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ORIGINAL RESEARCH

Caries Assessment Spectrum and Treatment: Would It direct Future Epidemiological Surveys?

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ABSTRACT

Aim: To evaluate caries spectrum among 12- and 15-year-old Indian children using the Caries Assessment Spectrum and Treatment (CAST) index.

Materials and methods: An epidemiological survey of the schoolchildren was carried out in a district in India. A stratified cluster random sampling method was used to select the sample. The caries prevalence of the surveyed population was obtained by using this CAST tool. Chi-square test was used to verify the association between dental fluorosis, socioeconomic status, and age and caries experience. Mann–Whitney U-test was used to compare the caries experience between the two age groups.

Results: A total of 2,610 children were examined. The majority of the schoolchildren (12 years: 74.2%, 15 years: 75.5%) were healthy concerning their caries experience and the prevalence of the other codes was minimal. The prevalence of dentin carious lesions and the percent of restorable teeth was greater among the 15-year-olds. The mean decayed, missing, and filled teeth (DMFT) of 12- and 15-year-old subjects was calculated to be 0.22 and 0.29 respectively.

Conclusion: The currently surveyed population showed a low caries prevalence and the use of the tool highlighted the caries spectrum in an impressive way.

Clinical significance: A well-designed tool to assess the carious spectrum of an individual or a community, thus enabling the responsible stakeholders to plan an appropriate care that is necessary.

Keywords: Caries Assessment Spectrum and Treatment, Caries epidemiology, Dental caries, Disease progression.

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INTRODUCTION

The recent World Health Organization (WHO) report states that dental caries is a major public health problem in the developing world, which affects a majority of the schoolchildren.[1,2] On the contrary, there has been a decline in the incidence of dental caries in the developed countries and this change has been attributed to the widespread use of fluorides.[3,4]

In a developing country like India, which has minimal access to oral healthcare facilities, dental caries has become a menace, particularly among the lower socioeconomic sections of the country.[5] According to the national oral health survey and fluoride mapping, the prevalence of dental caries among 12-and 15-year-old children stood at 53.8 and 63.1% respectively.[6] Dental caries is therefore a major public health problem in developing countries and steps have to be taken to shift the focus back to prevention.[4,7]

A valid reason for the perceived lack of interest shown by the policymakers toward addressing this menace can be attributed to the presentation of this issue. The WHO[8] criterion for assessing dental caries, which has been widely used in the DMF index[9] to document the

dental caries experience of the communities, is grossly uninteresting. This index has quite a few shortcomings, which notably include the nonrepresentation of the restorative/rehabilitative/surgical needs, the stages of the carious lesions, and the complications of untreated dental caries.[10,11]

A few systems have been proposed in the past such as the International Caries Detection and Assessment System (ICDAS)[12,13] and the PUFA index[14] to depict the above-highlighted aspects, but unfortunately, they had their share of problems. The ICDAS was cumbersome to use, grossly overestimated the presence of caries, and had difficulties in reporting the two-digit code of this system.[11,15,16] The PUFA index had its own shortcomings, such as doubts regarding the "u" component and with the fact that, this index had to be used in combination with other caries assessment criteria.[11]

Considering the above limitations, a new pragmatic and reliable instrument for use in epidemiological surveys was developed and named as the CAST, which covers the complete range of carious lesions: from no carious lesions to the advanced stages of dental caries.[11,17]

The CAST instrument has been validated for face and content by a group of 56 epidemiologists from 24 countries, using the e-Delphi consensus method.[18]. The construct validity and reliability have also been obtained.[19,20]

In today's modern era, there is a changing trend in lifestyles and dietary habits. The adolescents are the ones who are most likely to be affected, primarily in developing countries and therefore it is imperative to assess the entire spectrum of carious lesions using a valid instrument such as the CAST, which will help the policymakers in evaluating the current situation and to implement necessary preventive measures. To the knowledge of the authors, there has not been any documented report on the usage of the CAST tool spanning a large geographical area and therefore, the aim of the present study was to assess the carious spectrum of 12- and 15-year-old school-going children of a district in India.

MATERIALS AND METHODS

The Institutional Ethics Committee of Kamineni Institute of Dental Sciences (IEC/87B.15) had cleared this cross-sectional study and was conducted following the guidelines laid down by the World Medical Association and Helsinki Declaration. The duration of the study was for 5 months.

Study Area and Study Population

Nalgonda is one of the prominent districts in the newly formed state of Telangana. This area is divided into five administrative/revenue divisions that consist of 59 mandals. This district is a known endemic fluoride belt affected by the high fluoride content in the ground water.[21]

The study subjects comprised of a sample of 12- and 15-year-old school-going children from the government and private schools within the district.

