)	0.001	102 (29.2)	247 (70.8)	0.110
	Sometimes	42 (25.6)	11 (7.4)	2 (2)		10 (18.2)	45 (81.8)	
	Never	6 (3.7)	0 (0)	0 (0)		3 (50)	3 (50)	
Masks	Always	111 (67.7)	130 (87.8)	96 (98)	0.001	99 (29.4)	238 (70.6)	0.119
	Sometimes	47 (28.7)	18 (12.2)	2 (2)		13 (19.4)	54 (80.6)	
	Never	6 (3.7)	0 (0)	0 (0)		3 (50)	3 (50)	
Eyewear	Always	10 (6.1)	11 (7.4)	8 (8.2)	0.120	8 (27.6)	21 (72.4)	0.343
	Sometimes	34 (20.7)	44 (29.7)	33 (33.7)		37 (33.3)	74 (66.7)	
	Never	120 (73.2)	93 (62.8)	57 (58.2)		70 (25.9)	200 (74.1)	
Face shield	Always	11 (6.7)	7 (4.7)	7 (7.1)	0.212	8 (32)	17 (68)	0.476
	Sometimes	20 (12.2)	27 (18.2)	22 (22.4)		23 (33.3)	46 (66.7)	
	Never	133 (81.1)	114 (77)	69 (70.4)		84 (26.6)	232 (73.4)	
Protective gown	Always	78 (47.6)	62 (41.9)	35 (35.7)	0.370	40 (22.9)	135 (77.1)	0.130
	Sometimes	30 (18.3)	27 (18.2)	18 (18.4)		24 (32)	51 (68)	
	Never	56 (34.1)	59 (39.9)	45 (45.9)		51 (31.9)	109 (68.1)	
Head cap	Always	24 (14.6)	22 (14.9)	16 (16.3)	0.992	14 (22.6)	48 (77.4)	0.146
	Sometimes	25 (15.2)	21 (14.2)	15 (15.3)		23 (37.7)	38 (62.3)	
	Never	115 (70.1)	105 (70.9)	67 (68.4)		78 (27.2)	209 (72.8)	

Chi-square and Fisher exact test were used to compare proportions. *p<0.05.*

Regarding students' self-reported practice of basic infection control protocol, It was revealed that changing gloves between patients and hand washing between each glove change was performed frequently by most of the study sample (95.9% and 78.6%, respectively) with no significant difference based on year of study or gender. Significantly higher proportions of fourth-year students reported more frequent change of facemasks between patients, use of surface barrier, change of contaminated Gown/coat, and sterilized instruments after each procedure (49.3%, 80.4%, 68.2%, and 93.9%). However, females change face masks more frequently than males (P<0.031). More than two-thirds of intern students reported the removal of gloves and masks while walking around and the removal of watches, rings, and jewelry (75.5% and 81.6%), respectively (*p*<0.05) **Table 4**)

Table 4: Practice of basic infection control protocol among dental students

Practice of basic infection control protocol		Year of Study N (%)			*p*- value	Gender N (%)		*p*-value
		Third-year	Fourth-year	Interns		Male	Female	
Change gloves between patients	Always	149 (90.9)	142 (95.9)	94 (95.9)	0.144	105 (27.3)	280 (72.7)	0.352
	Sometimes	11 (6.7)	4 (2.7)	4 (4.1)		7 (36.8)	12 (63.2)	
	Never	4 (2.4)	2 (1.4)	0 (0)		3 (50)	3 (50)	
Hand wash between each glove change	Always	112 (68.3)	103 (69.6)	77 (78.6)	0.367	82 (28.1)	210 (71.9)	0.421
	Sometimes	42 (25.6)	39 (26.4)	17 (17.3)		25 (25.5)	73 (74.5)	
	Never	10 (6.1)	6 (4.1)	4 (4.1)		8 (40)	12 (60)	
Change of facemask between patients	Always	73 (44.5)	73 (49.3)	41 (41.8)	0.001	50 (26.7)	137 (73.3)	0.031
	Sometimes	62 (37.8)	60 (40.5)	23 (23.5)		34 (23.4)	111 (76.6)	
	Never	29 (17.7)	15 (10.1)	34 (34.7)		31 (39.7)	47 (60.3)	
Gloves /mask removal while around	Always	78 (47.6)	83 (56.1)	74 (75.5)	0.001	61 (26)	174 (74)	0.549
	Sometimes	66 (40.2)	56 (37.8)	20 (20.4)		44 (31)	98 (69)	
	Never	20 (12.2)	9 (6.1)	4 (4.1)		10 (30.3)	23 (69.7)	
Use of surface barrier	Always	120 (73.2)	119 (80.4)	78 (79.6)	0.025	86 (27.1)	231 (72.9)	0.697
	Sometimes	37 (22.6)	17 (11.5)	11 (11.2)		21 (32.3)	44 (67.7)	
	Never	7 (4.3)	12 (8.1)	9 (9.2)		8 (28.6)	20 (71.4)	
Change of contaminated Gown/coat	Always	97 (59.1)	101 (68.2)	55 (56.1)	0.001	68 (26.9)	185 (73.1)	0.180
	Sometimes	44 (26.8)	27 (18.2)	12 (12.2)		20 (24.1)	63 (75.9)	
	Never	23 (14)	20 (13.5)	31 (31.6)		27 (36.5)	47 (63.5)	
Watches, rings and jewellery removal	Always	112 (68.3)	114 (77)	80 (81.6)	0.041	88 (28.8)	218 (71.2)	0.702
	Sometimes	37 (22.6)	26 (17.6)	17 (17.3)		22 (27.5)	58 (72.5)	

