Assessment of Caries Status among Schoolchildren According to Decayed-Missing-Filled Teeth/Decayed-Extract-Filled Teeth Index, International Caries Detection and Assessment System, and Caries Assessment Spectrum and Treatment Criteria

Abstract

Background: Detection and evaluation of dental caries is of epidemiological importance. Its early detection is important to commence appropriate treatment planning. Cavitated, noncavitated, and initial lesions of dental caries can be detected by various indices. Objectives: The objective of the study was to assess the caries experience in schoolchildren using decayed-missing-filled teeth (DMFT)/decayed-extracted-filled teeth (deft) International Caries Detection and Assessment System-II (ICDAS-II), and Caries Assessment Spectrum and Treatment (CAST) systems.

Materials and Methods: An epidemiological survey was carried out among 1550 schoolchildren (37,644 teeth) between the age ranges of 4 and 14 years. American Dental Association type III examination was performed using plane mouth mirrors and community periodontal index probes using DMFT/deft, ICDAS II, and CAST indices. Results: Out of 37,644 teeth examined, 2,718 teeth had shown caries. Caries experience with DMFT/deft index was 5.54%. Highest score of DMFT was observed in deciduous dentition period (59.02%). Overall prevalence of dental caries with ICDAS and CAST system was 6.7% and 6.95%, respectively. The highest percentage of noncavitated lesions (ICDAS - 2.26% and CAST - 3.9%) and greater prevalence of caries among deciduous teeth (ICDAS - 53.2% and CAST - 58.7%) was observed with both ICDAS and CAST systems.

Conclusion: A high prevalence of noncavitated lesions and less number of sealants and restorations indicates the lack of awareness for prevention and treatment of oral diseases, which suggests a strong need for preventive and operative treatments.

Keywords: Caries assessment spectrum and treatment system, dental caries, decayed-missing-filled teeth/decayed-extract-filled teeth, epidemiology, International Caries Detection and Assessment System-II, prevalence

Introduction

Dental caries is one of the major oral health problems of human community. Clinically, it manifests from a faint white spot lesion to the frank cavitation.[1] There are manifold dental indices which are used for measuring dental caries such as decayed-missing-filled teeth/decayed-extract-filled teeth (DMFT/deft) index,[2] Caries severity index,[3] Nyvad's criteria,[4] International Caries Detection and Assessment System-I (ICDAS-I),[5,6] ICDAS-II,[7] and recently the Caries Assessment Spectrum and Treatment (CAST) system.[8]

The standard DMFT/deft indices have been used most frequently in epidemiological studies. It considers dental caries to be an unmistakable cavitated lesion into dentin.[9] With augmenting knowledge in preventive aspects, it has been observed in recent epidemiological studies that there is an immense decrease in dental caries. Although there is a downward trend in prevalence, the initial lesion may go anonymous, which further may create a greater health concern in later stages. Hence, a more rigorous diagnostic criteria need to be considered for identifying and measuring both cavitated and noncavitated lesions of dental caries.[10] Early detection, assessment, and correct diagnosis of these lesions are fundamental targets to move away from curative to preventive dentistry.[11]

An innovative index, ICDAS-II, involves visual examination of the teeth in a clean
and dry environment that increases the chance of detecting incipient carious lesions. In this system, coronal carious lesions, root carious lesions, and lesions accompanied by restorations and sealants have disparate codes.

An ingenious index called “CAST” was introduced by Frencken et al. in 2011. It is a comprehensive, reliable, pragmatic, cohesive system. It is the commixture of ICDAS, Pulpal involvement, Ulceration, Fistula, Abscess, and the DMF indices.[8]

The objective of this study was to assess the caries status in schoolchildren of Nalgonda population using DMFT/deft, ICDAS II, and CAST diagnostic criteria.

Materials and Methods

Study population

After accomplishing approval by the Institutional Ethical and Research committee with the ethical number “KIDS/IEC/PEDO/13-01,” the objective and nature of the study were elucidated to the principals of the schools, and a written informed consent was obtained from the respective personnel.