Sample Size Determination

According to an earlier published report, the prevalence of dental caries among 12- and 15-year-old children in this region was 56.3%.[22] Taking $\alpha = 5\%$, $\beta = 20\%$, and 80% power, a sample size of 1,085 was calculated. Considering the data loss, a sample of 1,250 was taken for the respective age groups.

A stratified two-stage cluster random sampling method was employed in this cross-sectional study. The district was divided into five administrative divisions. From each division, three mandals were selected from the database of the administration. A list of government and private schools was prepared from the selected mandals. A lottery method of simple random sampling was employed to choose the government and private schools from each division. Emphasis was laid to ensure that all the administrative divisions had an equal share of the sample size.

A set of criteria had been devised to select the study subjects and these are as follows:

Inclusion Criteria

- Children aged 12 and 15 years at the time of the examination
- Children who are the residents of this district since their birth

Exclusion Criteria

- Children with systemic diseases
- Children undergoing fixed orthodontic therapy and with severe extrinsic stains, which would make the process of examining tough

A list of 12- and 15-year-old children from these designated schools was obtained and their date of births verified well in advance.

A total of 2,793 students were invited to be a part of the district-wide survey, out of which 2,680 children gave their written consent through their parents, after explaining them regarding the nature of the study. Seventy subjects were excluded as they failed to satisfy the inclusion criteria, bringing down the sample size to 2,610.

The heads of the selected schools and the District Educational Officer were appraised of the epidemiological

survey and their permission was obtained before the study commenced.

Examiner Training and Calibration

Two graduate students (ST and TM) were selected to be a part of the survey. They were initially put through an academic session for 2 hours, wherein they were introduced to the CAST instrument by an oral epidemiologist (BHP) who had participated in a workshop on CAST and had prior experience in carrying out epidemiological surveys (Table 1). The photographs of teeth corresponding to the various codes of the CAST were displayed on a power point. Later, both the examiners were exposed to a set of 15 extracted teeth and were asked to score these teeth according to the criteria. Any discrepancies or doubts, which surfaced, were discussed and sorted out.

In the next stage, the examiners were calibrated for the CAST instrument during which interexaminer agreement was assessed. The examiners were asked to use the assessment tool on 30 schoolchildren, who belonged to the same district, where the epidemiological survey was carried out. The kappa coefficient for the interexaminer agreement was calculated to be 0.81. These values were considered sufficient to start the epidemiological survey.

The examiners were also trained and calibrated to identify subjects with dental fluorosis, using the Dean's fluorosis index, as this is a known endemic fluoride belt.[23]

The examination of the children was carried out within the school premises using portable dental chairs under natural light. The instruments used were the mouth mirror and the community periodontal index probe as recommended by the WHO for epidemiological surveys.[24] The condition of each tooth in the oral cavity was evaluated according to the CAST criteria and noted on a survey form, which was specially developed for this study. Trained assistants were provided to both the examiners during the examination procedure. Disinfection protocol was followed during the study to protect the subjects and the examiners from being cross-infected.

Duplicate examinations were carried out during the course of the survey, which involved about 5% of the subjects being reexamined during those respective days. The kappa coefficient for intraexaminer variability was calculated to be 0.80 and was considered as substantial.

Table 1: Codes and description of the CAST instrument in a hierarchical order[17]

Characteristic	*Code*	*Description*
	0	Sound. No visible evidence of a distinct carious lesion
Sealed	1	Sealed. Pits and fissures have been at least partially sealed with a sealant material
Restored	2	A cavity has been restored with (in) direct restorative material currently without a dentin carious lesion and no fistula/abscess present
Enamel	3	Distinct visual change in enamel. A clear carious related discoloration (white or brown in color) is visible, including localized enamel breakdown without clinical signs of dentin involvement
Dentin	4	Internal caries related discoloration in dentin. The lesion appears as shadows of discolored dentin visible through enamel, which may or may not exhibit a visible localized breakdown
	5	Distinct cavitation into dentine. No expected pulpal involvement is present
Pulp	6	Involvement of pulp chamber. Distinct cavitation reaching the pulp chamber or only root fragments is present
	7	Abscess/fistula. A pus containing swelling or a pus releasing sinus tract related to the tooth with pulpal involvement due to dental caries is present
Lost	8	The tooth has been removed because of dental caries
Others	9	Does not match with any of the other categories

Statistical Tests

The data were entered into Microsoft Excel worksheet and analyzed using IBM Statistical Package for the Social Sciences version 21. Descriptive statistics in the form of frequencies, percentages, mean, standard deviation, median, and quartiles were presented. Chi-square test was used to test the association between dental fluorosis, socioeconomic status, and age and caries experience. Mann–Whitney U-test was used to compare the caries experience between the two age groups; $p < 0.05$ was considered to be statistically significant.

