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Dental caries patterns in patients treated by dental students: insights from the faculty of dentistry, Benghazi University

Arig Mohammed Abdullah *, Fatma Othman Alfeitouri and Naeima Mohamed Betamar

Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, University of Benghazi, Benghazi, Libya.

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Abstract

Background: Dental caries remain a prevalent global health concern influenced by multiple biological and behavioral factors. This study aimed to assess caries patterns, prevalence, and restorative treatments among adult patients treated by dental students at the University of Benghazi.

Subjects and Methods: A retrospective analysis of 1,112 patient records from the Department of Conservative Dentistry and Endodontics (2024–2025) was conducted. Data included patient demographics, caries classification (based on Black's system), affected teeth, and type of restoration used. Descriptive and statistical analyses were performed using SPSS v20, with significance set at $p < 0.05$.

Results: Females accounted for 63.4% of cases, with the highest caries prevalence in the 21–30 age group. Mandibular first and second molars were the most frequently affected teeth. Class I caries (pit and fissure) was the most common type (83.5%), predominantly occurring in younger patients, while proximal caries (Class II and III) showed a lower prevalence. Root caries was rare (0.2%) and found exclusively in older males**.** Composite resin was the predominant restorative material used (85%), with no amalgam recorded. Gender was significantly associated with caries distribution and classification, but not with the choice of restoration type. Age showed significant variation in caries site and type, but did not influence material selection.

Conclusions: The study revealed females and young adults (21-30 years) had the highest caries prevalence, particularly in mandibular molars with dominant Class I occlusal caries. Biological and behavioral factors interacted to shape caries patterns, while practice showed complete transition to composite resin restorations aligned with global standards, maintained through standardized treatment protocols.

Keywords: Dental Caries; Caries Patterns; Dental Students; Restoration; Adult Patients; Conservative Dentistry Department

1. Introduction

Oral health plays a vital role in enabling individuals to speak, eat, and drink properly, and it contributes significantly to general health, well-being, and social interactions [1]. Consequently, oral diseases have a substantial impact, not only in terms of individual discomfort and reduced quality of life but also due to the financial strain they impose on both individuals and society. This burden extends beyond the cost of treatment to include decreased productivity in the workforce [2]. Dental caries are the most prevalent oral disease, caused by multiple factors, i.e., the tooth structure, oral microbiota (Streptococci and Lactobacilli bacteria), and dietary carbohydrates[3–5]. WHO (2003) has issued a project, "Global Goals for Oral Health by 2020 for all," to improve the oral health status of the world population [6]. The

* Corresponding author: Arig Mohammed Abdullah

prevalence of dental caries is between 60 and 90% worldwide[7]. The global burden of dental caries is nearly 100% among adults [8].

Dental caries present as cavities in the tooth's hard tissue, typically appearing brown or black [9]. These cavities are usually painless until they enlarge and extend to the innervated pulp cavity [10]. If untreated, the decay progresses, causing pain when subjected to various stimuli [11]. This condition can lead to inflammation and subsequent tissue death within the pulp chamber.

Information regarding a patient's caries pattern or the site of dental caries may provide knowledge regarding the etiology of the disease[12]. According to the site of dental caries, it is classified into occlusal pit and fissure caries, smooth surface caries, root caries, and recurrent caries[5]. The prevalence pattern of dental caries varies with age, socioeconomic status, race, food, and oral hygiene habits [13]. There are limited studies worldwide assessing the type of dental caries among the adult population [14,15]. The morphology of the posterior teeth has cusps and pits that are good sites for food packing [16]. The most frequent teeth for attacks are the 1st and 2nd permanent molars [17]. Individual tooth surface has different susceptibilities; pits and fissures on the occlusal surface are more susceptible than the smooth labial and lingual [18]. Dental caries prevalence also varies according to the position and morphology of teeth [19]. The risk of caries development on a tooth surface is low during the first post-eruptive year but increases markedly thereafter. [20]. The structure of a tooth is important because some surfaces are more susceptible to caries attacks than others [21]. The posterior teeth have a higher prevalence of caries than the anterior teeth [22]. Therefore, dental caries is largely attributed to personal behaviors [23]. Tobacco smoking, poor oral hygiene, and consumption of sugary diets increase the prevalence of dental caries [24]. Poor oral hygiene significantly increases the risk of developing multiple dental cavities[25,26]. Therefore, literature reported that the prevalence of dental caries is higher in rural areas than in urban areas [8]. In addition, it has been documented that older people have higher prevalence rates than younger people [11,12].