The study involved 1550 private schoolchildren (837 males and 713 females) of Nalgonda district between the age ranges of 4 and 14 years. Children with permanent (243 children), mixed (705 children), and deciduous (92 children) dentition were included in the study. Children with developmental dental anomalies, undergoing orthodontic treatment, and any other systemic illnesses were excluded from the study.

Training of the examiner

Single principal investigator was first trained to analyze the caries status of children attending the outpatient department (OPD) of Pedodontics and Preventive Dentistry, showing various clinical situations such as healthy teeth, white spot lesions, fractures, and cavitation with extensive destruction.

Decayed-missing-filled teeth/deft criteria

Caries status was recorded in permanent dentition as DMFT, in primary dentition as deft, and in mixed dentition, both DMFT and deft were combined.

D/d– decayed teeth
M/e– missing/extracted teeth because of caries
F/f– filled due to caries.

International Caries Detection and Assessment System II diagnostic criteria

ICDAS II is a two-digit coding system. The first line of digits refers to the presence of sealants or restorations (codes range from 0 to 9) and the second line of digits refers to the disparate stages of carious lesion progression (codes range from 0 to 6).[12]

First digit scoring

0- Unrestored or unsealed
1- Sealant, partial
2- Sealant, full
3- Tooth-colored restoration
4- Amalgam restoration
5- Stainless steel crown
6- Porcelain or gold or porcelain fused to metal crown or veneer
7- Lost or broken restoration
8- Temporary restoration
9- Tooth does not exist or other special cases
96- Tooth surface cannot be examined because of access problem to visualize the tooth surface
97- Tooth missing because of caries (all tooth surfaces are coded 97)
98- Tooth missing for reasons other than caries (all tooth surfaces are coded 98)
99- Unerupted (all tooth surfaces care coded 99).

Second digit scoring

0- Sound tooth surface: No evidence of caries after 5 s air drying
1- First visual change in enamel: Opacity or discoloration (white or brown) is visible at the entrance to the pit or fissure seen after prolonged air drying
2- Distinct visual change in enamel visible when wet, lesion must be visible when dry
3- Localized enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying
4- Underlying dark shadow from dentine
5- Distinct cavity with visible dentine
6- Extensive (more than half the surface) distinct cavity with visible dentin.

Caries Assessment Spectrum and Treatment diagnostic criteria

This system consists of 0–9 scores from the sound tooth structure to the tooth lost due to caries.[11]

0- Sound
1- Sealed
2- Restored
3- Distinct visual change in enamel
4- Internal caries-related discoloration in dentin
5- Distinct cavitation into dentin
6- Involvement of pulp chamber
7- Abscess/fistula
8- The tooth has been removed because of dental caries
9- Does not match with any of the other categories
A- The tooth has not been erupted.

Examination

A structured pro forma was prepared to record the data. American Dental Association type III examination
was performed using a clean dental mouth mirror, a community periodontal index probe, and artificial light conditions. Each examination was initiated from the right maxillary molar moving anteriorly, passing through left maxillary, left mandibular, and finally right mandibular teeth. The time spent for examination of each child was approximately 3 to 5 min.

The primary obligation for applying the ICDAS system is the examination of clean and dry teeth. Children teeth were cleaned and dried with cotton rolls and chip blower. No radiographs were taken. Drying of the tooth surface for about 5 s is the key for disclosure of noncavitated lesions because water usually clogs the pores in the carious teeth and the similar refractive index of tooth and water obscures the detection of early white spot lesions.\(^\text{[12]}\)

As recommended for CAST, the tooth surface was not air-dried, but, when necessary, excess saliva was removed with the help of cotton rolls or gauze pieces, and the caries status was recorded.

### Statistical analysis

The data were entered in Microsoft office excel sheet and analyzed with the help of SPSS 19.0 version software. (Long produced by SPSS Inc., it was acquired by IBM in 2009) Chi-square test was used to find the significance in age and gender between two indices (ICDAS and CAST). Percentages were calculated to record the prevalence of carious lesions.

### Results

The sample group constituted 1550 schoolchildren, among which 1040 children were affected. Males were affected more than females with no significant difference \((P > 0.05)\) [Table 1]. Of 37,644 teeth examined, 2718 teeth had caries. The age range of the participants was from 4 to 14 years. Most affected age group was 10 years and least affected age group was 4 years.