		Third-year	Fourth-year	Interns	p-value	Male	Female	p-value
	Never	15 (9.1)	8 (5.4)	1 (1)		5 (20.8)	19 (79.2)	
Instruments sterilization after each procedure	Always	143 (87.2)	139 (93.9)	66 (67.3)	0.001	92 (26.4)	256 (73.6)	0.089
	Sometimes	15 (9.1)	8 (5.4)	32 (32.7)		22 (40)	33 (60)	
	Never	6 (3.7)	1 (0.7)	0 (0)		1 (14.3)	6 (85.7)	

Chi-square and Fisher exact test were used to compare proportions. *P<0.05.*

Table 5 summarizes the practices of infection control among dental students in prosthodontic department. It was revealed that significantly higher proportions of fourth-year students generally reported more adherence to the recommended infection control practices than interns and third-year students (P<0.001). However, the results revealed highly significant values of intern students regarding the disinfection of rubber bowls between patients and disinfection of impressions following rinsing with water in comparison with other study groups (P<0.001). Moreover, a significantly higher percentage of females (70.8%) were found to disinfect dental casts (P<0.001) and metal frameworks for partail dentures (P<0.039) before sending and receiving them from the dental laboratory.

Table 5: The practices of infection control in the prosthodontic department

Disinfection between patients		Year of Study N (%)			p-value	Gender N (%)		p-value
		Third-year	Fourth-year	Interns		Male	Female	
Rubber bowel	Always	92 (56.1)	95 (64.2)	65 (66.3)	0.001	66 (26.2)	186 (73.8)	0.284
	Sometimes	51 (31.1)	39 (26.4)	6 (6.1)		26 (27.1)	70 (72.9)	
	Never	21 (12.8)	13 (8.8)	27 (27.6)		23 (37.7)	38 (62.3)	
Alginate mixing spatula	Always	89 (54.3)	104 (70.3)	59 (60.2)	0.001	63 (25)	189 (75)	0.277
	Sometimes	57 (34.8)	33 (22.3)	9 (9.2)		32 (32.3)	67 (67.7)	
	Never	18 (11)	10 (6.8)	30 (30.6)		20 (34.5)	38 (65.5)	
Shade guide	Always	74 (45.1)	93 (62.8)	40 (40.8)	0.001	58 (28)	149 (72)	0.718
	Sometimes	63 (38.4)	39 (26.4)	31 (31.6)		35 (26.3)	98 (73.7)	
	Never	27 (16.5)	15 (10.1)	27 (27.6)		22 (31.9)	47 (68.1)	
Wax knives, carvers	Always	94 (57.3)	111 (75)	54 (55.1)	0.001	67 (25.9)	192 (74.1)	0.238
	Sometimes	48 (29.3)	34 (23)	17 (17.3)		28 (28.3)	71 (71.7)	
	Never	22 (13.4)	2 (1.4)	27 (27.6)		20 (39.2)	31 (60.8)	
Coping pencil	Always	72 (43.9)	99 (66.9)	48 (49)	0.001	57 (26)	162 (74)	0.606
	Sometimes	60 (36.6)	38 (25.7)	24 (24.5)		36 (29.5)	86 (70.5)	
	Never	32 (19.5)	10 (6.8)	26 (26.5)		22 (32.4)	46 (67.6)	