Documenting the clinical cases managed by students is not only an educational tool but also an important source of data that can be analyzed to understand disease patterns, the distribution of treatment types provided, and the comprehensiveness of students' clinical training.

A comprehensive insight into the prevalence rates of dental caries among the adult population of various ages and genders treated by dental students at the Faculty of Dentistry, Benghazi University. These data can help plan preventive and treatment strategies for the population at greater risk of developing dental caries. This study aimed to assess caries patterns, prevalence, and restorative treatments among adult patients treated by dental students at the Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, University of Benghazi, during the 2024/2025 academic year.

2. Subjects and Method

2.1. Study design

This retrospective study reviewed the dental records of patients diagnosed with dental caries and treated by final-year dental students at the Department of Conservative Dentistry and Endodontics, Faculty of Dentistry, University of Benghazi, Libya. "Ethical approval for this study was obtained from the Scientific Research Ethics Committee (SREC) of the Faculty of Dentistry at the University of Benghazi [Approval No. 0290]." The data were collected reliably and supported by evidence.

2.2. Data Collection

Data were reviewed and collected from patient records over a one-year academic period (2024–2025). All patients diagnosed with dental caries who were between 15 and 80 years of age were included in the study. Only patients who received restorative treatment in the Department of Conservative Dentistry and Endodontics were considered. Patients with incomplete records or those under 15 or over 80 years old were excluded.

The patients' data were recorded, including the total number of patients who visited the Department of Conservative Dentistry and Endodontics and were diagnosed with dental caries. And the Patient's file number, gender, age, and type/pattern of dental caries. Patients were categorized into four age groups (15–25, 26–40, 41–60, and 61–80 years), with each group further stratified by gender.

2.3. Statistical Analysis

The collected data were first tabulated using Microsoft Excel 2010 and then exported to the Statistical Package for the Social Sciences (SPSS version 20.0) for Windows for statistical analysis. Descriptive statistics were used to summarize the data, and chi-square tests were performed to assess associations, with a significance level of 5% ($p < 0.05$).

3. Results

3.1. Demographic Characteristics

The total number of patients who visited the Conservative and Endodontic Department and were treated by dental students during the academic year 2024/2025 was 1,112. Therefore, the study population consisted of 1,112 patients with dental caries, revealing a significant gender disparity (Figure 1). Females represented 63.4% (n=705) of cases compared to 36.6% males (n=407). Age distribution analysis revealed that young adults (21-30 years) constituted the largest proportion (33.3%), followed by 31-40 years (24.1%) and <20 years (21.2%). Older age groups showed progressively lower representation: 41-50 years (15.7%), 51-60 years (3.2%), and >60 years (2.4%) (Table 1).

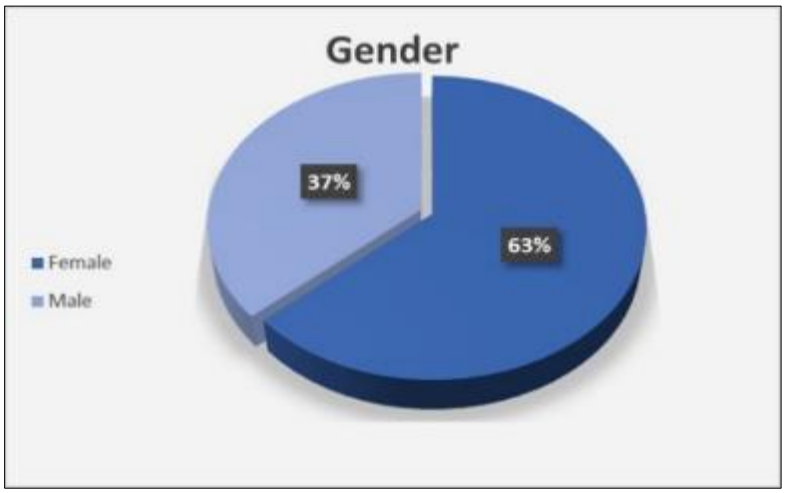

Figure 1 Patient distribution by gender

Table 1 Patient distribution by age groups

Age Groups	No.	(%)
less than 20	236	21.2%
21 - 30 years	370	33.3%
31 - 40 years	268	24.1%
41 - 50 years	175	15.7%
51 - 60 years	36	3.2%
over 61 years	27	2.4%

3.1.1. Caries Pattern Analysis across affected teeth

Dental caries exhibited distinct anatomical predilection, with the mandibular first molars being the most commonly affected at 39.5% (n=439), followed by the mandibular second molars at 31.7%(n=352), and the mandibular second premolars at 7.7%(n=86). Other teeth demonstrated substantially lower caries prevalence (range: 0.3%-5.5%), with minimal involvement of mandibular lateral incisors and maxillary third molars (0.3% each) (Table 2).