Table 2 summarizes that the caries experience with DMFT/deft was found to be 5.54%. Highest DMFT/deft score was observed in primary (59.02%), followed by permanent (15.28%) and mixed dentition period (6.75%).

According to DMFT/deft index, permanent mandibular 1\(^{st}\) molars were highly affected during permanent and mixed dentition and primary mandibular 2\(^{nd}\) molars were affected during deciduous dentition.

Overall prevalence of caries with ICDAS system was 6.7%. Table 3 summarizes that none of the participants had code 1. Majority of the teeth examined (92.7%) were scored as code 0 (sound teeth), followed by code 3 (2.26%) and code 40 had the least score (0.01%).

According to ICDAS, primary mandibular 2\(^{nd}\) molars were more affected during deciduous dentition period. Mandibular 1\(^{st}\) molars were highly affected in permanent dentition period. In mixed dentition period, primary mandibular 2\(^{nd}\) molars followed by permanent mandibular 1\(^{st}\) molars were majorly affected.

Table 4 summarizes that, in permanent dentition, all the codes (i.e., code 2–6; code 97, 30, and 40) were recorded more in mandibular 1\(^{st}\) permanent molars. In mixed dentition, codes 2, 3, 4, 5, and 6 were predominately found in mandibular 1\(^{st}\) permanent molars and primary mandibular 2\(^{nd}\) molars, respectively. Majority of the codes were found in primary mandibular 2\(^{nd}\) molars in deciduous dentition.

Overall prevalence of caries with CAST index was 6.95%. Table 5 summarizes that none of the participants had code 1. Greater number of teeth examined (92.7%) were scored as code 0 (sound teeth), followed by code 3 (3.9%) and code 8 had the least score (0.005%).

According to CAST, primary mandibular 2\(^{nd}\) molars were highly affected during deciduous dentition period. Permanent mandibular 1\(^{st}\) molars were more affected in permanent and mixed dentition periods.

| Table 1: Gender distribution of dental caries |
|---------------------------------------------|
| ![Table Image](image1.png) |

| Table 2: Dental caries experience according to decayed, missing, and filled teeth/decayed, extracted, or filled teeth criteria |
|---------------------------------------------------------------------------------------------------------------|
| ![Table Image](image2.png) |

| Table 3: Prevalence of dental caries according to International Caries Detection and Assessment System |
|-----------------------------------------------------------------------------------------------------|
| ![Table Image](image3.png) |

\(\chi^2=1.63; P>0.05\)
Discussion

Early detection of incipient caries is one of the important steps in modern dentistry to create awareness among the community. In epidemiological studies, DMFT is the most commonly used index for the caries assessment which does not cover the total spectrum of carious lesion progression.\(^{[13]}\) Advantages of this system include simplicity, ease to use in clinical practice, easy to master the criteria, and the possibility for comparing results collected from many populations worldwide over long periods.\(^{[14]}\) This index has limitations such as it does not record the initial white spot lesions,\(^{[15]}\) absence of codes for recording enamel lesions, difficulty for differentiating caries lesions in dentin that can be treated restoratively from those that require more complicated treatment,\(^{[14]}\) it does not give any information about the caries state, stage, depth of penetration, restoration types, and their conditions. It only provides a number that shows the teeth or surfaces which are decayed, missed, or restored. Furthermore, the need for health care and/or treatment of the carious teeth and regular evaluation of the teeth remains unknown.\(^{[6,16]}\)

The modern concepts of caries indices are based on the idea of incorporation of all caries stages into one tool.\(^{[17]}\) Recently introduced indices for the evaluation of caries status are ICDAS and CAST systems. Advantages of ICDAS system include accuracy, reproducibility, easy to understand the severity and activity state of the lesion, condition of the tooth, and the stages of caries progression are easily detectable by the investigators and clinicians.\(^{[18]}\) but the short comings include drying of the tooth surfaces and double checking of teeth which is a time-consuming procedure to implement in epidemiological studies.\(^{[17]}\) The CAST differs from other caries indices that the codes are in hierarchical order of severity of caries process that totally covers the diverse spectrum of the disease.\(^{[14]}\)

The principle objective of this study was to evaluate the dental caries experience using DMFT, ICDAS, and CAST indices in 4–14-year-old children.