While taking impressions, do you?		Year of Study N (%)			*p*-value	Gender N (%)		*p*-value
		Third-year	Fourth-year	Interns		Male	Female	
Apply barrier /disinfect gun	Always	95 (57.9)	105 (70.9)	53 (54.1)	0.003	67 (26.5)	186 (73.5)	0.247
	Sometimes	51 (31.1)	29 (19.6)	41 (41.8)		41 (33.9)	80 (66.1)	
	Never	18 (11)	13 (8.8)	4 (4.1)		7 (20)	28 (80)	
Rinse the impression under tap water	Always	150 (91.5)	139 (93.9)	92 (93.9)	0.550	107 (28.1)	274 (71.9)	0.458
	Sometimes	10 (6.1)	6 (4.1)	5 (5.1)		6 (28.6)	15 (71.4)	
	Never	4 (2.4)	1 (0.7)	1 (1)		1 (16.7)	5 (83.3)	
Disinfect impression after rinsing	Always	131 (79.9)	139 (93.9)	93 (94.9)	0.001	102 (28.1)	261 (71.9)	0.671
	Sometimes	27 (16.5)	8 (5.4)	4 (4.1)		12 (30.8)	27 (69.2)	
	Never	6 (3.7)	0 (0)	1 (1)		1 (14.3)	6 (85.7)	
Disinfect before sending and after receiving from dental laboratory		Year of Study N (%)			*p*-value	Gender N (%)		*p*-value
		Third-year	Fourth-year	Interns		Male	Female	
Dental cast.	Always	108 (65.9)	111 (75)	48 (49)	0.011	58 (21.7)	209 (78.3)	0.001
	Sometimes	41 (25)	22 (14.9)	20 (20.4)		32 (38.6)	51 (61.4)	
	Never	15 (9.1)	14 (9.5)	5 (5.1%)		13 (38.2)	21 (61.8)	
Dental prosthesis	Always	121 (73.8)	128 (86.5)	54 (55.1)	0.001	79 (26.1)	224 (73.9)	0.176
	Sometimes	31 (18.9)	14 (9.5)	18 (18.4)		19 (30.2)	44 (69.8)	
	Never	12 (7.3)	5 (3.4)	1 (1)		5 (27.8)	13 (72.2)	
Metal framework for RPD /Trail	Always	106 (64.6)	114 (77)	55 (56.1)	0.001	71 (25.8)	204 (74.2)	0.039
	Sometimes	40 (24.4)	19 (12.8)	16 (16.3)		26 (34.7)	49 (65.3)	
	Never	18 (11)	14 (9.5)	2 (2)		6 (17.6)	28 (82.4)	
Bite registration or record block	Always	106 (64.6)	119 (80.4)	55 (56.1)	0.001	74 (26.4)	206 (73.6)	0.053
	Sometimes	41 (25)	20 (13.5)	16 (16.3)		25 (32.5)	52 (67.5)	
	Never	17 (10.4)	8 (5.4)	2 (2)		4 (14.8)	23 (85.2)	
Autoclave before being used with patients.		Year of Study N (%)			*p*-value	Gender N (%)		*p*-value
		Third-year	Fourth-year	Interns		Male	Female	
Impression tray	Always	112 (68.3)	123 (83.1)	74 (75.5)	0.023	89 (28.8)	220 (71.2)	0.791
	Sometimes	34 (20.7)	12 (8.1)	17 (17.3)		17 (27)	46 (73)	
	Never	18 (11)	12 (8.1)	7 (7.1)		9 (24.3)	28 (75.7)	
Facebow fork	Always	101 (61.6)	120 (81.1)	74 (75.5)	0.001	80 (27.1)	215 (72.9)	0.745

	Sometimes	41 (25)	20 (13.5)	22 (22.4)		26 (31.3)	57 (68.7)	
	Never	22 (13.4)	7 (4.7)	2 (2)		9 (29)	22 (71)	
Fox occlusal plane	Always	97 (59.1)	122 (82.4)	68 (69.4)	0.001	87 (30.3)	200 (69.7)	0.365
	Sometimes	38 (23.2)	20 (13.5)	20 (20.4)		17 (21.8)	61 (78.2)	
	Never	29 (17.7)	5 (3.4)	10 (10.2)		11 (25)	33 (75)	

DISCUSSION

Dental students in the prosthodontic department are at risk of acquiring infection directly from their patients during dental procedures or indirectly through exposure to contaminated surfaces and dental laboratory items such as impressions, dental casts, record blocks, trial dentures, and finished prosthetic appliances.

The presented study attempted to evaluate attitudes, knowledge, awareness, and practice of infection control policies related to prosthodontics in Benghazi's public dental sector. The targeted sample in this study was the public rather than the private sector because public dental schools include more students. The sample included 3rd and 4th year dental students and interns. By focusing on this group, the study provided insights into the adequacy of dental teaching programs in covering essential information and behaviors related to infection control measures for future dental practitioners. Notably, the study concentrated on common categories rather than evaluating all aspects of infection control. Almost two-thirds of respondents (72%) were females which could be attributed to the higher number of female interns and dental students compared to males.

The study revealed alarmingly low HBV vaccination rates among dental students. Only 21.0% of students completed their HBV vaccination, significantly lower than rates reported in other countries (e.g., Canada: 100%, UAE: 95.8%, Brazil: 98.8%, Yemen: 70.0%).[11,13,15,16] Interestingly, male students were more likely to complete immunization doses, possibly due to easier access to vaccination centers. Lack of awareness about vaccine importance and the absence of mandatory vaccination requirements during dental school registration may contribute to this concerning drift.