Table 2 Caries Pattern Analysis: across affected teeth

Carious teeth	No.	(%)
Mandibular Central Incisor	4	0.4%
Mandibular Lateral Incisor	3	0.3%
Mandibular Canine.	11	1.0%
Mandibular First Premolar	24	2.2%
Mandibular Second Premolar	86	7.7%
Mandibular First Molar	439	39.5%
Mandibular Second Molar	352	31.7%
Mandibular Third Molar (Wisdom Tooth)	18	1.6%
Maxillary Central Incisor	61	5.5%
Maxillary Lateral Incisor	20	1.8%
Maxillary Canine	19	1.7%
Maxillary First Premolar	11	1.0%
Maxillary First Premolar	15	1.3%
Maxillary First Molar	33	3.0%
Maxillary Second Molar	13	1.2%
Maxillary Third Molar (Wisdom Tooth)	3	0.3%

3.1.2. Caries classification distribution

The analysis of caries morphology based on Black's classification, with the addition of class VI and root caries, revealed clear patterns of prevalence (Figure 2). Class I caries (pit and fissure caries lesions) showed a dominant presence of 83.5% (n=928), mainly affecting the occlusal surfaces of posterior teeth. The other classifications had significantly lower frequencies: Class III (proximal caries lesions in anterior teeth not involving incisal angles) comprised 5.6% (n=62), and Class II (proximal caries lesions in posterior teeth) made up 4.9% (n=54).

Less frequent classifications included: Class V (gingival one-third caries lesions): 4.3% (n=48), Class IV (proximal caries lesions in anterior teeth involving incisal angles): 1.3% (n=14), Class VI (caries lesions at cusp tip): 0.4% (n=4).and Root caries: 0.2% (n=2). The exceptionally low prevalence of root caries (0.2%) likely reflects the demographic composition of our study population, where older adults (>60 years) accounted for only 2.4% of cases.

Figure 2 Distribution of patients according to classes of dental caries

3.2. Restoration Type Analysis

The data revealed a predominant preference for direct composite resin restorations, accounting for 85.0% of all cases (n=945), establishing this as the primary restorative approach. Composite with linear insulating base represented 10.1% of cases (n=112), followed by glass ionomer cement at 4.9% (n=55). Notably, the study recorded a complete absence of amalgam restorations (0.0%), reflecting contemporary practice patterns in the studied clinical environment.

3.2.1. Gender Differences in Caries Distribution, Caries Classification, and Restoration Type

The analysis revealed a statistically significant association between gender and caries distribution patterns (p = 0.008). Females demonstrated significantly higher caries prevalence in posterior teeth, particularly in mandibular first molars, mandibular second molars, and mandibular second premolars. Conversely, males exhibited higher caries rates in anterior teeth, particularly affecting maxillary central incisors and mandibular canines.

A statistically significant association was found between gender and caries classification (p=0.004), with females exhibiting significantly higher prevalence of Class I caries (pit and fissure lesions) than males. No other caries classifications demonstrated significant gender-based differences in distribution. Notably, root caries showed exclusive occurrence in male patients, though this finding did not reach statistical significance due to the low overall incidence (0.2%) in the study population. Regarding restorative materials, statistical analysis showed no significant gender-based differences in material selection (p=0.854), indicating that treatment choices were not influenced by patient gender in this clinical setting (Table 3).

Table 3 Association between gender and caries classification

Cavity classes	**Gender**				**P_ Value**
	Female		**Male**		
	No	**%**	**No**	**%**	
Class I	609	54.8%	319	28.7%	0.004
Class II	29	2.6%	25	2.2%	
Class III	38	3.4%	24	2.2%	
Class IV	5	0.4%	9	0.8%	
Class V	22	2.0%	26	2.3%	
Class VI	2	0.2%	2	0.2%	
Root caries	0	0%	2	0.2%	

3.2.2. Age Distribution and Caries Patterns, Caries Classification and Restoration Choice

The study population had a mean age of 31.07 ± 11.78 years (range: 14-78 years), demonstrating broad age representation. Statistical analysis revealed significant age-related differences in caries susceptibility across tooth types (p=0.003), indicating non-random, clinically meaningful variation patterns (Table 4). Older age showed a strong association with caries in the mandibular lateral incisor (50.33 ± 11.55 years), representing the oldest affected group, followed by the maxillary canine (41.21 ± 15.63 years) and mandibular central incisor (41.00 ± 20.93 years). In contrast, younger age groups demonstrated higher caries susceptibility in molars, particularly the maxillary first molars (27.15 ± 10.47 years) as the youngest affected group, with mandibular first molars (29.79 ± 10.24 years) and mandibular second molars (29.99 ± 10.02 years) showing similar age distributions.