In the present study, mean DMFT/deft found to be 5.54%. The highest DMFT/deft score was observed in primary (59.02%), followed by permanent (15.28%) and mixed dentition period (6.75%). Mandibular permanent 1\(^{\text{st}}\) molars were more affected in permanent dentition, mandibular primary 2\(^{\text{nd}}\) molars were highly affected during deciduous dentition, and in mixed dentition, mandibular primary 2\(^{\text{nd}}\) molars followed by mandibular permanent 1\(^{\text{st}}\) molars were affected.

As the codes in ICDAS system are numerous and there is a need to assess the early stages of caries, reproducibility and validity problems may occur. A careful reading, appropriate attention combined with images of characteristic lesions during training period, makes it an effective, efficient, and user-friendly system.\(^{[19,20]}\) In the current study, examiner was

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**Table 4: Percentage distribution of International Caries Detection and Assessment System codes in evaluated permanent, mixed, and deciduous dentitions**

| Teeth  | 0   | 1   | 2   | 3   | 4   | 5   | 6   | 97  | 30  | 40  |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Permanent dentition** |     |     |     |     |     |     |     |     |     |     |
| 16/26  | 68.07 | 0   | 14.95 | 8.19 | 3.48 | 3.48 | 0.61 | 0   | 1.22 | 0   |
| 36/46  | 49.33 | 0   | 16.3  | 17.4 | 6.96 | 6.55 | 1.22 | 0.61 | 1.63 | 0   |
| 17/27  | 94.5  | 0   | 1.22  | 2.86 | 0.81 | 0.61 | 0   | 0   | 0   | 0   |
| 37/47  | 72.78 | 0   | 8.4   | 12.7 | 2.45 | 2.25 | 0.2  | 0   | 0.61 | 0.61|
| Incisors | 99.6 | 0   | 0     | 0    | 0   | 0   | 0   | 0.4 | 0   | 0   |

| **Mixed dentition** |     |     |     |     |     |     |     |     |     |     |
| 54/64  | 80.82 | 0   | 3.47  | 4.53 | 1.91 | 5.39 | 1.2  | 2.19 | 0.49 | 0   |
| 55/65  | 78.9  | 0   | 3.33  | 4.25 | 2.19 | 7.87 | 1.34 | 1.34 | 0.78 | 0   |
| 74/84  | 84.86 | 0   | 2.26  | 3.9  | 2.48 | 3.9  | 0.7  | 1.27 | 0.63 | 0   |
| 75/85  | 71.82 | 0   | 4.25  | 6.8  | 3.04 | 9.29 | 2.83 | 1.27 | 0.7  | 0   |
| 16/26  | 82.65 | 0   | 7.09  | 6.24 | 1.98 | 1.27 | 0.28 | 0.07 | 0.42 | 0   |
| 36/46  | 73.67 | 0   | 8.86  | 10.2 | 3.04 | 2.9  | 0.7  | 0.28 | 0.35 | 0   |
| 17/27  | 99.86 | 0   | 0.14  | 0    | 0   | 0   | 0   | 0   | 0   | 0   |
| 37/49  | 99.51 | 0   | 0.14  | 0.28 | 0   | 0   | 0   | 0   | 0.07 | 0   |
| Incisors | 93.07 | 0   | 0.14  | 0.42 | 0   | 0.07 | 0.14 | 0.14 | 0.14 | 0   |

| **Deciduous dentition** |     |     |     |     |     |     |     |     |     |     |
| 54/64  | 78.91 | 0   | 4.44  | 10   | 1.11 | 3.88 | 1.11 | 1.66 | 0   | 0   |
| 55/65  | 75.57 | 0   | 4.44  | 8.33 | 5   | 6.66 | 0   | 0   | 0   | 0   |
| 74/84  | 72.81 | 0   | 4.44  | 5.55 | 4.44 | 8.33 | 3.88 | 0.55 | 0   | 0   |
| 75/85  | 52.25 | 0   | 6.11  | 12.22 | 4.44 | 14.44 | 5.55 | 2.22 | 2.77 | 0   |
| Incisors | 93.9  | 0   | 1.66  | 2.22 | 1.11 | 1.11 | 0   | 0   | 0   | 0   |