The result of the presented study showed that female students are more likely to agree to treat a simulated patient with infectious disease in general compared with male students, which could be due to the fact that female students appear to follow infection-control measures more closely than their male colleagues.[17] However, generally, the mean percentage of willingness of dental students to treat patients with infectious diseases in our sample was 54.1%, which could be due to a lack of confidence and knowledge among students in their ability and preparedness to manage infectious cases. Unfortunately, this negative attitude could lead patients infected with HIV or HBV to withhold their condition from dentists due to fear of denial of treatment. To address this, strict adherence to infection-control protocols is essential for every patient encounter. Incorporating dental management of patients with infectious diseases into educational and continuous training programs is crucial. Such programs can enrich both students' and dentists' knowledge and practical skills related to disease processes and transmission risks. By doing so, we can foster an improved attitude toward treating these patients effectively.

When evaluating the practice of basic infection control protocol among dental students, most of them (90%–95%) were wearing and changing gloves between patients; however, the frequency of changing other protective barriers such as face masks, protective eyewear, face shields, and head caps was very unsatisfactory, which may indicate a low level of students' awareness about the possibility of disease transmission through blood splashes and aerosols. This result is comparable to previous studies[18,19] in which using head caps and protective glasses was low. To address this, dental students should be educated about the importance of wearing masks and other necessary protective barriers to minimize the risk of infection transmission. Additionally, emphasizing proper hand hygiene is crucial, as hands can serve as reservoirs for various pathogens.[20] Unfortunately, only 68.3%–78.6% of students in our sample reported hand washing between glove changes.

In our study, nearly half of the students reported changing their coats. It has been recommended that medical coats worn in dental clinics be changed daily and immediately following a blood splatter or when they are clearly contaminated to avoid cross-contamination.[13] A large number of pathogenic microorganisms have been isolated under watches and rings. The majority of students in this study reported removing their watches and jewelry while performing

dental procedures. However, the difference between the different groups involved in this study was significant (p = 0.041).

On the other hand, the evaluation of students' awareness and attitude toward infection control measures in the prosthodontic department is about the disinfection of items used regularly in the prosthodontic department, such as rubber bowels, shade guides, alginate mixing spatulas, wax knives, and coping pencils. The results presented a lack of commitment of students, especially 3rd year and intern students, toward the disinfection of such items (40.8%–66.3%). While making an impression, the majority of the students informed us that they rinsed the impressions under tap water and disinfected them with proper disinfectant immediately following their removal from the patient's mouth.

The risk of a cycle of cross-contamination, which may involve dental laboratory technicians, dental practitioners, patients, and auxiliary personnel through blood, mucus, or saliva, has been well-documented.[21] Therefore, items exposed to contamination should be disinfected both before being sent to the laboratory and immediately upon receiving them back from the lab.[22] Regarding the infection control protocol between the dental clinic and the dental laboratory, a few questions were included to assess the disinfection of some items sent or received from the dental laboratory, such as dental impressions, dental casts, metal frameworks, record blocks, and finished dental prostheses. The majority of 4th-year students (75%–86%) are disinfecting those items before sending and receiving them from the dental laboratory. However, the percentage of 3rd-year students who disinfected those items was statistically lower than that of 4th-year students. The probable reason could be that 3rd-year students have less work experience.

Generally, the findings of this study showed inadequate compliance with ideal infection control procedures among the participants, which could be due to an insufficient supply of protective equipment and a lack of continuous, periodic educational programs and refreshing training courses to support infection control measures. Furthermore, hepatitis B vaccination should be made mandatory before registration at any dental training institution to protect the students prior to exposure.

The findings could alert educators regarding the importance of instructing and teaching their students about infection control measures. Infection control measures can be written on a poster to be as a reminder for students to raise their knowledge and improve their practice in this field. Formal classes and evaluations could improve knowledge and clinical practice of dental students.

Some limitations of the present study should be acknowledged. The responses might not truly reflect the real level of attitude and knowledge of participants because they depended on participant self-assessment without the supervision of an investigator in a clinical environment. Moreover, because this study was conducted in a single public institution, the results did not reflect the attitudes, knowledge, and practices of the students in other dental institutions. However, the results could help plan a survey that includes other private and public sectors across Benghazi city and the whole country.

CONCLUSION

In this study, participants demonstrated moderate compliance with infection control procedures. However, their knowledge of infection control guidelines was limited. Despite a positive attitude toward infection control measures, greater emphasis on compliance with HBV vaccination is essential. Efforts should focus on providing comprehensive training in ideal infection control practices for undergraduate students, and continuing education courses for dentists in this field are recommended

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