The analysis revealed significant age-related patterns in caries distribution across different lesion classifications (p < 0.001). Class I caries (occlusal pit and fissure lesions) presented at significantly younger ages compared to other classifications, while root caries demonstrated the oldest age of occurrence. Intermediate caries classes showed distinct age distributions reflecting their varied etiological pathways.

Table 4 Distribution of average age according to carious teeth

Caries teeth	Mean ± Std Dev	P_ Value
Mandibular Central Incisor	41.00 ± 20.93	0.003
Mandibular Lateral Incisor	50.33 ± 11.55	
Mandibular Canine.	39.64 ± 18.22	
Mandibular First Premolar	36.00 ± 19.57	
Mandibular Second Premolar	31.91 ± 13.77	
Mandibular First Molar	29.79 ± 10.24	
Mandibular Second Molar	29.99 ± 10.02	
Mandibular Third Molar (Wisdom Tooth)	32.89 ± 9.09	
Maxillary Central Incisor	35.13 ± 13.98	
Maxillary Lateral Incisor	32.35 ± 15.33	
Maxillary Canine	41.21 ± 15.63	
Maxillary First Premolar	34.82 ± 13.37	
Maxillary First Premolar	34.33 ± 14.22	
Maxillary First Molar	27.15 ± 10.47	
Maxillary Second Molar	37.31 ± 18.45	
Maxillary Third Molar (Wisdom Tooth)	36.67 ± 14.64	

Regarding restorative interventions, statistical analysis indicated no significant association between patient age and selection of filling materials ($p > 0.05$). This finding suggests that material choice was independent of age considerations in the studied clinical population.

4. Discussion

Continuous enhancement of dental education and clinical training at the Faculty of Dentistry, University of Benghazi, is pivotal for maintaining high standards of patient care and ensuring that students acquire up-to-date practical skills. This commitment corresponds with international recommendations highlighting the essential role of supervised clinical experience in dental programs[27]. As part of this effort, rigorous evaluation of clinical skills and adherence to quality benchmarks remains fundamental to fostering competency and excellence in dental training[28]. Dental students in the Conservative Dentistry and Endodontics Department regularly perform caries management and restorative procedures under the supervision of faculty staff members. However, despite the clinical training provided, there is a notable lack of recent retrospective studies analyzing patient volume, restoration types (amalgam vs. composite), and tooth-specific prevalence (premolars vs. molars) within this department. The absence of such data limits evidence-based assessments of clinical trends, material preferences, and caries distribution patterns in this educational setting. This study was therefore conducted to address this lack of data,_offering insights into restorative practices and caries prevalence to guide future curriculum improvements and patient care strategies.

The study indicates that a total of 1,112 adult patients sought treatment for dental caries at the Conservative Dentistry clinic during the 2024/2025 academic year. This patient volume reflects a substantial burden of dental caries and the demand for restorative dental care services in the region. The predominance of patients from Benghazi and its surrounding areas underlines the department's role as a key provider of dental care locally.

The findings of this study highlight a notable gender disparity in the prevalence of dental caries, with females constituting a significantly larger proportion of cases compared to males. This gender difference aligns with previous research by Lukacs and Largaespada [29] . Kasana et al.,[30] suggested that hormonal fluctuations, particularly during puberty, menstruation, pregnancy, and menopause, may increase females' susceptibility to caries by affecting saliva composition and flow rate, which are critical in maintaining oral health. Additionally, Javed et al., [31] suggested that behavioral factors such as dietary habits and oral hygiene practices may differ by gender, contributing to this disparity.