RESULTS

A total of 2,680 schoolchildren out of 2,793 agreed to be a part of this epidemiological survey, which works out to be a 95% response rate among the study subjects. Table 2 depicts the age, gender, and the school-wise distribution of the study subjects.

In Table 3, the prevalence of the CAST codes among 12- and 15-year-old school-going children has been depicted. The data suggest that a majority of the schoolchildren (12 years: 74.2%, 15 years: 75.5%) are healthy

Table 2: Age, gender, and school-wise distribution of the study subjects

	12-year-old	*15-year-old*	*Total*
Males	658 (49.9%)	706 (54.6%)	1,364
Females	660 (50.1%)	586 (45.4%)	1,246
Government	660 (50.1%)	656 (50.8%)	1,316
Private	658 (49.9%)	636 (49.2%)	1,294

Table 3: Prevalence of CAST codes among 12- and 15-year-old study subjects (highest score per mouth used)

	Age		
CAST code	*12 years*	*15 years*	*Total*
0	978 (74.2%)	976 (75.5%)	1,954 (74.9%)
1	0	0	0
2	11 (0.8%)	3 (0.2%)	14 (0.5%)
3	148 (11.2%)	81 (6.3%)	229 (8.8%)
4	51 (3.9%)	45 (3.5%)	96 (3.7%)
5	62 (4.7%)	79 (6.1%)	141 (5.4%)
6	66 (5.0%)	107 (8.3%)	173 (6.6%)
7	0	1 (0.1%)	1
8	2 (0.2%)	0	2 (0.1%)
9	0	0	0
Total	1,318	1,292	2,610

concerning the caries experience and the prevalence of the other CAST codes is minimal.

The versatility of the CAST tool can be appreciated here (Tables 4 and 5), wherein the prevalence of the dentinal caries lesions (codes 4–7), enamel cum dentinal caries lesions (codes 3–7), the percentage of the teeth which can be restored (codes 4–5), and the percentage of edentulism affecting the study population can be extracted from the data using this novel instrument. The prevalence of dentin carious lesions and the percent of restorable teeth are greater among the 15-year-olds and are statistically significant. The mean number of dentin carious lesions (codes 4–7) was 0.20 for 12-year-olds and 0.28 for 15-year-olds. The mean enamel carious lesions (codes 3–7) were calculated to be 0.42 for both the age groups. Only 10.1 and 13.2% of the respective age groups required a restorative therapy (codes 4–5).

Table 5 depicts that 4.6% of 12-year-old children had at least one tooth with a carious lesion involving the dentin and 5.8% of the 15-year-old children had at least one tooth with a carious lesion involving the dentin.

Prevalence of Dental Fluorosis

The study subjects belonged to Nalgonda district, which is a known endemic fluoride belt in the state of Andhra Pradesh. Table 6 depicts the distribution of the subjects according to Dean's fluorosis index. The data depicted here indicate a low prevalence of the severe form of dental fluorosis among the schoolchildren (3.9% for 12-year-olds, 3.3% for 15-year-olds).

Relationship between Caries Experience and Dental Fluorosis among the Study Subjects

The caries experience of the subjects with moderate-to-severe dental fluorosis (Table 7) was lower in comparison to the subjects not affected with dental fluorosis and this association was statistically significant ($p < 0.05$). Similar results were seen, with the caries experience being lower

Table 4: Prevalence of dental caries, percentage of teeth which can be restored, and the proportion of teeth lost among the study subjects

		Age			*Chi-square test*	
		12 years	*15 years*	*Total*	*Chi-square value*	*p-value*
Codes 4–7	Absent	1,138 (86.3%)	1,060 (82.0%)	2,198 (84.2%)	9.07	0.003
	Present	180 (13.7%)	232 (18.0%)	412 (15.8%)		
Codes 3–7	Absent	990 (75.1%)	979 (75.8%)	1,969 (75.4%)	0.15	0.69 (NS)
	Present	328 (24.9%)	313 (24.2%)	641(24.6%)		
Codes 4–5	Absent	1,185 (89.9%)	1,122 (86.8%)	2,307 (88.4%)	5.98	0.01
	Present	133 (10.1%)	170 (13.2%)	303 (11.6%)		
Code 8	Absent	1,316 (99.8%)	1,292 (100.0%)	2,608 (99.9%)	–	0.50 (NS)
	Present	2 (0.2%)	0	2 (0.1%)		