**Table 5: Prevalence of dental caries according to Caries Assessment Spectrum and Treatment**

| CAST score | Percentage of teeth affected |
|------------|-----------------------------|
| 0          | 92.78                       |
| 1          | 0                           |
| 2          | 0.25                        |
| 3          | 3.9                         |
| 4          | 0.82                        |
| 5          | 1.62                        |
| 6          | 0.6                         |
| 7          | 0.01                        |
| 8          | 0.005                       |
| 9          | 0                           |
| A          | 0                           |

CAST=Caries Assessment Spectrum and Treatment

Table 6 summarizes that, in permanent dentition, all the codes (i.e., code 2–8) were more recorded in mandibular 1\(^{\text{st}}\) permanent molars. In mixed dentition, codes 2, 3, and 4 were high for mandibular 1\(^{\text{st}}\) permanent molars and code 5 was more for primary maxillary 2\(^{\text{nd}}\) molars. In deciduous dentition, codes 2 and 3 were observed predominately in primary mandibular 2\(^{\text{nd}}\) molars.

A greater number of teeth involved were lower second primary molars and least affected were incisors. A superior number of enamel lesions were detected with ICDAS system, whereas dentin and pulp lesions were highly detected with CAST system.
Table 6: Percentage distribution of Caries Assessment Spectrum and Treatment codes in evaluated permanent, mixed, and deciduous dentitions

| Teeth | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------|---|---|---|---|---|---|---|---|---|
| Permanent dentition |
| 16/26 | 71.6 | 0 | 1.22 | 19.26 | 3.68 | 3.48 | 0.81 | 0 | 0 |
| 36/46 | 46.52 | 0 | 2.04 | 37.5 | 5.53 | 6.76 | 1.43 | 0.2 | 0.2 |
| 17/27 | 95.11 | 0 | 3.68 | 0.81 | 0.4 | 0 | 0 | 0 | 0 |
| 37/47 | 76.49 | 0 | 0.2 | 18.4 | 2.66 | 2.25 | 0 | 0 | 0 |
| Incisors | 99.6 | 0 | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 |
| Mixed dentition |
| 54/64 | 80.54 | 0 | 0.49 | 8.01 | 1.84 | 5.6 | 3.54 | 0 | 0 |
| 55/65 | 78.74 | 0 | 0.85 | 7.23 | 2.34 | 8.15 | 2.69 | 0 | 0 |
| 74/84 | 84.13 | 0 | 0.85 | 6.59 | 2.62 | 3.9 | 1.84 | 0.07 | 0 |
| 75/85 | 87.9 | 0 | 0.71 | 6.02 | 2.19 | 2.12 | 1.06 | 0 | 0 |
| 16/26 | 92.94 | 0 | 4.1 | 1.34 | 1.27 | 0.35 | 0 | 0 | 0 |
| 36/46 | 71.37 | 0 | 1.13 | 20.07 | 3.47 | 3.33 | 0.63 | 0 | 0 |
| 17/27 | 99.86 | 0 | 0.07 | 0.07 | 0 | 0 | 0 | 0 | 0 |
| 37/47 | 99.37 | 0 | 0.14 | 0.49 | 0 | 0 | 0 | 0 | 0 |
| Incisors | 99.92 | 0 | 0 | 0.7 | 0 | 0.07 | 0.21 | 0 | 0 |
| Deciduous dentition |
| 54/64 | 77.89 | 0 | 0.55 | 13.8 | 1.11 | 3.88 | 2.77 | 0 | 0 |
| 55/65 | 76.75 | 0 | 0 | 12.7 | 5 | 5.55 | 0 | 0 | 0 |
| 74/84 | 76.7 | 0 | 0 | 8.88 | 3.88 | 8.33 | 1.66 | 0 | 0.55 |
| 75/85 | 69.49 | 0 | 2.8 | 15.5 | 4.44 | 5.55 | 2.22 | 0 | 0 |
| Incisors | 94.45 | 0 | 0 | 4.4 | 0 | 1.11 | 0 | 0 | 0 |