The age distribution analysis further reveals that young adults aged 21-30 years represent the largest proportion of dental caries cases This is consistent with epidemiological data from the World Health Organization (WHO, 2020), which indicates that dental caries prevalence peaks during young adulthood due to lifestyle factors such as increased sugar consumption, irregular dental visits, and stress-related behaviors that may compromise oral hygiene[6]. This also aligns with the idea that permanent teeth become less prone to decay after they erupt. As the enamel matures, it absorbs minerals like fluoride, making it harder, less porous, and more resistant to cavities [32]. The decrease in cavities seen in older age groups (especially after 40) may be due to fewer remaining teeth (from tooth loss) or improved dental care habits over time [7]. Interestingly, the relatively high proportion of cases among individuals under 20 years underscores the importance of early preventive measures. This age group is known to be at risk due to factors such as poor dietary habits, lack of fluoride exposure, and inadequate oral hygiene education [33]. The findings emphasize the need for targeted oral health promotion and caries prevention strategies focusing on both adolescents and young adults.

Moreover, the underrepresentation of older adults "over 60 years" contrasts with high-income countries' caries profiles [34]. Aloshaiby et al., [35] proposed that this pattern may indicate limited dental access for elderly Libyans or cohort effects from wartime healthcare disruptions, as those with poor oral health might have already experienced tooth extractions or other dental interventions.

There was a distinct anatomical caries pattern, with mandibular first and second molars most affected due to early eruption, complex occlusal morphology, and plaque-retentive fissures. Lower prevalence in premolars and minimal involvement of lateral incisors and third molars correspond to their later eruption and simpler anatomy[32]. These findings align with Demirci et al., [15], Alshehri et al.,[36], and Sumba et al.,[37]confirming the higher susceptibility of "first and second "molars to caries compared to other teeth. The mandibular arch demonstrated significantly greater caries prevalence than the maxillary arch, highlighting the need for targeted prevention in high-risk molars.

The dominance of Class I caries in this study highlights the high vulnerability of pit and fissure areas on occlusal surfaces of posterior teeth, due to their complex anatomy and limited saliva exposure, promoting biofilm formation, and it is also protected from mechanical cleaning[38]. The lower prevalence of proximal lesions (Class II and III) and other classifications reflects typical caries patterns in a younger population with fewer exposed root surfaces. Smooth surface caries, mainly on proximal and gingival areas, were linked to poor oral hygiene and plaque buildup, especially in rural areas with low dental awareness[39]. Kutesa et al., [40] also reported high interproximal caries in incisors, suggesting a lack of preventive practices like flossing. The minimal occurrence of root caries aligns with the small proportion of older adults in the sample, as root caries is more common in elderly populations due to gingival recession and root exposure. The strong predilection for occlusal surface caries (Class I) remains consistent with the previously observed high prevalence in mandibular molars, while the minimal Class VI occurrences suggest effective enamel protection at cusp tips[15,17,18].

The predominance of direct composite resin restoration reflects current clinical preferences for esthetic, adhesive, and minimally invasive materials. Composite resins offer advantages such as excellent esthetics, strong bonding to tooth structure, and preservation of healthy tissue, which contribute to their widespread use in restorative dentistry[41]. The limited use of composites with a linear insulating base and glass ionomer cement suggests these materials are reserved for specific clinical situations, such as deep cavities or the need for fluoride release. The complete absence of amalgam restorations aligns with global trends moving away from amalgam due to aesthetic concerns, environmental issues, and institutional policies favoring mercury-free dentistry[42]. Studies reported acceptable survival rates for composite restorations, with 5-year survival around 86% and annual failure rates between 1% and 4%, supporting their reliability as a primary restorative option[43,44]. These findings underscore the shift toward materials that balance function, esthetics, and biocompatibility in modern dental practice. While our study showed 0% amalgam use, some public health systems still utilize amalgam for posterior load-bearing restorations due to its proven 15–20 year survival[45]. This discrepancy highlights regional variations in restorative philosophies.

This study identified significant correlations between gender and three key aspects of dental caries: caries distribution patterns, caries classification types, and restoration preferences. Females exhibited higher caries prevalence in posterior teeth, particularly mandibular molars and premolars, and a greater prevalence of Class I caries (pit and fissure lesions). This can be attributed to several biological and behavioral factors. Females typically experience earlier eruption of permanent teeth, especially molars, which leads to a longer exposure of these teeth to the cariogenic oral environment, increasing their risk for decay[15]. Additionally, these hormonal changes in females lead to a more cariogenic oral environment, especially affecting posterior teeth due to their complex surfaces[30,31,46]

Conversely, males showed higher caries rates in anterior teeth, including maxillary central incisors and mandibular canines, which may be influenced by different oral habits, such as less attention to oral hygiene or higher rates of trauma

affecting anterior teeth. Moreover, males' lifestyle factors like smoking can contribute to oral health issues, but these tend to impact tooth loss more than anterior caries specifically[47].