Fisher's exact test

Table 5: Frequency distribution of the study subjects having teeth scored by the CAST codes

	12 years		*15 years*	
CAST code	*≥1*	*≥3*	*≥1*	*≥3*
0	0	0	0	0
1	1 (0.1%)	0	0	0
2	19 (1.5%)	2 (0.2%)	7 (0.6%)	1 (0.1%)
3	197 (14.9%)	22 (1.7%)	133 (10.3%)	10 (0.8%)
4	59 (4.6%)	4 (0.4%)	75 (5.8%)	3 (0.3%)
5	80 (6.1%)	4 (0.3%)	108 (8.4%)	3 (0.2%)
6	66 (5.0%)	4 (0.2%)	107 (8.3%)	8 (0.7%)
7	0	0	1 (0.1%)	0
8	2 (0.2%)	0	0	0
9	0	0	0	0

Table 6: Distribution of the study subjects according to Dean's fluorosis index

	Age		
Dean's fluorosis index	*12 years*	*15 years*	*Total*
Mild fluorosis	309 (23.4%)	302 (23.4%)	611 (23.4%)
Moderate fluorosis	284 (21.5%)	261 (20.2%)	545 (20.9%)
Normal	161 (12.2%)	174 (13.5%)	335 (12.8%)
Questionable	280 (21.2%)	308 (23.8%)	588 (22.5%)
Severe fluorosis	52 (3.9%)	42 (3.3%)	94 (3.6%)
Very mild fluorosis	232 (17.6%)	205 (15.9%)	437 (16.7%)
Total	1,318	1,292	2,610

Table 7: Caries experience according to the CAST codes and its association with dental fluorosis among the study subjects

		Fluorosis				
	Caries	Normal	Questionable or very mild	Mild	Moderate or severe	Total
12 years	Absent	108 (67.1%)	398 (77.7%)	232 (75.1%)	240 (71.4%)	978 (74.2%)
	Present	53 (32.9%)	114 (22.3%)	77 (24.9%)	96 (28.6%)	340 (25.8%)
		Chi-square value (df) = 9.08(3), p = 0.02*				
15 years	Absent	112 (64.4%)	395 (77.0%)	237 (78.5%)	232 (76.6%)	976 (75.5%)
	Present	62 (35.6%)	118 (23.0%)	65 (21.5%)	71 (23.4%)	316 (24.5%)
		Chi-square value(df) = 13.93(3), p < 0.005*				

*p < 0.05 statistically significant

Table 8: School-wise distribution of the caries experience among the study subjects

	Caries experience	School		
		Government	Private	Total
12 years	Absent	460 (69.7%)	518 (78.7%)	978 (74.2%)
	Present	200 (30.3%)	140 (21.3%)	340 (25.8%)
		Chi-square value (df) = 14.02(1), p < 0.001		
15 years	Absent	476 (72.6%)	500 (78.6%)	976 (75.5%)
	Present	180 (27.4%)	136 (21.4%)	316 (24.5%)
		Chi-square value (df) = 6.40 (1), p < 0.05		

Table 9: Representation of the CAST data through the DMFT index

Lifetime caries experience	Age	n	Mean	U statistic	p-value
Code (4 – 6) + 2 + 8	12 years	1,318	0.22 (0.61)	822,500.50	0.02*
	15 years	1,292	0.29 (0.73)		

Mann–Whitney U-test; *p < 0.05 statistically significant

in the children enrolled in private schools in comparison with the government-enrolled schoolchildren (Table 8, p < 0.05).

Representation of the CAST Score via the DMFT

The results of the CAST instrument can also be converted into the DMFT data. The mean DMFT of 12- and 15-year-old subjects was calculated to be 0.22 and 0.29, respectively, as seen in Table 9.

DISCUSSION

The CAST tool is a novel instrument, designed to quantify the caries experience of an individual or community in a way, which is radically different from the age-old DMFT/DMF surfaces (DMFS) index. This study is the first of its kind wherein the CAST tool has been used in a large-scale epidemiological survey to assess the magnitude of the disease load among 12- and 15-year-old subjects in India.

The entire spectrum of the carious lesions is represented in this study, thereby providing a clear picture of the disease load seen in the survey subjects. It is a refreshing change in comparison to an earlier way of presenting results via the DMFT/DMFS score, which was only a numerical number. Presently, there is no standard method of reporting the results of the CAST tool and, therefore, the authors have stuck to the highest score per mouth as propagated initially by Frencken et al[17] and have incorporated other combinations to make the picture clearer.