Trained thoroughly by assessing the caries status in patients from OPD and checked for the reliability and validity by recording the same after 2 weeks. As reported in ICDAS II manual, the use of compressed air is essential for detecting caries codes 1 and 3, whereas caries codes 2, 4, 5, and 6 can be assessed if the tooth is viewed while wet. Thus, in this study, chip blower was used to dry the tooth structure similar to the study conducted by Shankar et al.[10] ICDAS system has codes for coronal caries detection ranging from 1 to 6, in which 1, 2, and 3 denote enamel caries, 4 and 5 dentinal caries, and 6 extensive cavities. Therefore, these codes correspond to the absolute carious status, whereas the rest signify the restorative and lost/missing status. The overall prevalence of dental caries with ICDAS system was 6.7%. Highest percentage (2.26%) of the children had code 3 representing more noncavitated lesions in enamel. This could be due to occasional visits to the dentist and low utilization of preventive measures. In this study, around 92% of examined teeth were recorded as sound, whereas the rest represented various stages of dental caries.

In CAST system, the codes are ranged from 0 to 9, of which 3 represents enamel caries, 4 and 5 dentinal caries, and 6 and 7 pulp involvement. These codes were considered as diseased and included in the calculation of the prevalence of dental caries. A restored tooth (code 1 and 2) and an extracted tooth (code 8) were not included because the first one has been treated and the second one is not considered diseased anymore.[14] Enamel caries lesions in the CAST system were represented by only one category, in contrast to the one used in the ICDAS system, which uses three different stages.[17] In the present study, the prevalence of dental caries with CAST diagnostic criteria was 6.95%. It was well appreciated that the prevalence of sealants and restorations was 0% and 0.25%, respectively. This strongly suggests the lack of awareness for prevention of oral diseases. CAST system reported high percentage (3.9%) of noncavitated lesions (code 3) which indicated that there is an elevated possibility of progression toward cavity unless timely attention and monitoring is provided.

Reporting the caries status according to CAST and ICDAS systems allows the presentation of a premorbidity stage and also distinguishes dentin caries lesions that can be restored from those that are beyond treatment with a restoration alone, which are not included in the DMFT/deft criterion, which is a disadvantage.[14] However, both ICDAS and CAST systems are time-consuming procedures with an average of 3 min for each, when compared to the DMFT/deft system. The present study reported a low proportion of children (0.61%) having teeth affected with a caries lesion reaching the pulp and also showed high prevalence of caries in deciduous teeth (ICDAS - 53.2% and CAST - 58.7%), which could be due to inclusion of very early sign of dental caries in enamel (code 1).

The current study showed that the percentage of teeth with caries lesions was more for second primary (ICDAS - 79.18% and CAST - 85.59%) followed by first permanent molars (ICDAS - 77% and CAST - 82.29%). The cavitated lesions were more prevalent in primary (ICDAS - 20.6% and CAST-21.3%) than in permanent molars which were consistent with the other studies.[17,22] This could be because primary teeth are more prone to a faster lesion progression from enamel to dentin and then to the development of pulpitis due to a lower thickness and a relatively larger pulp chamber in comparison to permanent teeth.[23] Caries in primary molars is a well-known predictive factor for the development of cavities in the permanent dentition, particularly in the 1st molar.[24,25] A low number of sound primary molars at the age of 7 and 8 years constituted the best and most consistent predictor of a high caries increment in the permanent dentition.[26] As the presence of three or more carious deciduous molars at the age of five was the best predictor of caries experience in the first permanent molars at the age of 7 years,[24] a prospective study is desired in this study population to determine whether caries in deciduous molars is a predictive factor for the development of caries in the permanent molars.

Conclusion
Experience of dental caries with DMFT/deft, ICDAS, and CAST systems was 5.54%, 6.7%, and 6.95%, respectively. Both ICDAS and CAST systems quantified the whole
spectrum of dental caries precisely. A high prevalence for noncavitated lesions suggested a strong need for preventive treatments. Sealants and restorations were seldom found, indicating the lack of awareness for prevention of oral diseases. A high percentage of caries lesions were found in mandibular second primary molars followed by mandibular first permanent molars.

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Conflicts of interest
There are no conflicts of interest.

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