Regarding root caries exclusively, though not significantly, it was observed in males. despite its low incidence (0.2%) and lack of statistical significance, it may be linked to the high tobacco use among Libyan males, which has been documented, contributing to compromised oral health and elevated caries risk [48]. Occupational exposures, particularly among manual laborers who may face harsher working conditions and limited access to dental care, could further exacerbate this risk. No gender differences were found in the choice of restorative materials, indicating that treatment decisions were independent of patient gender. This lack of difference reflects the influence of standardized treatment protocols and limited restorative options typical of academic or institutional settings, promoting gender-neutral clinical decision-making. Such uniformity ensures equitable care but may also limit personalized treatment considerations observed in other practices. Although studies show that patient satisfaction with restorations can vary by gender particularly regarding esthetic factors these preferences do not necessarily influence the material selected by dentists in controlled clinical settings[49].

The difference in caries distribution between genders reflects a complex interplay of biological timing, hormonal influences, and social-behavioral factors affecting oral health differently in males and females.

The observed age stratification in caries susceptibility aligns closely with tooth development and eruption timelines. Later-developing teeth, such as third molars, tend to show caries at older ages, while early-erupting permanent molars are more vulnerable in younger adults. The approximately 20-year age gap between the most and least affected teeth corresponds well with their eruption schedules, and this confirms that these patterns reflect true biological variation rather than random distribution.

This supports the clinical importance of implementing age-specific preventive strategies, such as early application of fissure sealants for young adults at risk of Class I occlusal caries, whereas pit and fissure caries (Class I) predominantly affect younger individuals soon after tooth eruption[50], and targeted root caries prevention for older patients experiencing gingival recession. Furthermore, these findings reveal distinct etiological timelines: occlusal caries develops earliest due to post-eruptive vulnerability of pits and fissures, root caries emerges later as a consequence of periodontal aging, and intermediate caries classes reflect varying exposures to risk factors over time.

Despite these age-related differences in caries patterns, the non-significant association between age and restorative material choice suggests that treatment protocols are uniformly applied across all age groups. This consistency aligns with modern dental education frameworks, such as the European Society of Endodontology (ESE) guidelines, which emphasize evidence-based material selection rather than age-dependent criteria [51]. Similarly, the American Dental Association (ADA) Council on Scientific Affairs notes that material choice should prioritize lesion characteristics and patient-specific factors (e.g., caries risk, occlusion) over chronological age[52]. This indicates consistent standards of care without age-specific limitations in material selection within the studied clinical setting.

This study offers valuable baseline insights into dental caries patterns and treatment among adults at a university clinic in Benghazi, reflecting real-world clinical practices, patient demographics, and restorative trends in a major Libyan urban center. However, limitations such as missing or incomplete records and a single-center, single academic year design may affect accuracy and generalizability. Expanding future research to multi-center, longitudinal studies would strengthen caries assessment and broaden applicability.

5. Conclusion

Within the limitations of this retrospective study, it can be concluded that critical caries patterns and restorative trends show females and young adults having the highest prevalence, particularly mandibular molars and Class I caries dominate the clinical picture, highlighting the need for targeted prevention in high-risk molars. Notably, modern resin-based materials are now the standard restorative approach. reflecting global trends toward esthetic, minimally invasive materials, while standardized protocols ensured demographic-neutral treatment selection. These findings underscore the need for comprehensive strategies integrating both advanced restorative training and targeted caries prevention to reflect current disease patterns and facilitate superior clinical outcomes.

Recommendations

Future research should focus on overcoming these constraints by employing robust and comprehensive data collection and analysis methods., Curriculum enhancement to include advanced restorative procedures such as cusp capping and

direct veneers, Implementation of standardized adhesive protocols accounting for gender-specific anatomical variations in caries patterns, Improved clinical training focusing on evidence-based material selection and longevity-driven restoration design, Integration of these restorative approaches with preventive strategies like sealants for comprehensive caries management.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Statement of ethical approval

Ethical approval for this study was obtained from the Scientific Research Ethics Committee (SREC) of the Faculty of Dentistry at the University of Benghazi [Approval No. 0290]."

Statement of informed consent

This retrospective study used anonymized patient records and did not involve direct contact with participants. Therefore, individual informed consent was not required.

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