However, there have been two studies,[22,25] which have been carried earlier in this geographical area concerning caries experience by using the DMFT index among 12- and 15-year-old population. The flexibility of the CAST instrument is reflected in Table 9 as the data obtained from this tool can also be represented in the standard reporting format, which is the DMFT/DMFS index, thereby enabling the results of this present study to be compared with the earlier ones.

The DMFT for 12- and 15-year-old study subjects in the present study stood at 0.22 and 0.29, respectively, which indicates that the caries experience for the 15-year-old subjects is higher than 12-year-olds, and this difference was statistically significant (p < 0.05). Shekar et al[22] reported a DMFT score of 0.85 for 12-year-olds and 0.82 for 15-year-olds with an overall caries prevalence of 56.3%. Sukhabogi et al[25] presented a mean DMFT score of 0.71 with an overall caries prevalence of 43.4% for 12- and 15-year-old subjects. Both the studies mentioned have been carried in the same geographical area and the direct inference is that the caries experience of these age groups has reduced over a period and mimics the declining trend in caries experience of the communities worldwide.[2]

The decline in the caries experience has to be carefully analyzed because the subjects had an equal representation from both the government and private schools in the region. The earlier conducted studies in this area had taken a sample only from the government schools and it is a known fact that the economic status does play a role in the lifetime caries experience of an individual.[26,27] The results of the present study also suggest that the caries experience of the children enrolled in government schools across both the age groups has been higher than their counterparts in the private schools (Table 8, p < 0.001: 12 years, p < 0.05: 15 years).

However, the decline in the caries prevalence could also be attributed to the gradual increase in and regular home usage of fluoride in toothpaste.[28]

The CAST instrument has been used by research groups such as de Souza et al[29] and Baginska et al[30-32] across communities in Latin America and the Europe. The focus of these studies was to compare the similarities and differences between the CAST instrument and DMF index and is structurally different from the objectives of the present study. A noteworthy mention is that of the work carried out by Baginska et al[32] from 6- to 7-year-old Polish children, who assessed the caries prevalence by using the CAST instrument and found a high percentage of the disease load in the surveyed population.

An impressive aspect of this tool is that it also records the presence or absence of sealants and such information reflects a wealth of data on the preventive services available. The currently surveyed population has not been exposed to this preventive care at all, although the current study sample may not be placed under the high caries risk category. Sealants provide the best opportunity for the dental professional to prevent pit and fissure caries within the high caries risk communities and despite the proven benefits, this standard of care is being offered to a minuscule percentage of the population.[33]

In the present study, the prevalence of dental fluorosis was found to be 87% and is similar when compared with the earlier studies carried out in this region.[22,25,34] The residents of this endemic fluoride belt have been exposed regularly to fluoridated ground water and, therefore, the prevalence of dental fluorosis is expected to be on the higher side.[2] Of course, assessing the prevalence of dental fluorosis was not the stated objective of the study, but because of the subjects being the residents of a known endemic area, it was considered relevant to quantify the presence of dental fluorosis and its association with the caries experience. No effort has been made to estimate the fluoride levels in the drinking water samples from the administrative divisions of the district and thereby the areas could not be differentiated into low, moderate, or high fluoride areas.

Analyzing the secondary data elicited from this survey is the negative association between dental fluorosis and caries experience (Table 7) between both the age groups, which is in tune with the results obtained from other epidemiological studies.[35-39] These results are in contrast to the epidemiological data from different communities, which indicated a positive relationship between dental fluorosis and the caries experience.[40-42] The reasons stated for this positive association were that the teeth with severe dental fluorosis exhibited localized enamel breakdown, which clinically manifests as pitting, predisposing to plaque, and debris accumulation, thereby increasing the risk of demineralization.

Nevertheless, a possible reason for the negative association between caries experience and dental fluorosis could be the fact that only a meager 3.5% within each age group had been affected with severe dental fluorosis, thus downregulating the association between dental fluorosis and the caries experience. It echoes a similar pattern visualized by Kumar et al[43] who stated that children with mild to moderate dental fluorosis had a lower caries experience by 41 to 54%.

The authors of this study have found the tool to be extremely convenient to be used in an epidemiological setting as it not a prerequisite for the tooth surface to be dried during the examination. The interexaminer agreement (kappa statistic) was calculated to be 0.81 before the start of the survey, which indicates a good deal in the scoring pattern.[44] The intraexaminer agreement assessed by the duplicate examinations was found to be 0.84 and 0.86, respectively, for both the examiners.

To summarize, the study subjects presented with a minimal disease load as elicited by the CAST tool and the authors have found this instrument to be user-friendly in all the parameters and more such epidemiological studies are the need of the hour to ascertain the reliability of this tool with respect to different population subgroups with varying disease load.

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